Journal of Financial Economics 136 (2020) 676–694

Contents lists available at ScienceDirect

Journal of Financial Economics

journal homepage: www.elsevier.com/locate/jfec

Reducing information frictions in venture capital: The role of new venture competitions

Sabrina T. Howell[1]

New York University Stern School of Business and NBER, 44 West 4th St. KMC 9–93, NY 10012, NY, United States

ARTICLE INFO

Article history:
Received 18 January 2019
Revised 24 April 2019
Accepted 12 May 2019
Available online 28 October 2019

JEL classification:
D8
G2
G3
O3

Keywords:
Venture capital
Entrepreneurship
Information asymmetry
New venture competitions

ABSTRACT

Venture capital, an important source of financing for potentially high-growth new businesses, is believed to suffer from information frictions. This paper quantifies the magnitude of these frictions among participants in new venture competitions. In a regression discontinuity design with data from 87 competitions, winning a round increases the chances of external financing by about 35%. Winning is most impactful for ventures that are ranked just above the cutoff but receive no cash prize, and judge ranks strongly predict venture success. The results indicate that these information problems in new venture finance are large, and competitions can help resolve them through certification.

1. Introduction

Venture capital (VC) is a crucial resource for financing and nurturing potentially high growth but risky new ideas (Kaplan and Lerner, 2010; Gornall and Strebulaev, 2015). However, it suffers from information asymmetry between entrepreneurs and investors (Gompers and Lerner, 2001; Ozmel et al., 2013). Declining costs of starting a new venture may have intensified this problem over the past decade.[2] Ewens, Nanda and Rhodes-Kropf (2018) show that lower barriers to entrepreneurial entry have created greater uncertainty about startup quality among early stage VC investors. Yet there is little evidence about the size of information frictions or how consequential they might be in terms of real startup outcomes.

This paper uses data from new venture competitions to shed light on information frictions in new venture finance. In a competition, early stage startup founders present their businesses to a panel of expert judges, whose scores determine which ventures win each round. Private ranking data permit a regression discontinuity design to estimate the effect of winning, independent of the effect of any cash

E-mail address: sabrina.howell@nyu.edu

[1] The Kauffman Foundation generously funded this project. For especially useful comments, I thank first and foremost Ramana Nanda and also Manuel Adelino, Tom Åstebro, Tania Babina, Shai Bernstein, Edward Glaeser, Will Gornall, Boyan Jovanovic, Steve Kaplan, Saul Lach, Augustin Landier, Josh Lerner, Song Ma, Holger Mueller, David Robinson, Rick Townsend, Annette Vissing-Jørgensen, Ayako Yasuda, the anonymous referee, and participants at the NBER Entrepreneurship Working Group, Olin Corporate Finance Conference, Yale Junior Finance Conference, IDC Herzliya Eagle Labs Conference, Queens University Economics of Entrepreneurship and Innovation Conference, UC Berkeley-Stanford Innovation and Finance Conference, Georgia State CEAR Conference, and the Georgia Tech Scheller seminar. Finally, I thank Adam Rentschler of Valid Evaluation and all the others who provided the data, including Lea Lueck, Allison Ernst, and Catherine Cronin. Lucy Gong, Sreyoshi Mukherjee, and Jack Reiss provided excellent research assistance.

[2] This is especially due to the advent of cloud computing. See Miller and Bound (2011), Ewens et al. (2018). Also see "A Cambrian moment" (Economist, Special Report, 2014) and "Cloud computing cuts startup costs" (Palmer, M., Financial Times, February 29, 2012).

https://doi.org/10.1016/j.jfineco.2019.10.009
0304-405X/

prize. Specifically, the data include 87 competitions in 17 US states between 2007 and 2015. The 4,328 participating ventures are linked to employment, financing, and survival outcomes. Founders are linked to education and career histories. There are no local subsistence businesses—such as restaurants or landscapers—that often contaminate efforts to study high-growth entrepreneurship (Levine and Rubinstein, 2016).

Within a competition round, winning increases a venture's chances of raising subsequent external finance by between 9 and 13 percentage points, relative to a mean of 24%, after controlling for any cash prize. The effect is robust to an array of alternative specifications, including one with judge fixed effects. The most conservative estimates from preliminary rounds and among noncash prize winners suggest an 8.5 percentage point effect, or 35% of the mean. This finding, which demonstrates that new venture competitions certify winning startups as higher quality for early stage investors, offers a magnitude for information frictions among participating ventures.

New venture competitions are part of a larger phenomenon of new intermediaries that have emerged in the past two decades to support and finance early stage startups, especially those founded by young, first-time entrepreneurs. These also include accelerators, incubators, and crowdfunding platforms. Accelerators have received some attention in the literature (Hochberg and Fehder, 2015; Gonzalez-Uribe and Leatherbee, 2017; and Yu, 2019). There are also studies of crowdfunding, including Mollick (2014) and Hildebrand et al. (2016). In contrast, new venture competitions have received little academic attention. They are now ubiquitous, organized by universities, governments, corporations, and other institutions around the world seeking to promote high-growth entrepreneurship.

Four findings strongly suggest that certification is the primary mechanism for the effect of winning on financing: (a) winning is impactful among marginal ventures, (b) winning has an effect independent of any effect of cash prizes, (c) winning is more impactful for Internet- or software-based ventures, and (d) judge scores and ranks are informative about outcomes.

First, ventures of marginally investible quality should benefit from a good signal. Consistent with this, the effect is larger (16–17 percentage points) using narrow bandwidths of one or two firms around the cutoff for winning. Further, winning a preliminary round but not a final round is, at most, only slightly less impactful than winning a final round. The quality distribution is wider in preliminary rounds, potentially making a signal more valuable there. These results indicate that winning is impactful among ventures that the judges deem marginal. Corroborating this interpretation, the effects are somewhat smaller—though still very robust—when the dependent variable is an indicator for raising significant VC investment (defined as at least $3 million). Also, while there is a positive effect in preliminary rounds on being acquired or undertaking an initial public offering (IPO), this appears to be driven by relatively low-value acquisitions. It is possible that insufficient time has elapsed for large VC rounds or high-value exits, but it appears that competitions are most useful at relieving information frictions for the earliest stage investments in more marginal ventures. When a venture is high enough quality to quickly raise substantial VC or experience a large exit, it may have less need of certification services.

Second, winning may be useful because cash prizes directly alleviate financial constraints. The data permit separately identifying the effect of the cash prize, as not all winners receive prizes and prize amounts vary within a competition. An additional $10,000 in prize money increases the probability of subsequent financing by about 4%. However, this effect is not robust to all specifications. Further, the economic magnitude of the effect seems small: winning an average prize of $73,000 has a smaller effect than winning only a preliminary round. More importantly, not only is winning a preliminary round, but not a final round, useful, but winning a final round is most useful to those winners that do not receive a cash prize. Top-ranked winners may be less financially constrained because they can send strong signals independent of the competition. These results suggest that the cash prize, which is awarded to the highest-ranked winners, may to some degree crowd out private investment.

The relatively small effect of the cash prize is somewhat inconsistent with related studies in developing countries. For example, McKenzie (2017) finds that a Nigerian business plan competition cash prize has large, positive effects on firm outcomes.[3] In the US setting, prizes appear second order to information effects, possibly reflecting the relative importance of information asymmetry in the US context. In developing countries, startups may have to rely on internally generated funds because VC is absent altogether. They may also have business models that require more initial fixed capital, such as small-scale manufacturing.

Related to this point, signaling may be more important when a venture's initial prototyping stage is not costly. This leads to the third piece of evidence—finding (c)—for certification: Internet- or software-based ventures, rather than hardware ventures, drive the effect of winning. Ewens et al. (2018) show that low startup costs for Internet- or software-based ventures yield more marginal entrants and enable VCs to conduct more initial, high-risk funding experiments. Therefore, generating a better signal by winning a competition should have a larger effect for Internet- or software-based ventures.

Consistent with an important role for information, the final finding (d) is that the judge ranks are strongly predictive of success, which is measured using venture financing, survival, and employment. This is true even in competitions where ventures do not learn their ranks and so cannot be affected by them. The effects of rank are large in magnitude. For example, a one decile improvement in rank is associated with a 1.8 percentage point increase in the chances of financing, which is more than the effect of an additional $10,000 in cash prize. Overall ranks are aggregated from specific criteria ranks. Of these, the team cri-

[3] Also see Klinger and Schündeln (2011) and Fafchamps and Quinn (2017).

terion best predicts initial venture success, consistent with Gompers et al. (2016) and Bernstein et al. (2017). However, technology/product scores are strongly predictive—and are the only predictor—of long-run, high-level success (acquisition/IPO). This speaks to the "horse versus jockey" debate; team may matter most initially, but the business may matter most in the long run (see Kaplan, Sensoy and Strömberg, 2009).

There are two alternative channels to certification. One is that the judges themselves are the subsequent investors in startups. If this were the case, competitions might reduce search costs through a convening function. However, in only 0.2% of judge-venture pairs did the judge or judge's firm invest in the venture. Controlling for this has no effect on the estimates. Second, the effect could reflect type revelation on the part of the entrepreneur. That is, the signal of winning may alleviate information problems for the entrepreneur rather than the investor. In this case, losing should lead to abandonment. However, the effect of winning on venture survival is much smaller than the effect on financing and is less robust.

Winning a competition seems to primarily serve a certification function, signaling quality to the market and reducing search frictions between VCs and entrepreneurs, in the sense of matching models such as Inderst and Müller (2004), Sørensen (2007), and Ewens, Gorbenko, and Korteweg (2018). The results are consistent with VCs using new venture competitions to help identify promising startups, particularly among more marginal startups that may be just barely positive NPV investments and may have the greatest uncertainty.

The findings should be interpreted as applying to the type of startup that participates in a new venture competition. Unfortunately, it is difficult to assess representativeness, as there are no data available on the universe of new ventures at hazard of receiving external financing, especially with the requisite business and founder characteristics (an effort is made in Section 2.3). That said, it seems likely that the startups in this sample are relatively marginal, as the best networked or highest-quality ideas might be expected to receive VC without additional intermediation. Also, as there are no comprehensive data on competitions, it is impossible to establish that the programs studied here, while diverse, are representative of the universe of competitions. With these caveats in mind, the results suggest that information frictions in early stage startup finance are large. This paper builds on the literature on information asymmetry in VC, which includes Hellmann (2006), Lindsey (2008), Tian (2011), Cao (2018), and Hochberg et al. (2018).

This paper also provides the first systematic, causal evaluation of whether and how US new venture competitions are useful to participating startups. Given the substantial resources—both money and time—that organizers and judges contribute to competitions, it is important to understand their effects. Beyond financing, this paper shows that winning affects real outcomes. It increases survival, having at least ten employees, and the chances of an acquisition or IPO. This contributes to the literature evaluating programs and policies to encourage entrepreneurship, which includes Lach (2002), Klapper et al. (2006), Howell (2017), Hombert et al. (2016), and Barrows (2018), beyond the work cited above.[4]

The following section discusses the data, sample representativeness, and summary statistics. Section 3 presents the estimation strategy. Section 4 analyzes the effect of winning, and Section 5 assesses the cash prize and certification as possible channels. Section 6 concludes.

2. New venture competition data

This section introduces the new venture competition data (Section 2.1) and presents summary statistics (Section 2.2). Startups and founders in the data are compared to the US startup ecosystem in Section 2.3.

2.1. The competitions

New venture competitions, in which founders present (or "pitch") their technologies and business models to a panel of judges, have proliferated in the past decade. Sponsored by universities, foundations, governments, and corporations, among other institutions, competitions usually aim to serve convening, certification, education, and financing functions. They appear to now be an important part of the startup ecosystem, particularly for first-time founders. For example, among the 16,000 ventures that the data platform CB Insights reports received their first seed or Series A financing between 2009 and 2016, 14.5% won a competition. There are no data on the number of competitions in the world, but casual observation suggests that nearly every nonprofit university sponsors at least one, and most US state governments and many national governments provide public funds to support competitions.[5]

This paper uses data from 87 competitions between 2007 and 2016. The individual competitions are listed in Internet Appendix Table A.1. Data from these competitions permit observing startups and their founders at an earlier stage, with greater granularity, and in a larger sample than prior studies. Further, unlike many data sources commonly used to study entrepreneurship, such as the Survey of Consumer Finances or the Panel Study of Income Dynamics, local subsistence businesses do not appear. The data were obtained individually by the author from program administrators who were either cold called or previously known to the author and from Valid Evaluation, a company that provides application and judging software as a service. The competitions are therefore not randomly selected, but effort was made to include a variety of competition types. Some are organized by universities, which are

[4] Barrows (2018) evaluates accelerators and competitions that use the YouNoodle platform. Comfortingly, he also finds positive effects of winning on firm outcomes. An advantage of the data in this paper is that they permit a sharp regression discontinuity design. For the subset of firms with observed outcomes in Barrows (2018), there is no discontinuity in the probability of winning at the cutoff.

[5] For example, New York has at least three publicly funded competitions. Two examples of publicly funded competitions in this paper are the Arizona Innovation Challenge, which awards $3 million annually, and the National Clean Energy Business Plan Competition, with $2.5 million in allocated funding. For NY, see nypl.org/help/services/startup, queensstartup.org, and binghamton-ny.gov/binghamton-local-development-corporation-bldc.

a major sponsor. The competitions are held in a variety of US locations, including major hubs and areas without substantial entrepreneurial activity. There is no sense in which it is possible to assess whether the competitions are "representative," as there are no existing data on competitions (accelerator programs are substantively different).

All the competitions studied here have the following features: (1) They include a pitch event, where the venture presents its business plan for 5–15 minutes; (2) Volunteer judges privately score participants; (3) Venture ranks in the round determine which ventures win; (4) Ranks and scores are secret, except when a competition privately informs a venture of its rank; (5) The organizer does not take equity in any participating ventures and (6) The organizer explicitly seeks to enable winners to access subsequent external finance. The competitions are usually open to the public, but typically there are few people besides the judges in the room except in the final round.

In most competitions, judges score or rank ventures based on six criteria: team, financials, business model, market attractiveness, technology/product, and presentation. These criteria scores or ranks are aggregated into a judge-specific venture score or rank. When scores are used, they are ordered to produce ranks. Judge ranks are then averaged to create an overall rank, which determines round winners. The econometrician observes all ranking and scoring information. This includes overall ranks and individual judges' scores and ranks. In no case do founders observe individual judge scores or ranks. Judges score independently and observe only their own scoring and never overall ranks.[6] Winning participants are typically listed on a program website.

Summary statistics about the competitions are in Table 1, Panel A. Competitions consist of rounds (e.g., semifinals) and sometimes judging occurs in panels within a round. The mean number of judges in a competition round panel is 17. The median competition has two rounds. Within the 113 preliminary rounds, the average number of participating ventures is 45. Within final rounds, this average is 19. Importantly for the regression discontinuity design, there are multiple winners in most rounds, with a median of 11 winners in preliminary rounds and 4 in final rounds. The average prize is $73,000 and ranges from $2,000 to $275,000. Only 64% of winners in final rounds receive cash prizes.

In 34 of the competitions, representing 35% of unique ventures, ventures receive an email after the round containing their overall and criteria ranks. Ventures learn only their own ranks and not those of other participants. In the remaining 53 competitions, participants do not observe any rank information. There are no systematic differences in the way judges score or in services (e.g., mentoring, networking, or training) across the two competition types. In no case did a competition with feedback advertise itself as providing relative ranks or more feedback in general, so ventures with greater informational needs could not have selected into them. Judges were not informed that feedback would be provided, so there is no reason to believe they would exert greater effort in the feedback competitions. Judges also cannot learn from the feedback, as they observe only their own scoring.

This paper uses four transformations of the rank and score data. The first measure is decile rank, calculated for the round and within winners and losers separately. Decile ranks divide the group into ten equal bins, with the best ranks in decile 1, and the worst in decile 10. The second measure is rank centered around the cutoff for winning so that a rank of 1 indicates the lowest-ranked winner, and a rank of -1 indicates the highest-ranked loser. For example, if there are four winners, the first-place winner will have a centered rank of 4, and the second-place winner will have a centered rank of 3. The third measure is judge decile rank, calculated among ventures that the judge scored. Finally, z-scores are calculated for the subset of competitions that begin with raw scores. The z-score indicates how far, in terms of standard deviations, a given absolute score falls relative to the sample mean. A higher z-score is better.

2.2. Ventures, founders, and judges

The 4,328 unique ventures are described in Table 1, Panels B and C. Ventures were matched to investment events and employment using CB Insights, Crunchbase, AngelList, and LinkedIn.[7] Care was taken to account for name changes, as early stage startups often change their names. In researching the ventures, 765 name changes were identified. Panel B shows that, on average, 24% of participating ventures raise private investment (angel or venture capital) after the round. However, just 5% raise significant VC funding after the round, defined as at least $3 million. At the time of the competition, ventures are, on average, 1.9 years old, and 44% of them are incorporated as a C- or S-corp.[8] Thirty-five percent are located in either California, Massachusetts, or New York. Fifty-two percent are known to have business models centered around the Internet or software. There are 558 ventures that participate in multiple competitions.

Venture survival, which averages 34%, indicates that the venture had at least one employee besides the founder on LinkedIn as of August 2016. While some startups may not initially appear on LinkedIn, if they are ultimately successful, they almost certainly will because their employees will identify themselves as working at the company. That is, companies rarely remain in "stealth" mode forever. This measure of survival is not ideal and induces truncation bias (mitigated by time fixed effects). However, it is the best available measure for very early stage ventures. An obvious alternative, the presence of a website, is a

[6] Judges could in theory report their scores to each other. This is unlikely, as 17 judges score a venture on average.

[7] The match rates for companies were 19%, 15%, 36%, and 45%, respectively. The match rate of founders to LinkedIn was 79%. For LinkedIn, only public profile data is used by nonlogged-in users, based on Google searches for person and school or firm. VentureXpert was not used as it has poor coverage of very early stage investment and has not been found by the author to outperform the combination of the three data sets used here to identify external financing events.

[8] Age is determined by the venture's founding date in its application materials. Ventures that describe themselves as "not yet founded" are assigned an age of zero.

Table 1
Summary statistics.
This table contains summary statistics about the competitions (panel A), venture financing and exit outcomes (panel B), venture characteristics (panel C), and founders (i.e., team leaders) (panel D).

Panel A: Competitions						
	N	Mean	Median	S.d.	Min	Max
# competitions	87					
# competition rounds	200					
# competition round panels	454					
# competitions with feedback	34					
# rounds per competition	87	2	2	0.69	1	3
# ventures in preliminary rounds	113	45	35	43	6	275
# ventures in final rounds	87	19	12	21	4	152
# winners in preliminary rounds	113	12	11	9.3	1	64
# winners in final rounds	87	4.5	4	3.7	1	25
Prize| Prize >0 (thousand nominal $)	167	73	30	86	2	275
Days between rounds within competition	88	23	17	31	0	127
# judges in round panel	543	17	9	23	1	178
Panel B: Venture financing and exit outcomes						
	N	Mean	Median	S.d.	Min	Max
# unique ventures	4,328					
Raised external private investment before round	6,023	0.16				
External private investment after round	6,023	0.24				
Average deal amount if available ($, mill)	3,755	6.9	1.00	49.7	0.0012	1,650
Angel/VC Series A investment before round	6,023	0.09				
Angel/VC Series A investment after round	6,023	0.15				
$>$ $3 mill VC after round	6,023	0.05				
Survival (Has $>$ 1 employee as of 8/2016)	4,328	0.34				
Has $\geq$ 10 employees as of 8/2016	4,328	0.2				
Acquired/IPO'd as of 9/2016	4,328	0.03				
Acquired/IPO amount if available ($, mill)	83	236	86	591	10	4,300
Low-value acquisition (deal amount unknown)	4,328	0.014				
High-value acquisition ($>$ $15 mill)	4,328	0.016				
Very high-value acquisition ($>$ $150 mill)	4,328	0.0014				
Panel C: Venture characteristics						
	N	Mean	Median	S.d.	Min	Max
Ventures in multiple competitions (# $\mid >1$)	558	2.52	2	0.98	2	9
# founders/team members at first competition	2,305	3.1	3	1.6	1	8
Venture age at first competition (years)	2,073	1.9	0.77	3	0	20
Incorporated at round	4,328	0.44				
In hub state (CA, NY, MA)	4,328	0.35				
Internet/software	4,328	0.52				
Panel D: Founder characteristics (one per venture)‡						
	N	Mean	Median	S.d.	Min	Max
# founders	3,228					
# founders matched to LinkedIn profile	2,554					
Age (years) at event (college graduation year - 22)	1,702	32.8	29	10.2	17	75
Female$^{\pm}$	3,228	0.22				
Male	3,228	0.73				
Number of total jobs	2,554	6.63	6	3.93	0	50
Number of jobs before round	2,547	4.41	4	2.66	0	10
Number of locations worked in	2,554	2.71	2	2.27	0	29
Is student at round	2,554	0.2				
Graduated from top 20 college	2,554	0.27				
Graduated from top 10 college	2,554	0.18				
Graduated from Harvard, Stanford, MIT	2,554	0.1				
Has MBA	2,554	0.48				
Has MBA from top 10 business school	2,554	0.33				
Has master's degree	2,554	0.17				
Has PhD	2,554	0.13				
Previous founder (founded different company before competition)	2,554	0.02				
Founder or CEO of subsequent venture after round	2,554	0.17				

Note: The samples in this table include all ventures in the data for which the variable is observable. Where the variable is binary, only the mean is reported. Data on ventures post-competition data is based on matches to CB Insights (752 unique matches), Crunchbase (638), AngelList (1,528), and LinkedIn (1,933). ‡From LinkedIn profiles. Not all competitions retained founder data, so the number of venture leaders is less than the number of ventures. $^{\pm}$ Gender coding by algorithm and manually; sexes do not sum to one because some names are both ambiguous and has no clear LinkedIn match.

poor survival measure because websites often stay active long after a venture has failed. An outcome variable that proxies for meaningful real economic activity is having at least ten employees on LinkedIn as of August 2016, which averages 20%.

Three percent of the sample experiences an acquisition or IPO, which represents success from the perspective of a very early stage venture. However, acquisitions are not always significant "right-tail" successes, especially from the investor perspective. Therefore, the 129 acquisitions are subdivided into three types according to transaction value. Low value transactions are those for which there is no public information about the amount, which is likely the case in small "acquisitions for parts" cases. There are no acquisitions in the data that are less than $10 million, consistent with a lack of disclosure for small acquisitions. High value and very high value are acquisitions with deal amounts more than $15 and $150 million, respectively, corresponding roughly to 10th and 90th percentiles.

Founders are described in Table 1, Panel C, using data from the competitions and LinkedIn profiles. Founders are mostly first-time entrepreneurs. Twenty-two percent of founders are women, and 73% are men (the remaining 5% have ambiguous names and no clear LinkedIn match).[9] Age is calculated based on birth year, which is approximated as the college graduation year less 22. Eighteen percent graduated from a top ten college (see Internet Appendix Table A.2 for definitions), and 20% are students at the time of the competition. Almost half of founders have an MBA, and two-thirds of the MBAs are from top ten programs.

Judges participate to source deals, clients, job opportunities, or as volunteer work. There are 2,514 unique judges, described in Internet Appendix Table A.3, of whom 27% are VCs, 20% are corporate executives, and 16% are angel investors. Ventures and judges are assigned to 16 sectors. Sector assignations come from competition data, and each venture is assigned only one sector. Judge sectors are drawn from LinkedIn profiles or firm webpages, and judges may have expertise in multiple sectors. Ventures and competitions are sorted by state in Internet Appendix Table A.4. There is concern that the judges investing themselves might contaminate any impact of the competitions on venture financing. Careful comparison of funded ventures' investors and judges revealed 95 instances of a judge's firm invested in the venture and three instances of a judge personally investing.

These data shed new light on venture and founder characteristics associated with startup success. In Internet Appendix Table A.5, subsequent financing and having at least ten employees are projected on observable characteristics. More founder job experience, being an Internet or software venture, being located in a VC hub state, and having prior financing are all strongly associated with success. Having an MBA is negatively associated with success. This relation is weak for financing, but column 4 suggests that founders with MBAs are 5.4 percentage points (27% of the mean) less likely to have at least ten employees, significant at the 0.01 level. Conversely, attending a top ten college is associated with a higher likelihood of investment. Kaplan et al. (2012) find a similar relation between college selectivity and success for CEOs of VC-backed companies.[10]

2.3. Sample representativeness

There is little existing empirical analysis of startups before their first external funding event. Therefore, there are no obvious benchmarks against which to assess whether the participating ventures are representative. However, an attempt is made to compare the startups in this sample to other data about first-time, early stage US startups and their founders. Internet Appendix Table A.6 compares the distribution of ventures to overall US VC investment. The share of software startups, 37%, is close to the national average of 40% in both deals and dollars. In part because VC investment in clean energy has declined dramatically in recent years, as well as the presence of the Cleantech Open competition, the data are skewed toward clean energy.[11]

The competitions take place in 17 U.S. states. With the exception of Arizona, the top 20 states for venture location in the data almost entirely overlap with the top 20 states for VC investment, though the data has fewer ventures from California and more from Massachusetts. This may be expected from early stage ventures, as startups often move to Silicon Valley to raise VC. The probability of an IPO or acquisition, 3%, is comparable to the 5% found in Ewens and Townsend (2019)'s sample of AngelList startups. Ventures average three team members, similar to the 2.6 founders on the AngelList platform in Bernstein et al. (2017). The median founder age is 29 years, which is roughly representative of startup founders.[12]

3. Estimation strategy

A regression discontinuity (RD) design permits establishing a causal effect of winning a competition. Estimation is based on Eq. (1).

$$Y_i^{Post} = \alpha + \beta_1 WonRound_{i,j} + f\left(Rank/Zscore_{i,j/k}\right) + \beta_2 Prize_i + \gamma_{j/k} + \delta' \mathbf{X}_i + \varepsilon_{i,j}. \quad (1)$$

The dependent variable Y_i^{Post} is a binary measure of venture i's success. A function of rank or z-score is at the competition-round-panel (j) or judge (k) level. $Prize_i$ is the dollar amount that the venture won, if any. Fixed effects for either the competition round panel ($\boldsymbol{\gamma}_j$) or judge ($\boldsymbol{\gamma}_k$) are included. The former absorb the date and location.

[9] Genders were assigned to founder names using the Blevins and Mullen (2015) algorithm, based on gender-name combinations from the US Social Security Administration. Unclear cases, such as East Asian names, were coded by hand.

[10] A similar exercise using founder college majors does not find strong variation. Majoring in either entrepreneurship or political science/international affairs is weakly associated with success.

[11] On the decline in clean energy VC, see: Saha, D., and Muro, M., 2017. Cleantech venture capital: continued declines and narrow geography limit prospects. Brookings Institution Report.

[12] The average Y Combinator founder is just 26, and the average entrepreneur age at company founding among startups with at least a $1 billion valuation between 2003 and 2013 was 34 (techcrunch.com/2010/07/30/ron-conway-paul-graham/ and techcrunch.com/2013/11/02/welcome-to-the-unicorn-club/).

Venture controls $\mathbf{X_i}$ include whether the company received investment before the round, whether any of the venture's judges or those judges' firms ever invested in the venture, 17 sector indicator variables, company age, and whether the founder is a student. These, especially age, reduce the sample size and are not included in most specifications. Standard errors are clustered by competition round panel or by judge.

A valid RD design requires that treatment does not cause rank. This is not a problem here, as the award decision happens after ranking. One way this setting differs from a conventional RD design is that the ranking is ordinal rather than cardinal. This is similar to the ordinal ranking used in an RD design in Howell (2017); in both settings, the differences in the true distance between ranks should be the same, on average. That is, errors in differences on either side of cutoff in any given competition should average out. To address any concerns with an ordinal running variable, *z*-scores based on nominal scores are employed in an alternative specification.

The rating variable is also discrete—the average number of participants is 45 for preliminary rounds and 19 for final rounds. This discreteness is less severe than that in Howell (2017), where there are, on average, ten applicants per grant competition. Lee and Card (2008) note that the fundamental econometrics are not different with a discrete rating variable, even if there is greater extrapolation of the outcome's conditional expectation at the cutoff. To determine the appropriate polynomial, the goodness-of-fit test for RD with discrete covariates from Lee and Card (2008) is employed, which compares unrestricted and restricted regressions.[13] Also note that a McCrary (2008) test for density around the cutoff is not relevant here since, by definition, the ranks around the cutoff are populated equally.

The primary empirical concern is whether ranks are manipulated around the cutoff because the cutoff in a valid RD design must be exogenous to rank (Lee and Lemieux, 2010). That is, the identification strategy is threatened if judges or organizers sort ventures on unobservables around the cutoff. This is extremely unlikely because judges score independently and typically only score a subset of participating ventures. Scores are then averaged and sorted to create ranks, as explained in Section 2.1.

Reassuringly, observable baseline covariates and pre-assignment outcome variables are smooth around the cutoff, using both decile ranks and centered ranks. This is shown with decile ranks in Fig. 1 for venture variables observable at the time of the competition, such as previous financing and whether the venture is incorporated. Similarly, Fig. 2 shows that founder characteristics observable at the time of the competition, such as having a BA from a top 10 college, being female, and the number of previous jobs, are continuous across winners and losers. The figures use final rounds and decile ranks. They are similar when preliminary rounds or centered rank are used instead. Note that with decile rank, the winner and loser local polynomial lines overlap because the winning share varies across rounds.[14]

4. Effect of winning

This section describes the main effect of winning on subsequent financing (Section 4.1), which is then disaggregated by round type (Section 4.2). The effect on real outcomes is discussed in Section 4.3. The predictive power of rank is shown in Section 4.4. The last sub-section contains robustness tests (Section 4.5).

4.1. Effect of winning on subsequent financing

Visual evidence of the effect of winning is in Figs. 3 (using decile ranks) and 4 (using centered ranks around the cutoff). In each case, the top two graphs show the probability of subsequent external financing in preliminary and final rounds. The middle two graphs show the probability of venture survival, and the bottom two graphs show the probability of having at least ten employees. The positive effect of winning is apparent in all cases, especially for preliminary rounds. In the decile graphs, the winner line lies above the loser line, and in the cutoff graphs, there is a clear discontinuous jump at the cutoff. This provides strong evidence of a substantial raw effect of winning.

Regression estimates of the effect of winning are in Table 2, using variants of Eq. (1). The dependent variable is subsequent external financing. Final and preliminary rounds are included. Further, some ventures participate in multiple competitions, and all observations are included. Thus, in this main specification, a venture can appear multiple times. The preferred specification is in column 1, where decile ranks on either side of the cutoff are used. The effect of winning is 13 pp, relative to a mean of 24%. When a rich array of venture controls is added (substantially decreasing the sample size), the effect is 7.9 pp (column 2).

Eq. (1) is estimated at the judge-venture level in Table 2, Panel A, column 3. That is, each observation is a judge's rank of the venture within a competition round panel. This model includes judge fixed effects and controls for the venture's decile rank within ventures that the judge scored. Year fixed effects are also included. Note that judges often participate in multiple rounds and in some cases are observed in multiple competitions, so judge fixed effects are quite different from the competition round panel fixed effects used in other specifications. This model finds a larger effect of winning, at 17 pp. Standard errors are clustered by judge, but the standard error is essentially unchanged when clustering by venture. Table 2, Panel A, column 5 uses *z*-scores and so is restricted to the

[13] The unrestricted regressions projects the outcome on dummies for each of *K* ranks. The restricted regression is a polynomial like Eq. (1). The goodness-of-fit statistic is $G \equiv \frac{(ESS_{Restr.} - ESS_{Unrestr.})/(K-P)}{ESS_{Unrestr.}/(N-K)}$, where *ESS* is the error sum of squares from regression, *N* is the number of observations, and *P* is the number of restricted parameters. *G* takes an f-distribution. The null hypothesis is that the unrestricted model does not provide a better fit. If *G* exceeds its critical value, the null is rejected in favor of a higher order polynomial.

[14] There are no losers in the top bin, and winners are truncated at the fifth decile.

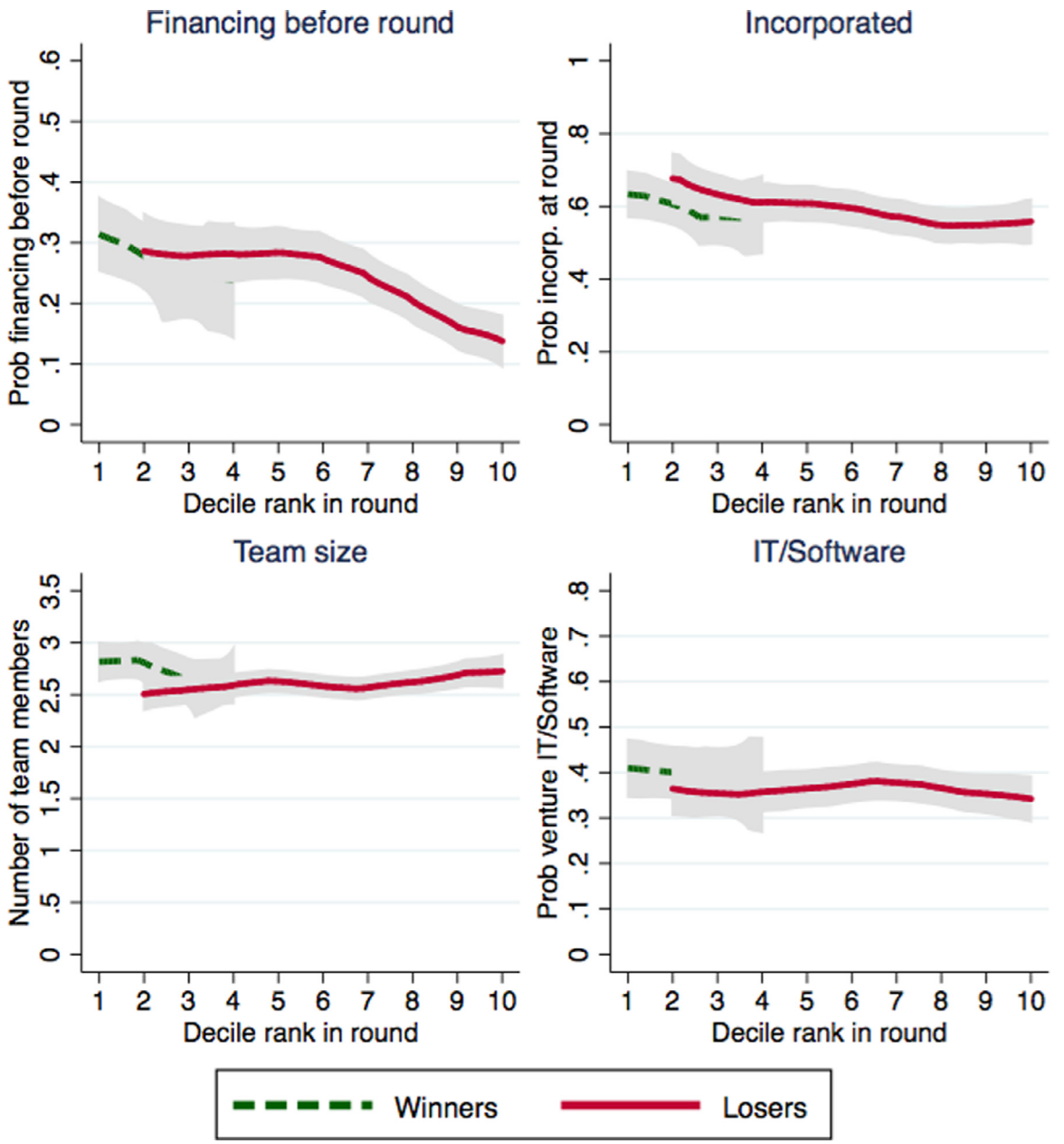

Fig. 1. Continuity of venture covariates. Note: This figure shows probabilities of venture-specific covariates observed at the time of the competition by percentile rank in the round (lower percentile rank is better). The sample consists of all ventures in final rounds. Note that there are no losers in the top bin, and winners are truncated at the fifth decile. The lines overlap because the share of participants that win varies across rounds. Local polynomial with Stata's optimal bandwidth and 95% CIs are shown.

subsample of competitions that use scores before force-ranking participants.

There may be concern that these results are driven by small VC investments or angel rounds. To address this possibility, Table 2, Panel A columns 5–7 replicate columns 1–3, but use an indicator for raising at least $3 million in VC after the round as the dependent variable. The main finding persists. In column 5, the effect is 6.7 pp, which is not significantly different from the effect of 13 pp in column 1. In column 6, with venture controls, the effect is almost the same as the main model (8.2 pp versus 7.9 pp). In column 7, with judge fixed effects, the effect is significantly smaller (7.9 pp versus 17 pp). All the main results subsequently described are robust to using this indicator for "serious" VC financing, but in general the effects are somewhat smaller in magnitude. This suggests that competitions are most useful at relieving information frictions for the earliest stage investments.

Table 2, Panel B, columns 1–3 use various forms of centered rank around the cutoff. In columns 1–2, linear

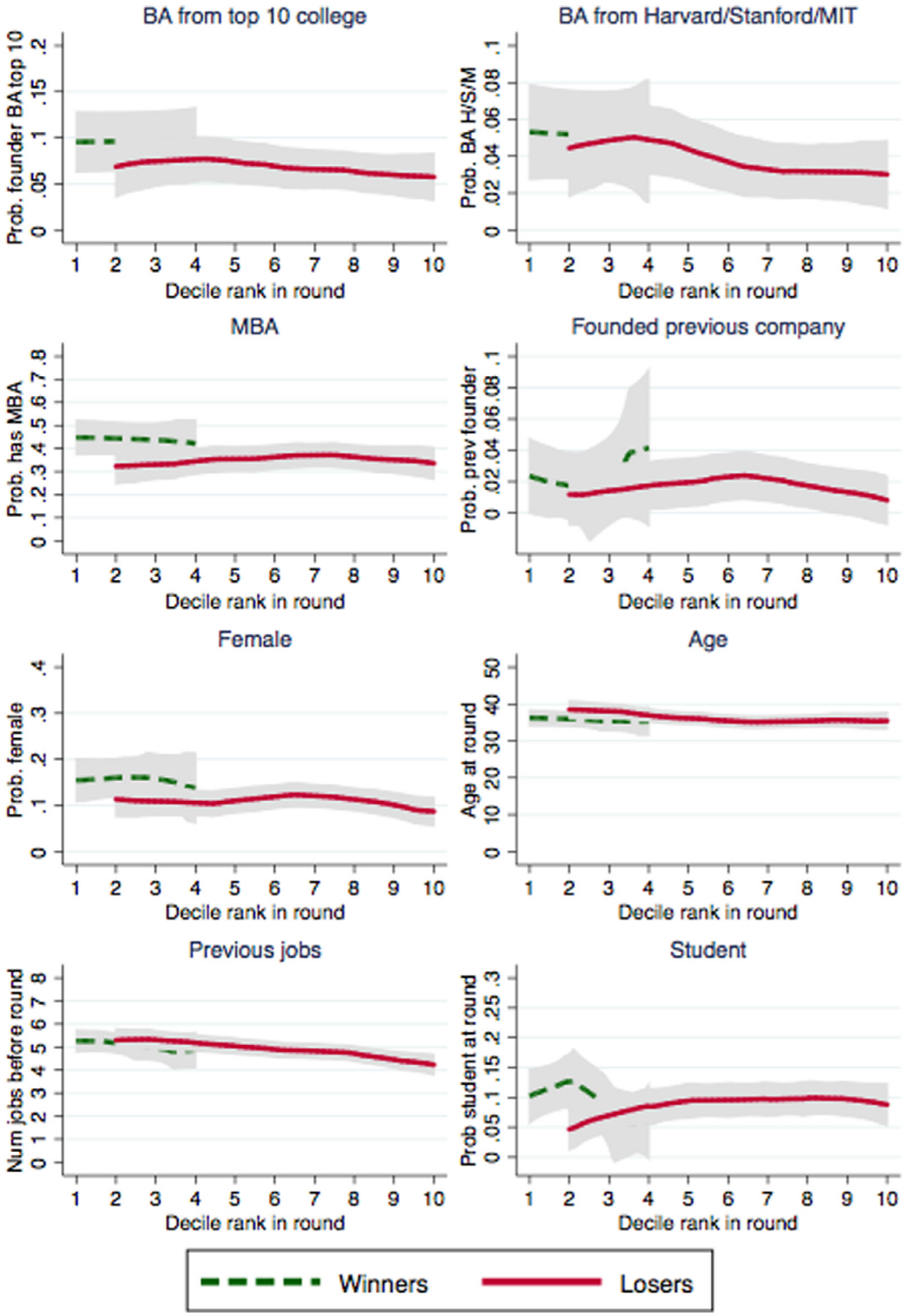

Fig. 2. Continuity of founder covariates. Note: This figure shows probabilities of founder-specific covariates observed at the time of the competition by percentile rank in the round (lower percentile rank is better). The sample consists of all ventures in final rounds. Note that there are no losers in the top bin, and winners are truncated at the fifth decile. The lines overlap because the share of participants that win varies across rounds. Local polynomial with Stata's optimal bandwidth and 95% CIs are shown.

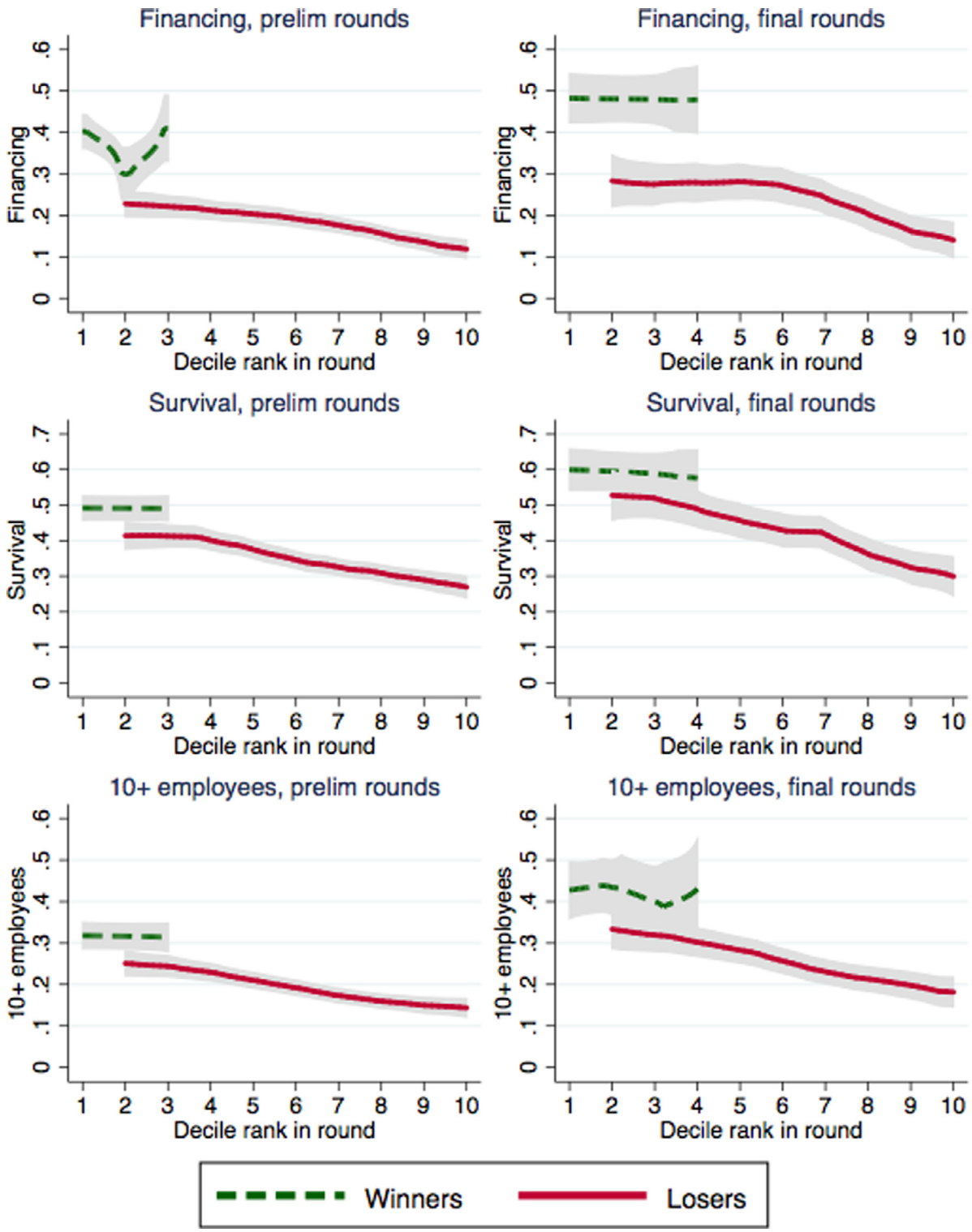

Fig. 3. Effect of winning with percentile rank. This figure shows probabilities of subsequent financing (top), survival (middle), and having ten-plus employees (bottom) by percentile rank in the round (lower percentile rank is better). The sample consists of all ventures in either final or preliminary rounds. Note that there are no losers in the top bin, and winners are truncated at the fifth decile. The lines overlap because the share of participants that win varies across rounds. Local polynomial with Stata's optimal bandwidth and 95% CIs are shown.

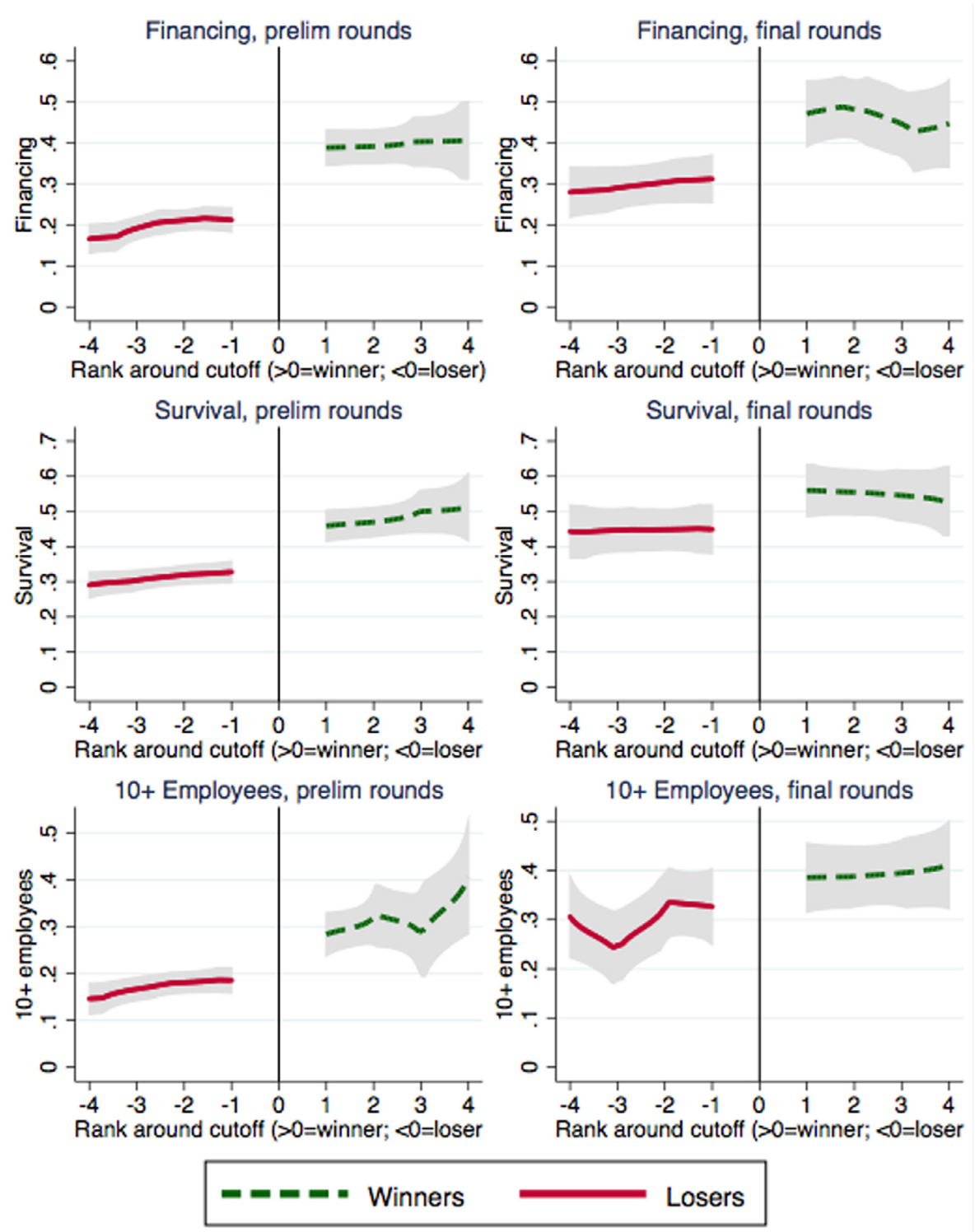

Fig. 4. Effect of winning with centered rank around cutoff. Note: This figure shows probabilities of subsequent financing (top), survival (middle), and having 10+ employees (bottom) by the venture's centered rank around the cutoff for winning. Centered rank improves from left to right. A rank of 1 indicates the lowest-ranked ranked winner (the winner with the worst rank, which just barely won). A rank of -1 indicated the highest-ranked loser (the loser which just barely lost). The sample consists of all ventures in either final or preliminary rounds. Note that there are no losers in the top bin, and winners are truncated at the fifth decile. Local polynomial with Stata's optimal bandwidth and 95% CIs are shown.

Table 2
Effect of winning on subsequent external financing.
This table shows regression estimates of the effect of winning, rank, and cash prize on whether the venture raised external financing after the competition using variants of Eq. (1).

Panel A

Dependent variable:	Financing after round				≥ $3 mill VC after round		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Won round	0.13***	0.079**	0.17***	0.15***	0.067***	0.082***	0.079***
	(0.026)	(0.036)	(0.015)	(0.019)	(0.018)	(0.028)	(0.0065)
Decile rank winners	–0.011***	–0.0059			–0.0091***	–0.011***	
	(0.0044)	(0.0054)			(0.0025)	(0.0039)	
Decile rank losers	–0.018***	–0.013***			–0.007***	–0.0056***	
	(0.0025)	(0.0031)			(0.0012)	(0.0018)	
Judge decile rank			–0.006***				–0.0036***
			(0.0011)				(0.00058)
Z-score winners				0.0074			
				(0.024)			
Z-score losers				0.031***			
				(0.011)			
Prize ($10,000)	0.0085***	0.0085***	0.011***	0.012**	0.0039**	0.0032	0.0086*
	(0.0024)	(0.0029)	(0.0034)	(0.0055)	(0.0017)	(0.0023)	(0.0052)
Venture controls	N	Y	N	N	N	Y	N
Comp. round panel f.e.	Y	Y	Y	Y	Y	Y	Y
Judge & year f.e.	N	N	Y	N	N	N	Y
N	6,023	3,487	26,663	3,973	6,023	3,487	26,663
R^2	0.16	0.4	0.4	0.19	0.15	0.33	0.25

Panel B

Dependent variable: financing after round				Bandwidth around cutoff			
				1 venture		2 ventures	
					No prize winners		No prize winners
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Won round	0.13***	0.13***	0.17***	0.16***	0.11*	0.14***	0.086**
	(0.017)	(0.019)	(0.019)	(0.046)	(0.064)	(0.029)	(0.037)
Centered rank	0.0018***	0.0018***					
	(0.00032)	(0.00056)					
Centered rank^2		–2.9e-07					
		(3.9e-06)					
Centered rank winners			–0.0066***				
			(0.0019)				
Centered rank losers			0.0023***				
			(0.00042)				
Prize (10,000$)	0.0095***	0.0095***	0.0088***	0.0037		0.007	
	(0.0024)	(0.0024)	(0.0024)	(0.0095)		(0.0062)	
Comp. round panel f.e.	Y	Y	Y	Y	Y	Y	Y
N	6,023	6,023	6,023	971	781	1,712	1,404
R^2	0.16	0.16	0.16	0.52	0.6	0.35	0.37

Note: (Panel A) The level of observation is a venture in a round (or panel if the competitions divides rounds into discrete judging panels). Decile rank is the overall decile rank in the round, while decile rank winners (losers) is the decile rank within the round's winners (losers). A smaller rank is better (1 is best decile; 10 is worst decile). Venture controls include whether the company received investment before the round; whether any of the venture's judges or those judges' firms ever invested in the venture, 17 sector indicator variables, company age; and whether the founder is a student. Competition fixed effects control for the date. The sample consists of all venture-round observations as described in Table 1 Panel B. Columns 3 and 7 use judge fixed effects, and the level of observation is judge venture round, so the sample includes all judge-venture-round observations. Column 4 uses z-scores instead of ranks and is restricted to the subsample of competitions that use scores before force-ranking participants. Errors are clustered by competition round panel except in columns 3 and 7, where they are clustered by judge. *** indicates p-value < 0.01.
Note: (Panel B) This panel shows regression estimates of the effect of winning, rank, and cash prize on whether the venture raised external financing after the competition using variants of Eq. 1. The level of observation is a venture in a round (or panel, if the competitions divides rounds into discrete judging panels). Centered rank is the venture's rank in the round centered around the cutoff for winning, such that a rank of 1 is the lowest-ranked winner, and –1 is the highest-ranked loser. If there are three winners, the highest-ranked winner will have centered rank of 3. If there are 20 losers, the lowest-ranked loser will have centered rank of -20. The sample consists of all venture-round observations as described in Table 1 Panel B. Columns 4 and 5 restrict the sample to ranks immediately around the cutoff. Columns 4–5 use only one venture on either side of the cutoff, and columns 6–7 use two ventures on either side of the cutoff. Cash prize winners are excluded in columns 5 and 7. Competition fixed effects control for the date. Errors are clustered by competition round panel. *** indicates p-value < 0.01.

Table 3
Effect of award and round on subsequent external financing.
This table shows regression estimates of the effect of winning, rank, and cash prize by round type on whether the venture raised external financing after the competition using variants of Eq. (1).

Dependent variable: financing after round						
Sample:	All	Final rounds		Preliminary rounds		
			No prize winners			No final winners
	(1)	(2)	(3)	(4)	(5)	(6)
Won prelim round	0.081***			0.14***	0.086***	0.085**
	(0.027)			(0.03)	(0.03)	(0.034)
Won final round	0.2***	0.12**	0.17*		0.2***	
	(0.033)	(0.05)	(0.085)		(0.044)	
Decile rank winners	–0.0096**	–0.00047	–0.01	–0.015***	–0.012**	–0.011*
	(0.0039)	(0.0076)	(0.012)	(0.0052)	(0.0049)	(0.0058)
Decile rank losers	–0.018***	–0.019***	–0.019***	–0.018***	–0.017***	–0.017***
	(.0025)	(.004)	(.0041)	(.0031)	(.0031)	(.0031)
Prize (dummy)	0.00079					
	(0.032)					
Prize ($10,000)		0.0052		0.012***	0.0032	
		(0.0033)		(0.0032)	(0.0037)	
Comp. round panel f.e.	Y	Y	Y	Y	Y	Y
N	6,023	1,617	1,286	4,406	4,406	4,148
R^2	0.17	0.17	0.12	0.16	0.17	0.14

Note: This panel shows regression estimates of the effect of winning, rank, and cash prize on whether the venture raised external financing after the competition using variants of Eq. (1). The level of observation is a venture in a round (or panel if the competitions divides rounds into discrete judging panels). Decile rank is the overall decile rank in the round, while decile rank winners (losers) is the decile rank within the round's winners (losers). A smaller rank is better (1 is best decile; 10 is worst decile). Column 2 restricts the sample to final rounds and column 3 to ventures in final rounds that did not win a cash prize. The sample in column 1 consists of all venture-round observations as described in Table 1 Panel B. Columns 2–3 restrict the sample to final rounds, and columns 4–5 restrict the sample to preliminary rounds. Column 6 further restricts the sample to ventures in preliminary rounds that did not ultimately win a prize. Competition fixed effects control for the date. Errors are clustered by competition-round-panel. *** indicates p-value < 0.01.

and quadratic centered rank yield the same effect as the main specification. The goodness-of-fit test discussed in Section 3 finds that linear rank is optimal. When centered rank is controlled for separately among winners and losers, the effect is somewhat larger (column 3). To assess the effect of winning near the cutoff, Table 2, Panel B, columns 4–7 use narrow bandwidths. When only one venture on either side of the cutoff is included, the effect is 16 pp. It is 11 pp when cash prize winners are excluded (column 5). With two ventures on either side of the cutoff, the effect is 14 pp overall and 8.6 pp without prize winners (columns 6–7). The differences between the estimates with and without winning a prize are not significantly different from one another.

4.2. Effects by round type

I decompose the overall effect of winning into the effect of the cash prize and the type of round (preliminary or final) to shed light on the mechanism. Two features of the data permit me to separately identify the effect of the prize and the effect of winning. First, as mentioned in Section 2.1, only 64% of winners in final rounds receive cash prizes. Second, the prize amount typically varies across winners that do win cash prizes in a final round. The average standard deviation of prize money within final round prize winners is $12,300. While prize amounts may vary with competition characteristics, competition fixed effects absorb this variation. The regressions in Table 2 consistently find that an extra $10,000 increases the probability of financing by nearly 1 pp. This implies that the average prize of $73,000 increases the chances of financing by 7.3 pp. The effect of cash prizes appears linear, as there is no effect of higher order functions of the prize on financing, such as the prize squared.

This positive effect of a cash prize is smaller than the effect of winning even a preliminary round and is not as robust. Table 3, column 1 includes dummies for winning a preliminary round, a final round, and a prize. Note that for prize winners, all three of these will equal one. The effect of winning a preliminary round after controlling for winning the final round is 8.1 pp. The prize indicator has a near-zero and insignificant coefficient. Columns 2 and 3 establish this more rigorously by restricting the sample to final rounds. The effect of winning is 12 pp, and there is no effect of an additional $10,000 in cash prize (column 2). When prize winners are excluded from the sample and the point estimate of winning a final round rises to 17 pp (column 3). This indicates that the effect of winning a final round is driven by marginal winners that do not win a cash prize.

The sample is restricted to preliminary rounds in Table 3, columns 4–6. The effect of winning a preliminary round is 14 pp (column 4), which is slightly higher than the overall effect using all rounds with the same specification in Table 2, column 2. After controlling for whether the venture won the final round (column 5), the effect of a preliminary win is 8.6 pp. The effect of a preliminary win is 8.5 pp when final round winners are excluded from the sample (column 6). The difference between the coefficients on winning final and preliminary rounds is significant at the 0.05 level in column 5. Note, however, that both coefficients on winning are relative to preliminary round losers. Winning a preliminary round but not a final round is, at most, only somewhat less useful than winning a final round (8.6 pp versus 12 pp, which are not significantly

Table 4
Effect of rank and winning on additional outcomes.
This table shows regression estimates of the effect of winning, rank, and cash prize on alternative outcomes using variants of Eq. (1).

Sample:	All				Preliminary rounds			Bandwidth of 2 around cutoff		
Dependent variable:	Survival	Founder subsequent. entrep.	10+ employees	Acquired/ IPO	Survival	10+ employees	Acquired/ IPO	Survival	10+ employees	Acquired/ IPO
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Won round	0.047*	−0.00053	0.051*	0.018	0.05	0.063**	0.026**	0.077**	0.059**	0.0091
	(0.028)	(0.02)	(0.027)	(0.012)	(0.031)	(0.03)	(0.012)	(0.03)	(0.029)	(0.013)
Decile rank winners	−0.006	−0.0013	−0.0041	−0.0028*	−0.0059	−0.0045	−0.0035**			
	(0.0043)	(0.0027)	(0.0044)	(0.0017)	(0.0052)	(0.0051)	(0.0018)			
Decile rank losers	−0.023***	0.0012	−0.017***	−0.0011	−0.024***	−0.016***	−0.0008			
	(0.0028)	(0.0016)	(0.0023)	(0.001)	(0.0031)	(0.0027)	(0.0012)			
Prize (10,000$)	0.0062*	−0.00059	0.0074***	0.0002				0.0053	0.0082*	−0.0019
	(0.0032)	(0.0013)	(0.0026)	(0.0013)				(0.0051)	(0.005)	(0.0012)
Comp. round panel f.e.	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
N	6,023	6,023	6,023	6,023	4,406	4,406	4,406	1,712	1,712	1,712
R^2	0.17	0.32	0.14	0.083	0.16	0.13	0.094	0.4	0.36	0.3

Note: Survival is one if the venture had ≥ 1 employee besides the founder on LinkedIn as of 8/2016; 10+ employees is defined analogously. Acquired/IPO indicates that the venture was acquired by another company or went public. In columns 1–4, the whole sample is used. In column 2, the dependent variable is one for founders that subsequently founded or were the CEO of another company. This could reflect unidentified name change but if not, it is a measure of serial entrepreneurship. The sample in columns 1–4 consists of all venture-round observations as described in Table 1 Panel B. Columns 5–7 restrict the sample to preliminary rounds. Columns 8–10 restrict the sample to a bandwidth of two ventures on either side of the cutoff for winning. The level of observation is a venture-round. Some rounds divide ventures into panels. Rank is defined as in Table 3. Competition fixed effects control for the date. Errors are clustered by competition round panel. *** indicates p-value < 0.01.

different from one another). In sum, winning a cash prize is useful but not nearly as useful as winning the round.

4.3. Effect of winning on real outcomes

Real startup outcomes—survival, having at least ten employees, and being acquired or going public—are considered in Table 4. The first four columns use the whole sample, the next three restrict the sample to preliminary rounds, and the final three use a bandwidth of two ventures on either side of the cutoff.[15] First, consider the probability of venture survival. Winning has a 4.7 pp effect across all rounds, though this is significant only at the 0.1 level (column 1). It loses significance in preliminary rounds but is a robust 7.7 pp with the narrow bandwidth (column 8). There may be concern that dead ventures are miscoded and in fact reflect a "pivot" and venture name change. As mentioned above, care was taken to identify name changes. Nonetheless, some miscoding may remain. Therefore, column 2 considers founders that subsequently founded or were the CEO of a different company in case these other companies are in fact the original ventures with new names. There is no effect of winning. This not only serves as a robustness test but also indicates that winning does not affect entrepreneurship as a career for the founder despite being useful for the venture.

Having at least ten employees is a measure of real economic activity. In the context of early stage ventures, it is a meaningful marker of success. The bottom two graphs in Figs. 3 and 4 show a clear jump at the cutoff in preliminary rounds, indicating a significant effect of winning. Winning increases the chances of having at least ten employees by 5.1 pp across all rounds and 6.3 pp in preliminary rounds (Table 4, columns 3 and 6). It has a similar effect of 5.9 pp using the narrow bandwidth (column 9).

There are not many acquisitions or IPOs in the data; the mean is just 3%. The effect of winning on exiting is not quite significant in all rounds or with the narrow bandwidth (columns 4 and 10), but it is 2.6 pp in preliminary rounds (column 7). At almost 100% of the mean, this effect is large in economic magnitude. In Internet Appendix Table A.7, I explore whether this effect is driven by especially successful acquisitions. The results suggest that the effect from Table 4 may be driven by low-value acquisitions. The effect on high-value acquisitions is of a similar magnitude but is statistically insignificant, and there is no effect on very high-value acquisitions. There is also no effect when independently considering IPOs (of which there are 11) or considering IPOs and very high-value acquisitions together. This could be explained by the small number of very high-value transactions. It is possible that the ventures have not had enough time to exit.

Alternatively, the competitions may reduce information frictions at the fundraising stage but have no meaningful effect on the high-value liquidity events that generate positive returns in the typical VC portfolio. This harkens back to the finding that the effect is somewhat smaller for serious VC financing than for all subsequent financing (see Section 4.1). Together, these results connect to the broader finding in this paper that the competitions are most useful for the more marginal participants. These ventures of "medium" quality within the context of the competitions (e.g., just above the cutoff for winning) are perhaps unlikely to have a high-value acquisition or IPO regardless of whether they raise VC or not. From the VC perspective, this could imply poor investment returns. However, from a social welfare perspective, these ventures could be quite valuable. Even if they never exit, they may become meaningful businesses, creating jobs, innovation, and wealth for

[15] The results are similar for all outcomes in Table 4 with controls for centered rank.

Table 5
Effect of criteria rank on venture outcomes.
This table contains regression estimates of the relation between criteria-specific ranks and venture outcomes.

Dependent variable:	Financing after round		10+ employees		Acquired/IPO	
	(1)	(2)	(3)	(4)	(5)	(6)
Decile rank in round:						
Team	−0.021***	−0.023***	−0.0091	−0.017***	0.00069	−0.0012
	(0.0057)	(0.0053)	(0.0063)	(0.0049)	(0.0026)	(0.0024)
Financials	−0.014**	−0.0079	−0.036***	−0.026***	0.0034	0.0023
	(0.0067)	(0.005)	(0.0083)	(0.0057)	(0.0031)	(0.0027)
Business model	0.0032	0.002	0.0024	0.0035	0.0046	−0.0059
	(0.016)	(0.011)	(0.014)	(0.011)	(0.0074)	(0.0074)
Market	0.01	−0.0091	0.0075	−0.011	−0.00047	0.0039
	(0.015)	(0.011)	(0.013)	(0.011)	(0.0072)	(0.0074)
Tech./Product	0.0098	0.0031	−0.0015	−0.0081	−0.0062**	−0.0056**
	(0.0078)	(0.0054)	(0.0069)	(0.0054)	(0.0024)	(0.0024)
Presentation	−0.015**	−0.0098**	0.0074	0.008	−0.0032	−0.0013
	(0.0059)	(0.0043)	(0.0071)	(0.0052)	(0.0024)	(0.0022)
Won Round	0.14***	0.2***	0.1***	0.17***	0.011	0.023***
	(0.024)	(0.013)	(0.032)	(0.015)	(0.013)	(0.0068)
Judge/judge co invested	0.47***	0.56***				
	(0.11)	(0.027)				
Comp,-round-panel f.e.	Y	N	Y	N	Y	N
Judge f.e.	N	Y	N	Y	N	Y
N	1,926	8,794	1,926	8,794	1,926	7,043
R^2	0.15	0.14	0.13	0.12	0.065	0.066

Note: The level of observation is a venture in a round (or panel if the competitions divides rounds into discrete judging panels). The criteria ranks are averaged to produce the overall ranks used in other tables. A smaller decile rank is better (1 is best decile; 10 is worst decile). Financing after round is an indicator for the venture raising private external investment after the round; 10+ employees is one if the venture had $\geq$10 employees besides the founder on LinkedIn as of 8/2016. The sample consists of all observations where dimension ranks are used; in columns 1, 3 and 5 these are defined as subsets of the venture-round level data, and in columns 2,4, and 6 they are subsets of the judge-venture-round level data. Competition fixed effects control for the date. Errors are clustered by competition round panel or judge, depending on fixed effects. *** indicates p-value $<$ 0.01.

their founders. Evaluating the net social benefits of reducing information frictions in entrepreneurial finance is beyond the scope of this paper, but the results suggest they may be nuanced and merit future study.

4.4. Predictive power of rank

A striking finding from Tables 2–4 is that rank and score strongly predict success after controlling for winning and competition fixed effects. For example, a one decile improvement in rank among losers is associated with a 1.8 pp increase in the probability of external financing, which is 7.5% of the mean (Table 2, Panel A, column 2). Individual judge ranks are also predictive in the within-judge decile rank model (Table 2, Panel A, column 4). Importantly, the effect of rank persists within the no-feedback competitions, where ranks cannot directly affect venture outcomes (Table 6, Panel A, column 6).

The criteria ranks are also informative. Table 5 shows the association between criteria ranks and outcomes, controlling for win status. A higher team rank (i.e., the quality of the founders) is the strongest predictor of success for all outcomes except IPO/acquisition. Similarly, Bernstein et al. (2017) and Gompers et al. (2016) find that early stage investors care most about information regarding founder team quality. For IPO/acquisition, the only criterion with predictive power is product/technology, and this is quite robust. Therefore, in these data, team is most relevant for low-level, early stage success, while technology matters most for high-level, late-stage success. This speaks to the horse versus jockey debate, suggesting that the team matters initially, but the business matters more in the long run. It is consistent with Kaplan et al. (2009), who examine 50 public firms and find that business lines, not management, remain stable from startup to IPO.

The strong predictive power of rank found here contrasts with the US Department of Energy ranks of Small Business Innovation Research (SBIR) grant applicants in Howell (2017), which are uninformative about firm outcomes. There are a number of differences between the SBIR grant process and new venture competitions. One is that competition judges tend to be expert market participants rather than government officials. Nearly half of the judges in these data are angel or VC investors (Internet Appendix Table A.3). Unreported regressions examine the predictive power of rank by judge occupation. There is little difference across investor, lawyer/consultant/accountant, and corporate executive judges. Perhaps surprisingly, entrepreneur judges are the exception: their scores have no predictive power. There is no relation between judge-venture sector match and the predictive power of judge ranks.

4.5. Robustness tests

Robustness tests confirm the main effect of winning and find it to be consistent across relevant subsamples. In Table 6, panel A column 1, errors are clustered by competition rather than competition round panel. Venture or judge clusters also yield similar results to the main model (unreported). In column 2, ventures in which a judge or judge's firm invested are excluded in case these judges' fa-

Table 6
Robustness tests of effect of winning.
This table shows regression estimates of the effect of winning, rank, and cash prize on whether the venture raised external financing after the competition using variants of Eq. (1).

Panel A

Dependent variable: financing after round						
	(1)	(2)	(3)	Logit (4)	Feedback (5)	No feedback (6)
Won round	0.13***	0.13***	0.13***	0.71***	0.13***	0.17***
	(0.03)	(0.026)	(0.027)	(0.14)	(0.034)	(0.04)
Decile rank winners	−0.011**	−0.012***	−0.012**	−0.069***	−0.0091	−0.017***
	(0.0043)	(0.0043)	(0.0047)	(0.021)	(0.0061)	(0.0063)
Decile rank losers	−0.018***	−0.018***	−0.017***	−0.13***	−0.011***	−0.025***
	(0.0027)	(0.0025)	(0.0026)	(0.017)	(0.0033)	(0.0033)
Prize (10,000$)	0.0085***	0.0088***	0.0067*	0.036***	0.011**	0.0068**
	(0.0023)	(0.0023)	(0.0039)	(0.011)	(0.0055)	(0.0027)
Comp. round panel f.e.	Y	Y	Y	Y	Y	Y
N	6,023	5,925	4,920	5,484	3,422	2,601
R^2	0.16	0.16	0.17	0.12	0.2	0.13

Panel B

Dependent variable: financing after round									
Sample:	University comps		HBS NVC	AIC	No small	Ventures		Founders	
	omitted (1)	only (2)	omitted (3)	omitted (4)	comps (5)	in VC hub states (6)	incorp. (7)	with MBAs (8)	students (9)
Won round	0.12***	0.15***	0.13***	0.13***	0.15***	0.13***	0.14***	0.12**	0.13**
	(0.039)	(0.037)	(0.029)	(0.029)	(0.028)	(0.049)	(0.038)	(0.053)	(0.056)
Decile rank winners	−0.012**	−0.01	−0.013***	−0.01**	−0.013***	−0.011	−0.015**	−0.0056	−0.014
	(0.0057)	(0.008)	(0.0046)	(0.005)	(0.0047)	(0.0082)	(0.0059)	(0.011)	(0.012)
Decile rank losers	−0.022***	−0.011**	−0.021***	−0.015***	−0.019***	−0.011**	−0.025***	−0.0091	−0.024***
	(0.0029)	(0.0043)	(0.0026)	(0.0029)	(0.0026)	(0.0049)	(0.0034)	(0.0057)	(0.006)
Prize ($10,000)	0.0081***	0.01*	0.0078***	0.01***	0.0082***	0.0074	0.0074***	0.017*	0.012
	(.0026)	(.0057)	(.0024)	(.0039)	(.0025)	(.012)	(.0027)	(.0094)	(0.0086)
Comp. round panel f.e.	Y	Y	Y	Y	Y	Y	Y	Y	Y
N	3,616	2,407	5,235	4,460	5,442	1,968	3,288	1,637	1,183
R^2	0.11	0.24	0.15	0.19	0.17	0.28	0.18	0.34	0.33

Note: (Panel A) The level of observation is a venture in a round (or panel if the competitions divides rounds into discrete judging panels). Decile rank is the overall decile rank in the round, while decile rank winners (losers) is the decile rank within the round' s winners (losers). A smaller rank is better (1 is best decile; 10 is worst decile). The sample in column 1 consists of all venture-round observations as described in Table 1 Panel B; subsequent columns restrict the sample as follows. Column 2 omits ventures in which a judge or judge's firm invested. Column 3 restricts observations to a venture's first competition. Column 4 uses a logit model instead of OLS. Column 5 restricts the sample to competitions that gave participants feedback (informed them of their rank in the round), while column 6 restricts the sample to competitions that did not provide feedback. Competition fixed effects control for the date. Errors are clustered by competition round panel except in columns 1 and 4, where they are clustered by competition and judge, respectively. *** indicates p-value < 0.01.

Note: (Panel B) This table shows regression estimates like those in Panel A. The sample consists of subsets of all venture-round observations as described in Table 1 Panel B, constructed as follows based on competition, venture, or founder characteristics. Column 1 excludes competitions organized by universities, while column 2 includes only these competitions. Columns 3 and 4 omit the two largest competitions in the data, the HBS New Venture Competition (NVC) and the Arizona Innovation Challenge, respectively. Column 5 omits competitions where there are less than 30 participants. Competition fixed effects control for the date. Errors are clustered by competition round panel. *** indicates p-value < 0.01.

vorable opinion of the ventures mechanically causes winning or rank to predict financing. Column 3 restricts observations to a venture's first competition. Column 4 uses a logit model instead of ordinary least squares (OLS) and finds that winning doubles the odds of receiving financing. Note that logit is not preferred, as it drops groups without successes (i.e., panels without ventures that subsequently received financing). Column 5 restricts the sample to competitions that gave participants feedback by informing them of their rank in the round, while column 6 restricts the sample to competitions that did not provide feedback. The effect is somewhat larger in the no-feedback competitions, at 0.17 pp, though the difference is not statistically significant.

The main model uses competition fixed effects, so the results should not be affected if participants are, on average, higher quality in some competitions. However, to ensure robustness and explore potential heterogeneity, Table 6, Panel B divides the sample by competition type. The effect is 12 (15) pp in competitions not held at (held at) universities (columns 1–2). The effect is unchanged when the two largest competitions are excluded (HBS New Venture Competition in column 3 and Arizona Innovation Challenge in column 4). The effect is very similar to the main result when small competitions (less than 30 participants) are excluded (column 5).

The final columns of Table 6, Panel B divide the sample by venture and founder characteristics. The effect is

robust to restricting the sample to ventures located in California, Massachusetts, and New York (column 6), incorporated ventures (column 7), founders with MBAs (column 8), and student founders (column 9).

Judge ranks remain predictive of outcomes in all cases except among founders with MBAs. They are most predictive for incorporated ventures, which may be easier to assess because they are more mature. The above robustness tests for winning in Table 6 yield similar results for survival and 10-plus employees; these are available on request. With the exception of technology type (discussed below), the remarkable consistency of the effect across subsamples indicates that conditional on selecting to participate in a competition, winning provides ventures with roughly homogenous benefits.

5. Interpretation

This section introduces two possible mechanisms for the positive effect of winning on subsequent financing: cash (Section 5.1) and certification (Section 5.2).

5.1. Channel 1: Cash

Nondilutive cash may directly alleviate financing constraints. Founders could, for example, use it to build initial prototypes of their products, which might reduce uncertainty about the startup among prospective investors. Cash could also improve the bargaining position of the entrepreneur or reduce the amount of outside equity needed. Indeed, independent of winning, the cash prize is useful, with positive effects on financing, survival, and employment (Tables 2 and 4).

Yet the effect is economically small relative to the effects of winning either a preliminary or final round, and the effect of winning a final round is stronger among winners that do not receive a prize. The effect of the cash prize is also small relative to the predictive power of rank. Even in the specification where it has the largest, most robust coefficients, the effect of an additional $10,000 is similar to or smaller than one decile of rank's predictive power. It is also smaller in economic magnitude than the effect of US Department of Energy SBIR grants found in Howell (2017). The effect of an additional $10,000 in SBIR grants on the probability of subsequent financing is 0.66 pp, or 8% of the sample mean, compared to about 1 pp, or 4% of the sample mean, for the same amount of competition prize money.[16]

Heterogeneity in the effect of the cash prize exists for two variables and suggests that the cash prize is more impactful among more financially constrained ventures. Table 7 interacts all covariates except the competition fixed effects with a characteristic C. Column 1 shows that the cash prize has a significantly smaller effect for founders with elite college degrees.[17] Column 2 shows that the cash prize has a significantly smaller effect for founders who were previously the CEO or founder of a different venture (i.e., serial entrepreneurs). Founders with top college degrees are likely wealthier (Chetty et al., 2017) and may have superior access to investor networks. The sensitivity of nonelite college founders' venture outcomes to cash suggests that cash prizes may help to level the entrepreneurship playing field. Serial entrepreneurs also may have better access to investor networks and may have accumulated capital from the previous venture. Both these types of founders are likely less financially constrained.

5.2. Channel 2: Certification

Winning could be an informative signal to the market, especially to early stage investors. If certification is the primary mechanism for the positive effect of winning on financing and real outcomes, it should be the case that

1. Winning has a strong effect independent of any cash prize effect;
2. Judge scores and ranks are informative about outcomes;
3. Winning is impactful among marginal ventures and
4. Winning is more impactful for Internet- or software-based ventures.

The first two hypotheses are the most important, and the last two are ancillary. The evidence is consistent with the first hypothesis. Table 3 shows that winning has an effect separate from the prize. Moreover, winning a final round is more impactful among winners that do not receive a cash prize (Table 3, column 3). Further, winning an average prize of $73,000 has a smaller effect than winning only a preliminary round. Finally, while the cash prize has a positive effect in some specifications, it is not robust across models (e.g., Table 3, columns 1, 2, and 5). The cash prize, which is awarded to the highest-ranked winners, may to some degree crowd out private investment.

Second, since winning is a binary transformation of judge ranks, rational investors should perceive winning as a quality signal only if the aggregated opinion of the judges is informative about venture outcomes. As explained in Section 4.4, the judge ranks are strongly predictive of success, even in competitions where ventures do not learn their ranks and so cannot be affected by them. This is consistent with an important role for information on how the competitions are useful.

The third hypothesis is that a quality signal should be impactful for marginal ventures that are not clearly positive net present value (NPV) investments. Two findings are consistent with this. First, the effect is larger (16–17 pp) using narrow bandwidths of one or two firms around the cutoff for winning. This means that the effect is larger for firms that just barely won, relative to higher-ranked winners. These results indicate that ventures of more marginal quality in the vicinity of the cutoff benefit most from winning rather than the effect being consistent

[16] A $150,000 SBIR grant increased the probability a venture subsequently received external financing by about 10 pp. Thus an extra $10,000 in SBIR grants was associated with a 0.66 pp increase in financing, while in the competition context an extra $10,000 is associated with a 1 pp increase. The sample means are 8% and 24%, respectively.

[17] The definition of "elite" is the top ten colleges (Appendix Table A.2). The result is robust to only using Harvard-Stanford-MIT or the top 20colleges.

Table 7
Heterogeneity in effect of rank and winning on external finance.
This table shows regression estimates of heterogeneity in the effect of winning, rank, and cash prize on whether the venture raised external financing after the competition.

Dependent variable: financing after round			
C:	Founder BA from top 10 college	Founder founded previous company	Internet/software-based venture
	(1)	(2)	(3)
Won round	0.13***	0.097***	0.041
	(0.028)	(0.035)	(0.031)
Won round · *C*	–0.0027	0.049	0.21***
	(0.081)	(0.058)	(0.056)
Decile rank winners	–0.011**	–0.0057	–0.0089*
	(0.0046)	(0.0059)	(0.0048)
Decile rank winners · *C*	–0.0039	–0.013*	–0.0087
	(0.013)	(0.0077)	(0.0076)
Decile rank losers	–0.018***	–0.015***	–0.014***
	(0.0026)	(0.003)	(0.0024)
Decile rank losers · *C*	0.0068	–0.0075	–0.011**
	(0.0083)	(0.0048)	(0.0048)
Prize (10,000$)	0.0098***	0.013***	0.0042
	(0.0024)	(0.0029)	(0.0036)
Prize (10,000$) · *C*	–0.013**	–0.0084**	0.0016
	(0.0056)	(0.004)	(0.0044)
C	0.076	0.14***	0.28***
	(0.049)	(0.03)	(0.036)
Comp. round panel f.e.	Y	Y	Y
N	6,023	6,023	6,023
R^2	0.17	0.18	0.24

Note: The sample consists of subsets of all venture-round observations as described in Table 1 Panel B. The level of observation is a venture in a round (or panel if the competitions divides rounds into discrete judging panels). The characteristic in the column header is interacted with all covariates except the competition fixed effects. Competition fixed effects control for the date. Errors are clustered by competition round panel. *** indicates p-value < 0.01.

among lower- and higher-ranked winners. Second, information asymmetry between ventures and investors is likely higher in preliminary rounds. There should be more uncertainty about quality for preliminary round participants because they include all finalists as well as a left tail of lower-quality ventures. However, preliminary round winners are less observable, which should be expected to temper potential certification. Table 3 demonstrates that winning a preliminary round is independently very useful. Winning a preliminary round but not a final round is, at most, only slightly less useful than winning a final round (the difference between 8.6 and 12 pp in columns 2 and 5). These results point to winning having an effect for those ventures that the judges deem marginal.

The last hypothesis is that certification from winning should be more impactful among Internet- or software-based ventures. There are two reasons, both of which emerge from the theory and findings in Ewens et al. (2018). First, the low costs of starting an Internet- or software-based venture should increase entry, resulting in more marginal entrants. Second, precisely because it is cheaper to experiment in funding these sorts of ventures, investors can more readily pursue a "spray and pray" strategy with minimal due diligence than they can with hardware startups that require large initial investments. Therefore, the signal of winning a competition, which is essentially costless for the VC to acquire, is likely to be more impactful. Table 7, column 3 shows that the main effect of winning is driven by Internet- or software-based ventures. The cash award is not differentially helpful for these ventures.

There are two alternative explanations for the effect of winning. First, it may be that the investors driving the main effect are the judges themselves; recall that about half of judges are angel or VC investors. If this were the case, the competitions might reduce search costs through a convening function. However, as Internet Appendix Table A.3 shows, in only 0.2% of judge-venture pairs did the judge or judge's firm invest in the venture. Further, as mentioned above, controlling for the judge or judge's firm investing has no effect on the estimate. Second, it is possible that the effect could reflect type revelation on the part of the entrepreneur. If an entrepreneur is uncertain about the quality of his own venture, he might perceive winning as a positive signal and be more likely to continue rather than abandon the venture. If this is the case, it means that the certification function serves to alleviate information problems for the entrepreneur as well as (or in lieu of) the investor. However, the effect of winning on venture survival is much smaller than the effect on financing, at about 14% of the mean (Table 4, column 1), relative to 54% for financing (Table 2, column 2). This suggests that the effect of winning on venture success acts primarily through reducing information asymmetry with investors.

In sum, the large effect of winning independent of the cash prize effect and the fact that ranks are informative indicate that competitions produce valuable signals to early stage investors about venture quality. While certification may not be the only way that competitions are useful to entrepreneurs, it is an important mechanism driving the effect. Using the most conservative estimates from preliminary rounds and winners that do not receive a prize, the

effect of certification is between 8 and 9 pp, or a 35% increase relative to the mean of 24% (Table 2, Panel A, column 6, and Table 4 columns 1, 5, and 6). This contrasts with the finding in Howell (2017) that SBIR grants do not serve a certification function and instead appear useful because the cash award funds prototyping. In the competition context, winning has a larger effect among winners that do not receive a cash prize. Top-ranked winners can send strong signals independent of the competition and so are likely less financially constrained.

6. Conclusion

In the presence of asymmetric information and search costs, it is difficult for VCs to identify the most promising early stage startups. As the barriers to entry have fallen, especially for Internet- and software-based ventures, new intermediaries are screening and offering support to very early stage startups. Such intermediaries could serve an information provision function, filling a gap that may have emerged, as some VCs either shift to later stages of the startup lifecycle or do less independent due diligence. In the context of competitions, an important new intermediary, this paper demonstrates the large magnitude of information frictions in early-stage startup financing. It shows that new venture competitions help identify promising ventures by certifying winning ventures as high quality. Marginal winners benefit a lot, consistent with being the ventures for which information asymmetry is a binding constraint on financing.

This paper also provides the first systematic, causal evaluation of whether and how new venture competitions are useful to participating startups. Winning has economically significant positive effects on subsequent financing, employment, and successful exit (acquisition/IPO). Notably, winning is quite useful in preliminary rounds and is most useful among those final round winners that do not receive cash prizes. Cash prizes are useful, but their effect is small relative to the effect of winning and the predictive power of rank. These results have implications for competition organizers. Rather than focusing on large cash prizes, competitions might consider directing resources to improve the quality of judging and market signaling.

References

Barrows, G., 2018. Do entrepreneurship policies work? Evidence from 460 start-up program competitions across the globe. Working paper. French Association of Environmental and Resource Economists.

Bernstein, S., Korteweg, A., Laws, K., 2017. Attracting early-stage investors: evidence from a randomized field experiment. J. Financ. 72 (2), 509–538.

Blevins, C., Mullen, L., 2015. Jane, John... Leslie? A historical method for algorithmic gender prediction. Dig. Hum. Q. 9 (3).

Cao, R., 2018. Information frictions in new venture finance: Evidence from product hunt rankings. Working paper. Harvard University.

Chetty, R., Friedman, J. N., Saez, E., Turner, N., Yagan, D., 2017. Mobility report cards: the role of colleges in intergenerational mobility. Working paper. Stanford University, Brown University, UC Berkeley, and NBER.

Ewens, M., Gorbenko, A.S., Korteweg, A., 2018. Venture capital contracts. Working paper. Caltech and USC Marshall.

Ewens, M., Nanda, R., Rhodes-Kropf, M., 2018. Cost of experimentation and the evolution of venture capital. J. Financ. Econ. 128 (3), 422–442.

Ewens, M., Townsend, R.R., 2019. Are early stage investors biased against women? J. Financ. Econ. https://www.sciencedirect.com/science/article/pii/S0304405X19301758.

Fafchamps, M., Quinn, S., 2017. Aspire. J. Dev. Stud. 53 (10), 1615–1633.

Gompers, P., Gornall, W., Kaplan, S. N., Strebulaev, I. A., 2016. How do venture capitalists make decisions? Working paper, Harvard Business School, National Bureau of Economic Research.

Gompers, P., Lerner, J., 2001. The venture capital revolution. J. Econ. Perspect. 15 (2), 145–168.

Gonzalez-Uribe, J., Leatherbee, M., 2017. The effects of business accelerators on venture performance: evidence from start-up chile. Rev. Financ. Stud. 31 (4), 1566–1603.

Gornall, W., Strebulaev, I.A., 2015. The economic impact of venture capital: evidence from public companies. Working paper Stanford University Graduate School of Business Research.

Hellmann, T., 2006. Ipos, acquisitions, and the use of convertible securities in venture capital. J. Financ. Econ. 81 (3), 649–679.

Hildebrand, T., Puri, M., Rocholl, J., 2016. Adverse incentives in crowdfunding. Manag. Sci. 63 (3), 587–608.

Hochberg, Y., Serrano, C.J., Ziedonis, R.H., 2018. Patent collateral, investor commitment, and the market for venture lending. J. Financ. Econ. 130 (1), 74–94.

Hochberg, Y.V., Fehder, D.C., 2015. Accelerators and ecosystems. Science 348 (6240), 1202–1203.

Hombert, J., Schoar, A., Sraer, D., Thesmar, D., 2016. Can unemployment insurance spur entrepreneurial activity? Evidence from france. Working paper NBER.

Howell, S.T., 2017. Financing innovation: evidence from R&D grants. Am. Econ. Rev. 107 (4), 1136–1164.

Inderst, R., Müller, H.M., 2004. The effect of capital market characteristics on the value of start-up firms. J. Financ. Econ. 72 (2), 319–356.

Kaplan, S.N., Klebanov, M.M., Sørensen, M., 2012. Which CEO characteristics and abilities matter? J. Financ. 67 (3), 973–1007.

Kaplan, S.N., Lerner, J., 2010. It ain't broke: the past, present, and future of venture capital. J. Appl. Corp. Financ. 22 (2), 36–47.

Kaplan, S.N., Sensoy, B.A., Strömberg, P., 2009. Should investors bet on the jockey or the horse? Evidence from the evolution of firms from early business plans to public companies. J. Financ. 64 (1), 75–115.

Klapper, L., Laeven, L., Rajan, R., 2006. Entry regulation as a barrier to entrepreneurship. J. Financ. Econ. 82 (3), 591–629.

Klinger, B., Schündeln, M., 2011. Can entrepreneurial activity be taught? quasi-experimental evidence from central america. World Dev. 39 (9), 1592–1610.

Lach, S., 2002. Do r&d subsidies stimulate or displace private r&d? evidence from israel. J. Ind. Econ. 50 (4), 369–390.

Lee, D.S., Card, D., 2008. Regression discontinuity inference with specification error. J. Econ. 142 (2), 655–674.

Lee, D.S., Lemieux, T., 2010. Regression discontinuity designs in economics. J. Econ. Literat. 48 (2), 281–355.

Levine, R., Rubinstein, Y., 2016. Smart and illicit: Who becomes an entrepreneur and does it pay? Q. J. Econ.

Lindsey, L., 2008. Blurring firm boundaries: the role of venture capital in strategic alliances. J. Financ. 63 (3), 1137–1168.

McCrary, J., 2008. Manipulation of the running variable in the regression discontinuity design: a density test. J. Econ. 142 (2), 698–714.

McKenzie, D., 2017. Identifying and spurring high-growth entrepreneurship: experimental evidence from a business plan competition. Am. Econ. Rev. 107 (8), 2278–2307.

Miller, P., Bound, K., 2011. The startup factories: the rise of accelerator programmes to support new technology ventures. Working paper NESTA.

Mollick, E., 2014. The dynamics of crowdfunding: an exploratory study. J. Bus. Ventur. 29 (1), 1–16.

Ozmel, U., Robinson, D.T., Stuart, T.E., 2013. Strategic alliances, venture capital, and exit decisions in early stage high-tech firms. J. Financ. Econ. 107 (3), 655–670.

Sørensen, M., 2007. How smart is smart money? a two-sided matching model of venture capital. J. Financ. 62 (6), 2725–2762.

Tian, X., 2011. The causes and consequences of venture capital stage financing. J. Financ. Econ. 101 (1), 132–159.

Yu, S., 2019. How do accelerators impact the performance of high-technology ventures? Manag. Sci. https://www.sciencedirect.com/science/article/pii/S0304405X19301758.