

Online-only, Not-for-Publication, Supplemental Materials

For “Information Frictions and Employee Sorting Between Startups” by Kevin Bryan, Mitchell Hoffman, Amir Sariri

There are four parts in the online-only, not-for-publication Supplemental Materials. [Appendix E](#) is a Data Appendix containing definitions of variables and details on the creation of the sample. [Appendix F](#) provides key documents from the Secondary RCT. [Appendix G](#) provides further details on the survey of economist experts. [Appendix H](#) shows the detailed explanation of the quadratic scoring rule that was made available to subjects (in addition to the simpler and intuitive explanation that was provided to subjects and that can be seen in [Appendix D](#)).

Appendix E Data Appendix

E.1 Creating Our Samples of Workers and Firms

Candidates contacted. For the Primary RCT, we contacted business school alumni from two North American business schools in three different email campaigns. From the first business school, we reached out to 7,894 Master’s alumni on May 27, 2019 with a reminder sent on June 21, to 5,721 undergraduate alumni from the same school on June 25, 2019 with a reminder sent on July 9. For the second business school, we reached out to 3,701 undergraduate and 2,083 Master’s alumni on August 6, 2019, though the school preferred not to send a second reminder. Furthermore, 40 double-degree alumni from the first school were contacted twice. In calculating our balance tables, we remove these individuals from the undergraduate subsample, resulting in 5,681 undergraduate alumni. Thus, we contacted 19,359 unique alumni. PhD alum were not emailed.

Subjects. We received 264 survey submissions. We dropped from this set 4 repeat submissions from identical individuals where we only kept their earlier time-stamped submission. We dropped 1 dummy submission by a staff member of the SEP. Finally, we dropped 9 submissions by individuals who we could not match to our original contact lists. We managed to contact 5 of these individuals; they all told us that their friends and family had forwarded the Job Board email invitation to them. The remaining 250 submissions constitute our Primary RCT data.

In Section 3 of the main text, we discuss the tracking data which allow us to provide information on the participation rate conditional on clicking on the job board link. As mentioned, there were 587 recipients who opened the email and clicked on the job board link. 93 out of 587 recipients clicked the link in the reminder email. It is possible that some of those 93 people overlap with the initial 494 people who clicked from the original email. This makes the lower bound of unique individuals equal to 494, which would make the participation rate even higher than 46%. Within each individual email, people are unique.

Startups. Primary RCT ventures are 26 startups recruited from the SEP’s 2018-19 cohort. The Secondary (pilot) RCT ventures are 26 startups selected from the 2017-18 cohort. The analysis in Table 1, which shows the correlation between expert ratings and performance, uses the full cohort of 130 startups in 2017-18, from which 24 startups were dropped due to missing one or both scores.

E.2 Random Assignment using Unique URLs

It would not be possible for a job seeker to know from the website link that an experiment was going on. The randomization trigger was part of a non-descript block

of text such as “nytimes.com/sports?id=Aa674k”. The text following the question mark is referred to as a “url query”. In nine cases, dropped from our analysis, we received applications from people who were not the original targeted recipient of the job board invite.

E.3 Description of Variables

Gender. Obtained by linking first names to the US Social Security Administration’s list of most common names by gender. Names with a greater than 50% chance of being male are classified as male, whereas names with a greater than 50% chance of being female are classified as female.

Race. By clicking on the link provided on the resume, race is obtained by checking the social media (typically LinkedIn) profile of the candidate. In the absence of a web link, individual names are searched online and identification is ensured by cross referencing profile information with resume information. All other cases are obtained by linking last names with census information on the distribution of race by last name.

City is SEP HQ is an indicator equal to 1 if worker’s lives in the same city as SEP HQ.

Graduation year is a worker’s year of graduation obtained from the business school registrar’s office records.

Startup founder is an indicator from resumes equal to 1 if the applicant founded a business.

Startup employee is an indicator from resumes equal to 1 if the worker has startup employment experience.

Employed is an indicator from resumes equal to 1 if the worker is currently employed.

Years of experience is an integer from resumes equal to the total years of worker experience rounded to the nearest year. Includes internships.

STEM is a binary variable from the applicant’s resume that is equal to 1 if the candidate listed an undergraduate degree in natural, formal, or engineering sciences.

Worker Quality (1-10) is a number from 1 to 10 that reflects candidate quality for a business development job at a fast-growing, science-based startup that has just received early venture capital investment (10 is the highest score). An independent startup-focused HR expert determined these scores based on de-identified worker resumes.

Predicted Salary (Thousand) is the annual salary the worker should be offered in order for the startup to have a chance at hiring them. An independent experienced HR consultant determined these salaries based on de-identified worker resumes.

Number of founders is an integer that is equal to the size of the founding team reported on the application form of the firms submitted to SEP in the summer of 2018.

Number of employees is an integer that is equal to the number of non-founding employees reported on the application form of the firms submitted to SEP in the summer of 2018.

PhD founder is an indicator from startup applications to SEP equal to 1 if the startup had at least one PhD founder.

Technology fixed effects are a series of dummy variables reflecting the core technology of the startup. These include machine learning, quantum machine learning, blockchain, space, cities, and health.

Pct SEP Activities Completed is the fraction of high-priority business objectives firms completed during SEP. Every eight weeks, founders and mentors set three objectives that constitute the highest priorities of startups. SEP then verifies whether each objective is completed.

BizDev experience is an indicator from startup applications to SEP equal to 1 if the startup had at least one founder with business development professional experience. It includes experience in marketing, operations, finance, or other executive roles.

Top 1/3 Page is an indicator equal to 1 if the startup’s profile is positioned in the top one-third of the website.

Raised capital is an indicator obtained from SEP internal data equal to 1 if the firm raised external capital before the experiment.

E.4 Description of AngelList classification

We examine the full text of all 1017 advertisements for a full-time job posted on AngelList’s job board between October 30 and November 13, 2020 by a startup with between 1 and 10 employees. 40.4% of the advertisements are for non-technical roles, including sales, marketing, upper management, HR, communications, and finance. The remainder are technical roles, largely engineering. From each advertisement, we hand-code the following variables.

Founder Education. The advertisement lists the university at least one founder holds a degree from.

Academic Spinout. The advertisement describes the firm as based on, or a spinout from, an academic lab or academic research performed by the founding team.

Other spinout. The advertisement describes the firm as based on, or a spinout from, work done at an incumbent firm or government agency.

Incubator Participation. The advertisement lists participation in a named incubator or accelerator.

Formal IP. The advertisement notes that the firm holds formal IP such as a patent or pending patent.

Named Buyer or Partner. The advertisement specifically names a current customer or partner.

International Sales. The advertisement notes the company has made sales beyond its country of origin.

Named Investor or Large Grant. The advertisement notes that the company has received funding from a named investor, foundation, or government agency.

Unnamed Investor’s Prior Exits. The advertisement describes the company as receiving investment from the backer of a prior named successful startup.

Prize or Contest Winner. The advertisement describes the company as a winner (including non-first prize winners) of any business model, technical, or product contest.

Prominent Advisor. The advertisement describes the firm as being advised or mentored by a specific named person.

Founder’s Startup/Corporate Experience. The advertisement describes the founders as having previously led a successful exit, founded a named startup, or worked in an executive position at a related incumbent firm.

Founder’s Award for Related Work. The advertisement notes that a founder has won a prize, or is well-known for, work related to the startup.

Media Mention. The advertisement listed a named media source as having written up the company, or the company has participated in a popular entrepreneurship program like Dragon’s Den or Shark Tank, or the company has appeared on Product Hunt.

Tech Based on Published Science. The firm’s technology is described as being derived from published, peer-reviewed scientific work.

Specific Sales Traction. Specific sales success, such as a high position on an App Store, are included in the advertisement.

Product Description. The advertisement describes the company’s primary product. In general, “stealth” startups are the only ones who do not give this detail.

Technical Description. The advertisement gives specific technical details about the operation or production or nature of the product (e.g., “We use a generative adversarial network to investigate financial fraud...”).

Business Model/Monetization Strategy. The advertisement specifically describes how the product is being monetized or scaled (e.g., “We operate a two-sided platform where we charge banks to connect to our high net-worth investors...”).

Appendix F Key Documents from the Secondary RCT

The two figures below show a sample startup dossier and treatment shown to MBA students in the Secondary RCT. The top panel shows the background information provided, while the bottom panel shows how expert ratings were displayed for the group that received both the Business Model and Science scores.

Sample Startup Dossier Shown to MBA Students



Prospectus ID: 67139

VENTURE OVERVIEW:

Company's patent-pending technology employs a novel generative synthesis approach to dramatically reduce the size of deep neural networks while maintaining (and sometimes improving) their functional characteristics. The applications of this IP are numerous, most notably the optimization of neural networks for both cloud and edge systems.

PRODUCT DETAILS

Describe how your product or service works.

Company's engine is employed as follows: 1) the user provides a model or task, training inputs, and hardware and performance specifications; 2) the Company engine builds an optimized deep neural network up to three orders of magnitude more compact than the original; 3) the network is deployed and significant performance gains are realized; 4) the network is re-optimized using the platform as new training data becomes available and/or new features are added.

What is the value proposition for your customers?

The value proposition for customers is twofold: 1) a dramatic reduction in the cost to run deep learning solutions (Company achieved an 80 percent reduction in cloud costs for one of its clients); 2) enabling real-time deep learning solutions on the edge, such as a cell phone or stand-alone GPUs (Company can enable powerful convolutional neural networks on modest hardware chips that would otherwise require large computing infrastructures).

Do you have a working prototype or demo?

Company's technology is currently being used by clients across numerous verticals, including automotive, security & surveillance, and manufacturing. In addition, Company has used the engine to construct prototypes and demos that illustrate the power of the platform: (link to video demonstration – omitted)

How do you sell to your customer?

Company currently generates revenues from constructing end-to-end solutions for enterprise clients. Company's future commercialization strategy will be based on a B2B licensing and a SaaS model, as well as, secondarily, a B2C model, charging fees to individuals to use the self-service platform (primarily for its academic benefits).

Who else is selling to your customer and why will your customer buy your product or service instead of your competitor's?

Although there are other players in the deep learning optimization space (e.g., SigOpt, XNOR.AI), Company's technology provides: 1) better performance without sacrificing accuracy (the neural networks generated by Company are smaller, faster and have equal or better accuracy compared to other models); 2) flexible hardware endpoints (optimizes neural networks for CPUs, GPUs, FPGAs and DSPs on cloud and embedded systems); 3) AI at the edge (enables AR/VR, IoT, real-time visual and audio perception possible on edge devices); 4) scope and flexibility (works against any deep neural network architecture).

What is the long-term vision of your company and how is your product going to change the world?

The ultimate goal of Company is to increase scope, power and efficacy of AI solutions through its deep learning optimization technology. Company wants to unearth new possibilities for deep learning (medical, aerospace, education) and accelerate those areas where it is already being employed.

Treatment Shown to the Group Receiving both Business Model and Science Scores

Advisor	14.5%
SCIENTIST OPINION OF FIRM'S SCIENCE	
Below Average	
<p><i>A scientist from Canada's National Research Council with expertise in the technical area where this Company operates was asked to evaluate this firm's underlying science quality and the team's technical ability. Scientists score companies as 1, 2, 3, 4, or 5. We excluded the 1's and 2's, which are fairly uncommon. The most common (or modal) score is 4. We randomly selected firms from the 3's and 5's. Thus, a score of 5 is Above Average and 3 is Below Average. Among the 20 CDL firms chosen, about half are 3's and half are 5's.</i></p>	
ANALYST OPINION OF BUSINESS MODEL	
Below Average	
<p><i>People with experience in the evaluation of technology-based start-ups were asked to evaluate this firm's business model, scalability, and potential to execute, on the basis of information like what you have seen. Two to four evaluators scored each start-up on a 1-10 scale. The average score among all firms is about 6.5. Thus, Above Average means 7 or higher, and Below Average means 6 or below. Among the 20 CDL firms chosen, about half are Above Average and half are Below Average.</i></p>	
Notable Talent:	
<p>██████████ PhD, Systems Design Engineering</p>	

Appendix G Survey of Economist Experts

Of the 270 NBER economists contacted, 120 were attendees from NBER Personnel, 100 were attendees from NBER Entrepreneurship, and 50 were attendees from NBER Labor.⁵ Our 32% response rate from NBER economists is slightly higher than that in a leading recent study by [Deshpande & Dizon-Ross \(2023\)](#) who receive a response rate of 24% in surveying members from the NBER Children and Education groups. Note that we do not know the job titles (e.g., full professor, associate professor, ...) for the 10 responses from the Social Science Prediction Platform. Results in the economist survey are qualitatively similar when restricting to faculty members.

As in any expert prediction exercise, it is critical that experts are not already familiar with the results of the study. We addressed this point in two ways. First, in drawing our base survey sample of 270 NBER economists, we manually excluded several economists we believed were familiar with the results (e.g., by seeing the paper at a seminar). Second, as described in the main text, we began the survey by asking a screener question.

Question 1: As a screening question, are you familiar with the main findings from the NBER working paper “Information Frictions and Employee Sorting between Start-ups?” For example, have you read the paper or its abstract?

- Yes
- No

If the respondent answers “Yes” to being aware of the study’s main results, the survey terminates. If the answer is “No,” then the respondent sees an overview of the study before proceeding to the prediction questions. Below is the description that respondents saw about our study:

⁵Some economists attend multiple meetings from our set of Personnel, Entrepreneurship, and Labor. We drew first from Personnel attendees, second from Entrepreneurship, and third from Labor. Thus, an economist who attended Personnel and Entrepreneurship would count as a Personnel attendee, and an economist who attended Entrepreneurship and Labor would count as an Entrepreneurship attendee.

Overview of the study

Alum of two North American business schools were invited to participate in a startup job board. This job board featured 26 early-stage science-based startups who had 1) participated in a world-leading entrepreneurship program, and 2) chose to be on the job board. To fix ideas, a typical startup in our setting would be one founded by two computer science professors with an advancement in artificial intelligence for autonomous vehicles.

Treatments

Each job seeker was randomly selected to receive a customized link to one of the four versions of the job board. The **control group** saw a job board with just the ads written by the startups. The remaining three groups saw those ads alongside a note indicating whether the startup's **science** and/or **business** quality received an above-average expert rating.

The science expert rating was determined by a PhD scientist from Canada's National Research Council with expertise in the startup's technological domain. This rating was based on a 30-minute interview with founders and detailed written materials the venture provided in advance of the meeting. The business expert rating was provided by experts with experience in the evaluation of technology-based startups who were asked to evaluate the startups' business models, scalability, and potential to execute. The business rating was based on an in-person interview and extensive documents, as well as informal interactions.

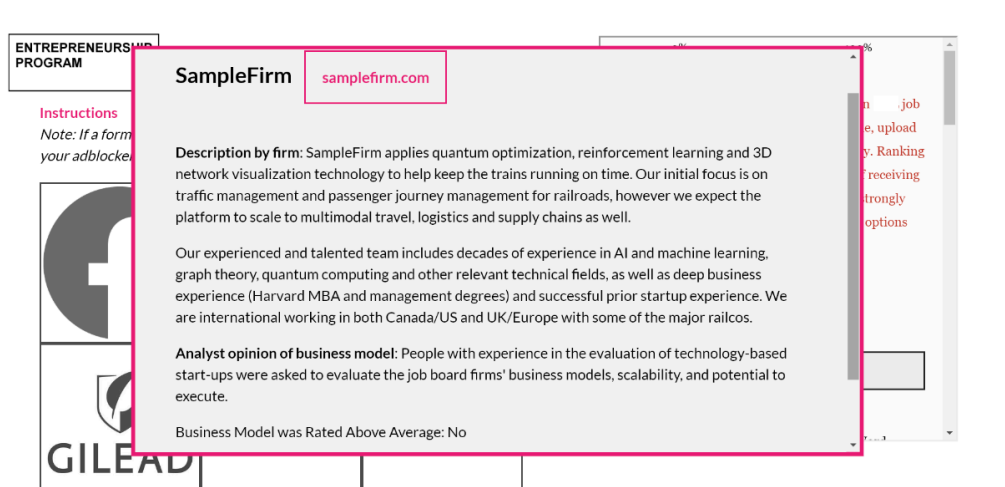
The image below summarizes our 2X2 RCT design:

	Hide Business Rating	Show Business Rating
Hide Science Rating	Standard Job Ad	Standard Job Ad + Business Rating
Show Science Rating	Standard Job Ad + Science Rating	Standard Job Ad + Science & Business Rating

Note: Standard Job Ad includes the firm's description, names of the founders, and link to the firm's website.

Overview of the study

The below screenshot shows a sample anonymized job ad with a negative business rating. Note that the expert rating treatment was at the **market level** and not at the job ad level--job seekers in a given job board either saw or did not see a given expert rating treatment for all job ads.



Next, we provide the full list of questions in the survey following the screener.

Question 2: Which had a larger effect on job applications, science or business expert ratings?

- Science expert ratings
- Business expert ratings
- Science and business expert ratings had about the same effect
- Both had no effect

Question 3: Which had a larger effect in terms of magnitude on job applications, positive or negative information?

- Positive information (i.e., information that firm quality is above-median within our sample) has a larger effect
- Negative information (i.e., information that firm quality is below-median within our sample) has a larger effect
- Positive and negative information had about the same effect in terms of magnitude
- Both had no effect

Question 4: Were science ratings and business ratings complements or substitutes in terms of their impact on job applications?

- Complements
- Substitutes
- Both had no effect

For the next questions, we define a good firm as one rated above-average in terms of both its science and business by experts. We define a bad firm as one rated below-average in terms of both its science and business by experts.

Please use a response of "X" to predict that good firms received X% more applications than bad firms, and use a response of "-X" to predict that bad firms received X% more applications than good firms. X is the number that you provide.

Question 5: Baseline: In the control group where we showed no expert ratings, how many percent (%) more or less applications did good firms receive compared to bad firms?

Question 6: Impact of Science Expert Ratings: When jobseekers viewed expert science ratings, how many percent (%) more or less applications did good firms receive compared to bad firms?

Question 7: Impact of Business Expert Ratings: When jobseekers viewed expert business ratings, how many percent (%) more or less applications did good firms receive compared to bad firms?

Question 8: Impact of Science and Business Expert Ratings: When jobseekers viewed both expert science and business ratings, how many percent (%) more or less applications did good firms receive compared to bad firms?

Question 9: Do you think the effect of expert ratings on job applications varied based on whether the job seeker had an undergraduate STEM degree?

- Yes, significantly smaller effect for those with a STEM degree than those without
- No difference based on worker STEM background
- Yes, significantly larger effect for those with a STEM degree than those without
- Expert ratings had no effect

Question 10: Do you think the effect of expert ratings on job applications varied based on the “quality” of the job seeker? To measure the job seeker quality, the project partnered with an HR expert who focuses on startup hiring. This HR expert rated the resumes of the job seekers based on suitability for working at a startup, and we divided these into above-median quality and below-median quality.

- Yes, significantly smaller effect for above-median quality candidates than for below-median
- No difference based on worker quality
- Yes, significantly larger effect for above-median quality candidates than for below-median
- Expert ratings had no effect

Question 11: Do you think the effect of expert ratings on job applications varied based on the gender of job seeker?

- Yes, significantly smaller effect for women than men
- No difference based on worker gender
- Yes, significantly larger effect for women than men
- Expert ratings had no effect

Appendix H Detailed Explanation of the Quadratic Scoring Rule

The figure below displays the more detailed explanation of the risk-invariant quadratic scoring rule that was made available to subjects (in addition to the simpler and intuitive explanation that was also provided to subjects, and that can be seen in [Appendix D](#)). This explanation was used in both the primary and secondary RCTs. The quadratic scoring rule is used to provide incentives on the probability questions. In the primary RCT, the more detailed explanation was accessed by clicking a link “For Further Detail”. In the secondary RCT, the more detailed explanation was given on a separate sheet of paper.

Quadratic Scoring Rule Explanation Sheet

INCENTIVES ON SOME PROBABILITY QUESTIONS:

As added encouragement on probability questions, five people who complete this survey will be chosen at random to be paid via a lottery system. Payment will be based on one of two questions below. This lottery system has been used to elicit people's probability beliefs in various contexts, and is specially designed so that **it's mathematically optimal for you to state your true belief about the probability an event will occur.**

Specifically, if you are randomly chosen for possible payment, you will receive \$250 CAD or \$0. The probability of receiving \$250 is equal to $2p-p^2$ if the event occurs, and is equal to $1-p^2$ if the event does not occur, where p is the probability that you give. The below table gives examples of your probability of winning \$250 depending on the probability that you state and whether the event in question occurs or not.

Your Stated Probability	Your probability of winning \$250 if event occurs	Your probability of winning \$250 if event does not occur
0	0.0000	1.0000
5	0.0975	0.9975
10	0.1900	0.9900
15	0.2775	0.9775
20	0.3600	0.9600
25	0.4375	0.9375
30	0.5100	0.9100
35	0.5775	0.8775
40	0.6400	0.8400
45	0.6975	0.7975
50	0.7500	0.7500
55	0.7975	0.6975
60	0.8400	0.6400
65	0.8775	0.5775
70	0.9100	0.5100
75	0.9375	0.4375
80	0.9600	0.3600
85	0.9775	0.2775
90	0.9900	0.1900
95	0.9975	0.0975
100	1.0000	0.0000