Give Me Your Tired, Your Poor, Your High-Skilled Labor: H-1B Lottery Outcomes and Entrepreneurial Success

Stephen G. Dimmock, Jiekun Huang, and Scott J. Weisbenner*

This draft: March 2, 2021

First draft: November 16, 2018

Abstract

We study how access to high-skill labor affects the outcomes of start-up firms. We obtain exogenous variation in firms' ability to access skilled labor by using win rates in H-1B visa lotteries. Relative to other firms that also applied for H-1B visas, firms with higher lottery win rates are more likely to receive additional venture capital funding and to have a successful exit via an IPO or acquisition. H-1B visa lottery winners also subsequently receive more patents and patent citations. Overall, our results suggest that access to high-skill labor is a critical determinant of success for start-up firms.

JEL Codes: D22, G24, G32, J23, J24, J61, O3

Keywords: Immigration, H-1B Visa, IPO, Venture Capital, Patent, Innovation, Skilled Labor, High-Skill Immigration, Hiring Constraints

*Stephen G. Dimmock, National University of Singapore, dimmock@nus.edu.sg. Jiekun Huang, University of Illinois at Urbana-Champaign, huangjk@illinois.edu. Scott J. Weisbenner, University of Illinois at Urbana-Champaign and National Bureau of Economic Research, weisbenn@illinois.edu. We thank Yunju Cha, Akshaya Muthu, Yu Sheng Loh, Phoon Ruei, and Chunxue Yang for excellent research assistance; and Steven Skiena and Junting Ye for providing access to *NamePrism*. For helpful comments we thank Zachary Arnold, William Gerken, Britta Glennon, Sari Kerr, Kai Li, Gustavo Manso (editor), Tim McQuade, Neil Pearson, Johan Sulaeman, Kenneth Swinerton, Yufeng Wu, an anonymous associate editor, and the referee; seminar participants at Australia National University, University of Illinois at Urbana-Champaign, and University of Wisconsin - Milwaukee; and participants at the American Economic Association, European Finance Association, Red Rock Finance, Singapore Symposium, and Western Finance Association conferences. All opinions expressed are those of the authors and not the National Bureau of Economic Research.

There is considerable debate about the desirability of allowing high-skill foreign workers to enter the U.S. Proponents argue that there is a shortage of high-skilled labor, creating a need for foreign workers. Accordingly, access to high-skilled foreign workers may benefit domestic firms, increasing investment and innovation. Yet, critics contend that, instead of filling a skill gap, foreign workers merely provide cheap labor and have little effect on investment and innovation by firms. Despite the intense debate, evidence on the effect of high-skill foreign workers on firm-level outcomes remains relatively scarce.

In the United States, firms can access high-skill foreign workers through the H-1B visa system. For each federal government fiscal year, there is a fixed quota of H-1B visas available to for-profit firms.[1] During years in which applications for H-1B workers exceed the available quota, the visas are allocated through a "lottery." By exogenously varying the supply of H-1B visas across firms that are ex ante similar, these lotteries provide an ideal setting to identify the causal effect of high-skilled foreign labor on the success of firms.

In this paper, we exploit exogenous variation in firms' H-1B visa lottery outcomes to identify how access to high-skill foreign workers affects the success of start-up firms. High-skill workers can contribute to the success of start-up firms by increasing productivity and innovation, as start-ups often depend heavily on their employees' human capital. If high-skilled foreign workers are important for the development of start-up firms, then winning the H-1B visa lottery could lead to better firm outcomes. There are at least two reasons, however, why H-1B visa lottery outcomes could have little effect on the success of start-up firms. First, access to domestic workers may allow firms to fully offset the results of the visa lotteries. Second, H-1B visa recipients could transfer to other firms after arriving in the U.S., making the outcome of the visa lottery irrelevant.

The success or failure of start-ups has significant economy-wide implications, making them an important group of firms to study. First, most large firms started as small firms. Thus, it is important to

[1] The H-1B visa quota does not apply to hiring by universities and certain non-profit organizations. In this paper, we study for-profit firms that are subject to the quota.

understand whether and how high-skill labor contributes to entrepreneurial success. Second, innovation and technological progress are key drivers of economic growth (Romer, 1990; Aghion and Howitt, 1992; Kogan, Papanikolaou, Seru, and Stoffman, 2017). Work dating back to Schumpeter (1942) highlights the role of start-ups in generating innovation and disruptive technologies. More recently, Gourio, Messer, and Siemer (2016) highlight how the number of start-ups in a region has an important role in explaining the region's long-term economic development.

We construct a sample of start-up firms in the Crunchbase dataset that filed H-1B petitions for government fiscal years in which all non-cap-exempt H-1B visas were awarded through lotteries. Unlike firms that submit a large number of applications, for which the win rate would converge to the aggregate win rate by the law of large numbers, the firms in our sample on average apply for 2.5 H-1B visas, providing reasonably large variations in the win rate.

The key identification assumption of our study is that a firm's H-1B lottery win rate is exogenous to the quality of the firm and its prospects. This assumption appears reasonable, as the U.S. Citizenship and Immigration Services (USCIS) states that it uses "a computer-generated random selection process"[2] to select H-1B visa applications in the years included in our sample. Nevertheless, to test the key identifying assumption, we regress the H-1B lottery win rate on firm and application characteristics. Consistent with H-1B visa lottery outcomes being random, we fail to find that lottery outcomes are significantly related to firm and application characteristics.

We find that the H-1B lottery win rate positively predicts the likelihood of receiving external financing during the next three years.[3] This result is robust to controlling for firm characteristics, such as the amount raised in prior funding rounds, the number of H-1B applications, and the average salary of the H-1B petitions. We further control for industry-city-year fixed effects, ensuring that our results are relevant for comparable firms. The economic magnitude of the result is large. For example, a one

[2] For example, see https://www.uscis.gov/news/alerts/uscis-completes-h-1b-cap-random-selection-process-fy-2019.
[3] By "external financing" we simply mean external, private investment, the majority of which is from venture capitalists. We also examine how H-1B visa lottery outcomes are related to subsequent venture capital funding.

standard deviation increase in the win rate is associated with a 4.4 percentage point increase in the likelihood that the firm receives subsequent external funding (a 10% increase relative to the baseline funding rate). Strikingly, the magnitude of this effect is little changed by the inclusion of controls or fixed effects, indicating that H-1B visa lottery outcomes are indeed random and uncorrelated with observable firm characteristics.

The positive relation between winning H-1B lotteries and receiving subsequent funding may arise because H-1B workers bring valuable human capital to firms or because H-1B workers provide cheap alternatives to domestic workers. We use the ratio of salary-to-prevailing wage to shed light on the economic mechanism underlying the result (the prevailing wage is the benchmark wage determined by the Department of Labor based on education, experience, occupational classification, and the geographic area). We find that the positive relation between winning H-1B visa lotteries and receiving subsequent funding is concentrated among firms whose H-1B applicants command a higher salary relative to the prevailing wage. This result is consistent with H-1B workers providing valuable human capital and hence enabling the firms to secure funding.

Because exit through initial public offerings (IPOs) or acquisitions is commonly used as a measure of success for start-up firms (e.g., Hochberg, Ljungqvist, and Lu, 2007; Sørensen, 2007; Kerr, Lerner, and Schoar, 2014; Bernstein, Giroud, and Townsend, 2016), we examine the effect of H-1B visa lottery outcomes on the probability of a successful exit. We find that firms with higher win rates are significantly more likely to have a successful exit. The economic magnitude of this result is large. A one standard deviation increase in the win rate is associated with a 1.4 percentage point increase in the probability of a successful exit over a three-year period following the lottery, representing a 14% increase relative to the baseline rate. We find a similar effect of winning H-1B visa lotteries on the probability of exit through IPOs. These results suggest that H-1B visa lotteries have long-term effects on start-up firms.

We next examine a mechanism through which high-skill foreign workers could affect the outcomes of start-up firms – through their contribution to innovation. To test this, we match firms with patent data and construct four measures of innovation performance: the number of patents, the adjusted

number of patents, the number of adjusted citations, and the average number of adjusted citations per patent. We find that the win rate in the H-1B visa lottery has a significant positive effect on patenting and patent citations. The economic magnitudes of the results are nontrivial. For example, a one standard deviation increase in the win rate is associated with a 5.8% increase in the number of patents. These results suggest that highly skilled foreign workers contribute to the innovation success of start-up firms.

To further evaluate whether H-1B workers contribute to firm innovation, we map inventor names to nationalities using the classification algorithm of Ye et al. (2017) and identify inventors who are likely immigrants from the countries that are the main sources of H-1B workers (likely H-1B inventors). We find a positive relation between a firm's win rate in the H-1B visa lottery and patent filings by likely H-1B inventors. This result provides suggestive evidence that H-1B workers are directly involved in the firm's innovation activities.

We also show that H-1B lottery success predicts an increase in H-1B applications in subsequent years. This suggests that, in addition to the direct effects of H-1B workers on firm outcomes, there may be indirect effects through increased demand for subsequent H-1B workers.

Our study has important policy implications. The findings that a higher win rate in H-1B visa lotteries leads to improved funding and patenting outcomes suggest that foreign workers do not simply provide cheap labor, but rather bring valuable human capital that is otherwise difficult for start-up firms to obtain. Thus, our results suggest that an immigration policy that facilitates access to high-skilled foreign workers for start-ups could produce significant economic benefits.

A caveat is that our results are specific to a system such as the H-1B program where there are significant frictions in the application process. Because of the high costs and uncertainty associated with H-1B applications, the marginal benefit from hiring a high-skill worker through the U.S. H-1B program is likely high compared to an immigration system with lower costs and uncertainty.

Our paper makes two contributions to the literature on the effect of high-skill immigrant workers. First, in contrast to much of this literature that relies on shocks to H-1B visa quotas at the national level (e.g., Kerr and Lincoln, 2010; Xu, 2018), we use shocks at the firm level generated by H-1B visa lotteries.

The quota approach, while clever and informative, has the disadvantage of relying on a small number of aggregate shocks that simultaneously affect all firms. In such studies, it is challenging to disentangle the effects of the aggregate shocks from other forces that may directly affect firm outcomes (e.g., Roberts and Whited, 2013). In contrast, exploiting firm-level exogenous variation in the win rate of H-1B lotteries allows us to provide precise causal estimates of how access to high-skill labor affects firm outcomes.

Second, we focus on a sample of innovative start-up firms for which access to high-skill workers is particularly important. Further, the success of start-up firms is critical for long-term economic growth. We also provide evidence that access to human capital is significantly related to obtaining external financing, both from private investments and through IPOs.

1. Related Literature

Our paper contributes to the literature on the effect of access to high-skilled foreign workers on firm outcomes. Kerr and Lincoln (2010), Ghosh, Mayda, and Ortega (2016), Ashraf and Ray (2017), and Xu (2018) examine the effect of the 2004 reduction in the H-1B quota on publicly traded firms. They find that firms that made more extensive use of the H-1B visa program reduced innovation and capital investment following the change. Our paper complements these analyses by focusing on variation in H-1B allocations to specific firms through the H-1B lottery system as opposed to a time-series change that affects all firms simultaneously and by focusing on a sample of innovative start-up firms rather than publicly traded firms.

Chen, Hshieh, and Zhang (2019) examine the 2004 reduction in the H-1B quota and also use H-1B lottery outcomes to examine how access to H-1B workers relates to funding and patenting outcomes for start-up firms. However, their empirical design makes their results difficult to interpret as causal effects. For example, their analysis of pooled cross sections of lottery outcomes effectively compares lottery winners to lottery losers *and* firms that do not participate in the lottery (i.e., firm-years without applications for any H-1B workers). Regressions of this type suffer from a serious selection bias as firms that apply for H-1B workers have had more past success and appear to have better prospects than non-

filers (see Internet Appendix Table 1). Chen, Hshieh, and Zhang (2019) also estimate cross-sectional regressions in which the dependent and independent variables are aggregated over the same nine-year period to form a single observation. In these regressions, the firm outcomes in the dependent variables can occur years before the lottery outcomes in the independent variables, making the results subject to reverse causality concerns.[4]

Doran, Gelber, and Isen (2020) also use the H-1B lottery as part of their identification strategy. They use H-1B visa lotteries in two fiscal years when only a small fraction of the visas were allocated through lotteries, and find that H-1B workers crowd out domestic workers and have little effect on patenting. While both our paper and Doran et al. use H-1B visa lotteries for identification, the two papers differ in three important ways. First, Doran et al. focus on labor outcomes and do not examine the firms' financing; Obtaining external financing is crucial for the survival and success of start-up firms. Second, we focus on high-tech start-up firms whose success depends critically on matching with the right employees. In contrast, Doran, Gelber, and Isen (2020) pool different types of firms in their analysis, which might mask substantial variation in the effect of lottery outcomes. Third, the four years of H-1B lotteries (i.e., fiscal years 2008, 2009, 2014, and 2015) we use provide sharper identification than the two years (i.e., fiscal years 2006 and 2007) Doran, Gelber, and Isen (2020) use.[5] In the four years we use, all 85,000 H-1B visas were allocated through lotteries. In contrast, only a small fraction of the visas in fiscal years 2006 and 2007 were allocated through lotteries. For example, in 2006, only about 150 visas (roughly 0.2% of the total) were allocated through lotteries for applications filed on the final receipt date

[4] Another issue with the empirical design of Chen, Hshieh, and Zhang (2019) is that they do not make adjustments for renewals and transfers in their measure of the demand for H-1B workers. As we show in Internet Appendix Tables 2 and 3, not making appropriate adjustments will introduce significant bias into the measure.

[5] While the main analysis of Doran, Gelber, and Isen (2020) uses partial lotteries in fiscal years 2006 and 2007, they also conduct an additional analysis using the lottery data for fiscal year 2008. However, they infer the number of H-1B applications using Labor Condition Applications (LCAs) submitted in March and April (as opposed to February and March) with a start date five to six months in the future. As Internet Appendix Table 3 shows, February and March account for 32.0% and 63.7% of the LCAs for new employment, respectively, with April only accounting for 0.5%. Thus, their measure of the number of H-1B applications contains significant measurement error.

when the quota is reached.[6] Given that the H-1B visa quota is common knowledge, H-1B applications filed on the final receipt date may be less important than the average application – if the worker was important to the firm, the firm would have submitted the application well before the quota was met. Thus, this sample selection could bias against finding significant positive effects of winning the lotteries.

Our paper also contributes to the literature on the importance of high-skill foreign workers for innovation. Studies such as Hunt and Gauthier-Loiselle (2010), Kerr and Lincoln (2010), and Bernstein, Diamond, McQuade, and Pousada (2019) show that immigrants are responsible for a disproportionately large share of U.S. innovation. Our paper complements these studies by using random assignment via lotteries to identify the effect of H-1B workers on innovation.

Our paper also complements studies such as Kerr, Lerner, and Schoar (2014) and Howell (2017), which provide causal evidence of the effects of angel financing and government R&D subsidies, respectively, on the outcomes of start-up firms. Both papers identify causal effects by exploiting internal rankings of agents who fund start-ups. As Kerr, Lerner, and Schoar (2014) highlight, identifying causal determinants of entrepreneurial success has proven a challenge for the literature. Our paper highlights, through random assignment, the importance of high-skilled labor to start-up firm outcomes, including economically large effects on patenting, the likelihood of obtaining financing, and having an IPO.

2. Background on H-1B Visas

The purpose of the H-1B visa program is to allow U.S. employers to hire skilled foreign workers in specialty occupations that require highly specialized knowledge and having at least a bachelor's degree in the specific specialty. An H-1B visa permits the holder to work in the U.S. for three years, renewable once for an additional three years (maximum total of six years), and the employer can sponsor the H-1B visa holder for permanent residency.

[6] Further, partial lotteries used by Doran et al. exhibit a high concentration of a single outcome. Specifically, the 2006 and 2007 regular lotteries have win rates of 3.8% and 98%, respectively. Thus, for a given lottery, the win rate is highly skewed, reducing the power to detect effects on firm outcomes. In contrast, the win rate in the four years in our sample ranges from 49.3% to 68.8%, which provides more evenly distributed winners and losers.

To receive an H-1B visa, an individual must have an offer of employment from a U.S. firm. The firm must file a Labor Condition Application (LCA) with the Department of Labor, stating that the employment offer complies with the requirements of the H-1B visa program. If the Department of Labor certifies the LCA, the firm may submit an I-129 petition for an H-1B visa to the USCIS.

The number of H-1B visas available to for-profit firms is capped in each federal government fiscal year (beginning on October 1 and ending September 30). During our sample period, the quota of available new H-1B visas was capped at 65,000 per fiscal year (the regular cap), with an additional quota of 20,000 H-1B visas available for individuals who hold a master's degree or Ph.D. from an eligible U.S. based university (the master's cap). The quota applies only to new H-1B applications (not renewals or transfers) made by for-profit firms.

LCAs can be filed up to six months before the employment starting date and typically take about a week to be approved. The USCIS begins processing applications on April 1 for positions beginning in October of that year and continues to process applications until that year's quota is filled. Figure 1 illustrates the timeline of the application process. Because of the sequential approval process, firms frequently "pre-date" LCA applications by filing LCAs prior to April 1, giving a start date that is 180 days in the future.[7] Pre-dated and approved LCAs can then be used to file I-129 petitions immediately at the beginning of April. The cost of pre-dating is that the firm loses one or two months at the end of the desired work period as LCAs are valid for a maximum of three years.

For fiscal years 2008, 2009, and each fiscal year beginning from 2014 onward, *all* new H-1B visas were allocated by "a computer-generated random selection process," because the quota of available H-1B visas was oversubscribed within the filing period (i.e., the first five business days of the April preceding the fiscal year).[8] In other years, because the cap was reached after the filing period, most visas were granted on a first-come-first-served basis. In years when the cap is reached within the filing period,

[7] For example, an LCA filed on March 1, 2014 for new employment would specify a start date of August 28, 2014 (although the effective start date is the start of the government fiscal year, i.e., October 1, 2014). See Peri, Shih, and Sparber (2015) for further discussion of pre-dating.

[8] For example, see https://www.uscis.gov/news/alerts/uscis-completes-h-1b-cap-random-selection-process-fy-2019.

USCIS first conducts a lottery to assign the 20,000 H-1B visas available under the master's cap. After this lottery, the unselected applicants from the master's cap lottery are pooled with the other applicants, and USCIS conducts a second lottery to assign the remaining 65,000 H-1B visas. Thus, individuals eligible for the master's cap pool have a higher probability of receiving an H-1B visa relative to ineligible applicants. Applications that are not selected in either lottery are then returned unopened, and USCIS does not retain records of the unselected applicants (see Clemens, 2013; Peri, Shih, and Sparber, 2015).

The USCIS processes the I-129 petitions selected in the lottery and denies those that fail to meet the H-1B program criteria (e.g., the employer is not a valid firm or the job does not require specialized knowledge or skill). During the last two years in our sample, when data on denials are available, the denial rate for the firms in our sample is only 3.1%. As will be discussed in Section 5.1, our baseline results are essentially unchanged if we adjust our win rate variable for denials.

Although H-1B visas are linked to specific employers, workers can change employers subject to USCIS approval. Such transfers do not count against the H-1B visa quota and are not subject to the lottery. Hunt and Xie (2019) find that 13.7% of H-1B workers change employers over a two-year period and conclude that H-1B workers and domestic workers have similar job mobility. However, Hunt and Xie (2019) and Wang (2020) find that job changes increase when visa holders receive permanent residency, suggesting that employers enjoy some monopsony power over H-1B workers. In our study, the ability of H-1B workers to change employers would bias downwards the true effects of obtaining an H-1B worker on firm outcomes.

3. Data and Variables

Our study combines data from multiple sources. We obtain data on H-1B visa applications and approvals from the Department of Labor and USCIS. We obtain data on a set of private start-up companies from Crunchbase. Finally, we obtain data on patents from the PatentsView data files provided by the United States Patent and Trademark Office (USPTO).

To construct our sample of firm-fiscal year observations, we begin with the set of Crunchbase firms that meet the following two criteria: (1) the firm is a private firm as of the April 1 preceding the federal government fiscal year, and (2) it has completed at least one round of external financing and the information on the dollar amount of the financing is available.[9] Using firm names and addresses, we match the Crunchbase firms to the H-1B data and retain the firms that applied for at least one H-1B visa for fiscal years 2008, 2009, 2014, and 2015. There are 1,866 unique firms meeting these criteria and 2,570 firm-year observations.

3.1. H-1B Visa Data

We obtain data on approved H-1B applications from USCIS through a Freedom of Information Act (FOIA) request filed on May 9, 2016. Our analyses focus on fiscal years 2008, 2009, 2014, and 2015, because in these fiscal years all new H-1B visas were granted through lotteries. The data provide the number of H-1B petitions for initial employment approved for each employer in each fiscal year.

We obtain data on firms' Labor Condition Applications (LCA) from the Department of Labor,[10] which provide information for each prospective foreign worker, including job information such as salary, start date, and end date; employer information such the firm's name, address, and NAICS code; and the status of the application (i.e., whether it is certified, withdrawn, or denied). We use the number of certified (and not withdrawn) LCAs for H-1B visas filed by a firm in February and March with a start date that is five to six months in the future as a proxy for the firm's demand for new H-1B workers in the upcoming fiscal year (i.e., a proxy for the number of H1-B applications).[11] Table 1 shows that the average firm-year in the sample applies for 2.5 H-1B visas. Just over half (58%) of the sample applies for a single visa and only 6.6% apply for more than five.

[9] The requirement that the firm must have prior funding at the time of the lottery is to ensure that the Crunchbase data for the firm are sufficiently detailed and to avoid look-ahead bias. The baseline results of the paper are essentially unchanged if we do not require firms to report the amount of prior funding for inclusion in our sample.
[10] The data are available at https://www.foreignlaborcert.doleta.gov/performancedata.cfm.
[11] See Section 4.2 for a detailed discussion of our choice of the screens.

Our key explanatory variable, *Win Rate*, equals the number of approved new H-1B visas divided by the number of applications. Table 1 shows that the average *Win Rate* for firms in the sample is 55%. Based on USCIS press releases, the overall H-1B lottery win rate for the four years in our sample is 56.6%.[12] Thus, the average *Win Rate* in our sample of start-up firms is comparable to that in the full sample. Panel A of Figure 2 shows a histogram of *Win Rate* across all 2,570 firm-year observations. Given that most firms in our sample apply for only a single visa, the observations are clustered at zero and one. The distribution of *Win Rate* highlights an important advantage of focusing on small firms – with few applications there is a large dispersion in *Win Rate*. We also consider an alternative measure of success in the H-1B lottery, *Win Any*, which is an indicator for whether a firm wins at least one H-1B visa in that firm-year. As shown in Table 1, the average of *Win Any* for the firm-years in the sample is 66%.

In the LCA filing, companies are required to state the salary offered to the H-1B visa applicant. For companies that file multiple LCAs in a given fiscal year, we take the average of the reported salaries. As Table 1 shows, the average (median) salary offered is $85,100 ($80,000).

We also compute the number of H-1B applications for new employment following a given lottery. Table 1 shows that our sample firms on average apply for 1.6, 3.2, and 4.7 new H-1B visas in the one, two, and three years following the lottery, respectively.

3.2. Crunchbase Data

We obtain data on start-up firms from Crunchbase, a crowd-sourced database that tracks events related to start-up companies, especially those in high-tech sectors.[13] As of April 2019, the dataset covers over 233,000 firms and more than 366,000 events (including private funding rounds, IPOs, and

[12] See https://www.uscis.gov/archive. The difference between the *Win Rate* in our sample and the overall H-1B lottery win rate is not significantly different from zero (p-value = 0.398).

[13] Crunchbase was founded in 2005 and the data before 2005 are backfilled (see Wang, 2017). Since our sample starts from federal government fiscal year 2008, this backfill issue is unlikely to bias our results. Several recent studies show that Crunchbase provides comprehensive and accurate coverage for early-stage companies (e.g., Block, Fisch, Hahn, and Sandner, 2015; Ling, 2016; Wang, 2017; Dalle, den Besten, and Menon, 2017).

acquisitions). For each firm, Crunchbase provides the name, address, and industry, as well as detailed information on the events (e.g., the date and amount of a funding round, IPO, or acquisition).

From the Crunchbase data, we create several control variables. Table 1 shows that firms in the sample have completed an average of 2.8 prior financing rounds, have received an average of $40.1 million in prior external financing, had their first financing round 56.0 months ago, and the most recent round 26.3 months ago. All control variables are measured as of the March 31 prior to the H-1B visa lottery, and thus are measured before the uncertainty related to the H-1B visa lottery is resolved. Figure 1 provides a timeline of the H-1B visa process and our variables.

From the Crunchbase data, we create several firm-level outcome variables based on events that occur during the three-year period beginning in October of the year of the H-1B lottery (i.e., the three-year period during which the H-1B visa recipient would be eligible to work in the U.S.). The first variable, *Funded*, is an indicator variable for firms that receive additional external financing, the majority of which is venture capital financing. Numerous prior studies use external financing as a signal of a start-up firm's success (e.g., Hochberg, Ljungqvist, and Lu, 2007; Kerr, Lerner, and Schoar, 2014; Howell, 2017). Table 1 shows that *Funded* has a mean of 44.7%. Panel B of Figure 2 shows *Funded* for different levels of *Win Rate* (conditional on having at least 100 observations, leaving 2,424 firm-year observations): firms with a *Win Rate* of zero receive subsequent funding 40.6% of the time, while firms with a *Win Rate* of 100% receive subsequent funding 48.9% of the time. This univariate result provides initial evidence that *Win Rate* is positively associated with the probability of securing external financing.

The variable *Funded by VC* is an indicator variable for receiving funding from a venture capital firm (as opposed to other types of external investors such as incubators and angel investors) in the three-year post-lottery period. *Funded by VC* is thus a subset of *Funded*. The average of *Funded by VC* is 31.4% in our sample.

From the Crunchbase data, we create two additional measures of firm outcomes. *IPO* is an indicator for firms that have an initial public offering during the post-lottery period. *Successful Exit* is an indicator for firms that either have an IPO or are acquired for at least $25 million (in inflation adjusted

2008 dollars).[14] We follow Bernstein, Giroud, and Townsend (2016) and include only acquisitions above this threshold as, unlike IPOs, acquisitions do not necessarily indicate a successful exit. Indeed, Metrick and Yasuda (2011) note that many acquisitions result in a loss for investors. The means of *IPO* and *Successful Exit* in our sample are 4.3% and 10.3%, respectively.

Internet Appendix Table 1 compares our sample of Crunchbase firms that file LCAs with Crunchbase firms that do not file LCAs. LCA filers, which actively seek high-skill foreign labor, appear to have better prospects than non-filers. LCA filers receive significantly more prior funding and are more likely to receive subsequent external funding and exit through an IPO. That is, the financing outcomes of LCA filers appear better both ex ante and ex post. Accordingly, in our empirical tests we limit the sample to include only Crunchbase firms that file LCAs, as this avoids sample selection biases. We do not compare a firm that desires to hire high-skill immigrant labor with a firm that does not, because these firms likely have different growth prospects. Instead, we compare two firms that both want to hire high-skill labor, with random chance determining which firm is allowed to hire the high-skill worker.

3.3. Patent Data

We obtain patent data from the USPTO PatentsView database,[15] and match Crunchbase firms to the patent assignees using firm names and locations. The PatentsView dataset includes information on patents granted starting in 1976, including information about technology classes and citations. For each approved patent, the dataset provides both the application and approval dates.

Using the PatentsView data, we create several variables that measure innovative output. Each of these variables is based on approved patents that the firm applied for during the three-year period that the H-1B visa applied for would be valid. We adjust the patent and patent citation variations based on the

[14] For observations where Crunchbase does not report the acquisition amount, we use the SDC Platinum database to fill the missing data points. We exclude acquisitions for which we are unable to find the acquisition amount, as Metrick and Yasuda (2011, pg. 127) note that these often "indicate a going-out-of-business sale."
[15] We use the PatentsView data files as of May 28, 2018.

year of application and technology category, following Hall, Jaffe, and Trajtenberg (2001, 2005), Lerner, Sørensen, and Strömberg (2011), Bena and Li (2014), and Seru (2014).[16]

Table 1 shows that 32.2% of the firm-years in our sample have at least one patent in the three-year post-lottery period and the average number of patents is 5.4. Patent numbers are highly skewed, however, with less than 1% of firms responsible for half of the approved patents.

Similar to Kerr (2008) and Kerr and Lincoln (2010), who impute the ethnicity of inventors named in patent filings, we infer the nationality of the inventors named in the patent filings to capture H-1B workers' direct contributions to patenting. Although we cannot directly observe whether an inventor is an H-1B worker, the *NamePrism* classification tool developed by Ye et al. (2017) and Ye and Skiena (2019) allows us to impute the nationality of the inventors.[17] During our sample years, the majority of H-1B visa recipients originate from India and China.[18] Accordingly, we flag all inventors who are assigned a 50% or greater probability of being from India or China. Because we are interested in inventors who are hired via the H-1B lotteries in our sample, we identify *new* inventors who are named in a firm's patent filings during the post-lottery period but are not named in the firm's pre-lottery filings. We classify inventors who are flagged as being from India or China and who are new inventors as likely H-1B inventors. Admittedly, the classification of likely H-1B inventors contains measurement errors. However, there is no apparent reason why such measurement error would be correlated with *Win Rate* in a manner that would introduce directional bias into our tests.

Number of Likely H-1B Inventors is the number of unique likely H-1B inventors, i.e., those named in a firm's patent filings during the three-year post-lottery period, classified as being from India or

[16] Dass, Nanda, and Xiao (2017) and Lerner and Seru (2017) show that these adjustments are less effective towards the end of any given sample period (when truncation issues are more severe). Thus, we report results for patenting using both the full sample and using only data from the H-1B lotteries for the 2008 and 2009 fiscal years.
[17] We are grateful to Junting Ye and Steven Skiena for providing us with access to the *NamePrism* API. See http://www.name-prism.com/. We classify names using the *NamePrism* nationality classifications and not the ethnicity classifications, as nationality is directly relevant for inferring H-1B visa status.
[18] In all years in our sample, the majority of initial H-1B visa recipients are from India, ranging from a low of 55.4% in 2008 to a high of 66.2% in 2015. China ranks second in terms of the number of initial H-1B visa recipients, accounting for between 8.4% (in 2009) and 11.0% (in 2015) of the total. Ye et al. (2017, Table 4) show that nationality classification based on names is highly accurate for individuals from India and China.

China, and not named in the firm's pre-lottery patent applications. *Number of Likely H-1B Inventor-Patent Pairs* is the number of likely H-1B inventor-patent combinations.

4. Evaluating the Validity of the *Win Rate* Variable

The key identification assumption for this paper is that *Win Rate* captures exogenous variation in firms' access to skilled foreign labor. Given that H-1B visas are assigned by computer generated pseudo-random numbers during our sample years, this assumption appears reasonable. However, there are two issues that could affect the validity of *Win Rate*. First, H-1B applications that are eligible for the master's cap have a higher probability of selection. Second, because we impute H-1B applications for new employment from LCA filings, there could be measurement errors in the denominator of *Win Rate*. In this section, we address these two issues and provide empirical support for the validity of *Win Rate*.

4.1. H-1B Master's Cap

As discussed in Section 2, there are two separate pools for the H-1B lottery. Applicants with an approved U.S. graduate degree are first entered into a lottery for the 20,000 "master's cap" visas. The non-selected master's cap applicants are then pooled with the non-master's cap applicants in a second lottery for the remaining 65,000 visas. Thus, H-1B applicants eligible for the master's cap pool have a higher probability of winning. Unfortunately, neither the LCA data nor the USCIS FOIA data identify applicants who were entered in the master's cap pool. We can, however, examine how applicant education correlates with variables in the LCA data using education information from the prevailing wage determination (PWD) data files provided by the Department of Labor (available for the 2014 and 2015 fiscal years). As part of the LCA process, firms must certify that the salary offered to the foreign worker meets or exceeds the "prevailing wage" offered to domestic workers in the same occupation and with similar qualifications (e.g., education and experience). The firm must support its claim with reference to an external source, such as the PWD program.[19]

[19] Firms are not required to file a PWD as part of the LCA process, and the majority of firms instead rely on alternative sources such as the Occupational Employment Statistics database. Thus, we are not able to match most of the LCA filings by our sample firms to a PWD filing.

We examine the PWD data[20] and find that the baseline fixed effects we include in our regressions absorb much of the variation in applicant education. Specifically, industry-city-year fixed effects explain 73% of the variation in whether an applicant has a graduate degree. In the next section, we show that the inclusion of these fixed effects has little effect on the coefficient on *Win Rate*. Given that these fixed effects directly absorb most of the variation in applicant education, it seems unlikely that applicant education biases our findings.

4.2. The Imputation of Applications for New Employment from LCA Filings

Since we do not have data on actual H-1B applications (i.e., I-129 petitions), we construct *Win Rate* as the number of newly approved H-1B visas divided by the number of applications for new employment imputed from LCA filings. During our sample period, the LCA data released by the U.S. Department of Labor do not state whether an LCA is for new employment. However, beginning in 2017 the LCA data include an indicator for whether an LCA petition is for new employment. We use the 2017 data to evaluate the choice of screens we use to identify LCAs for new employment in our sample years. Note that this approach assumes that the characteristics of H-1B applicants in the Crunchbase data are sufficiently stable that the 2017 data are informative about the earlier years. To focus on firms that are similar to those in our main sample, we manually match employers in the 2017 LCA dataset with Crunchbase firms using firm name and address. We require that Crunchbase firms be private as of April 1, 2017 and have completed at least one round of external financing with non-missing values of the dollar amount raised. We are able to match 1,018 firms in Crunchbase with employers in the 2017 LCA data.

As discussed earlier, we use two screens to impute the number of H-1B applications for new employment: 1) the LCA must be filed in February and March, and 2) the start date must be five to six months in the future. We apply the two screens to the 2017 LCA data to evaluate their effectiveness in identifying applications for new employment. Internet Appendix Table 2 reports the fraction of LCAs for

[20] The PWD data sample we use includes only filings related to H-1B visas. We exclude filings that are cap-exempt, i.e., those by universities and other educational institutions, hospitals, clinics, medical institutions, and research institutions, and those for medical doctors and dentists.

new hires that are in a given sample as well as the fraction of LCAs in a given sample that are for new hires. Row (1) shows the results for the full sample of all LCAs filed during government fiscal year 2017. While 100% of the LCAs for new hires are, by definition, in this sample, only 63.9% of the full sample of LCAs is for new hires. Row (2) restricts the sample to LCAs filed in February and March. This sample restriction increases the fraction of LCAs in the sample that are for new hires to 79.7% and retains 95.7% of the LCAs for new hires. Row (3) further adds our second requirement that the start date be five to six months in the future. This increases the fraction of LCAs in the sample that are for new hires to 91.0% while retaining 93.0% of the new hires. Thus, the two screens are fairly effective in removing LCAs for renewals and transfers from the sample while retaining LCAs for new hires.

Internet Appendix Table 3 shows the false positive rate for LCAs submitted by the matched Crunchbase firms separately for each month from September 2016 through April 2017. A false positive is defined as an LCA with a start date five to six months in the future that is not for new employment. The table shows that 95.7% of LCAs for new employment are submitted in February and March, with no other month contributing more than 2% of the yearly total LCAs for new hires. Also, February and March have by far the lowest false positive rates (5.9% and 10.5%, respectively). Combined with the previous results, these numbers suggest that our imputation algorithm provides reasonably precise estimates of the number of H-1B applications for new employment.

4.3. Win Rate is Not Predictable

If the H-1B lottery *Win Rate* variable captures exogenous variation in firms' access to high-skill foreign workers, then *Win Rate* should not be predictable using lagged firm characteristics or information about the applicants.[21] Following this logic, we regress *Win Rate* on the baseline set of control variables measured prior to the H-1B lottery, including log(number of rounds of financing), log($ amount raised

[21] Consistent with the notion that H-1B lotteries generate random variation in the win rate, Clemens (2013) finds that H-1B visa lottery outcomes are not significantly related to applicant age, education, and work experience, which he interprets as "strong evidence of true natural randomization." Similarly, Doran, Gelber, and Isen (2020) regress H-1B visa lottery outcomes on firm characteristics and fail to find significant relations.

previously), log(months since first round), log(months since last round), log(number of H-1B applications), log($ salary for H-1B positions), and log(1 + number of prior patents).

Table 2 shows the results. Columns (1) and (2) include fiscal-year fixed effects and industry-city-year fixed effects (industry is defined as 2-digit NAICS code and there are 1,272 unique industry-city-year combinations in the sample), respectively. In column (1) a single control variable is significant, and in column (2) none of the control variables are significant. For both columns, the control variables are jointly insignificantly different from zero as shown by the *p*-values of the model *F*-statistics. The insignificance of the coefficient estimates and the model *F*-statistics are consistent with the H-1B lottery *Win Rate* providing exogenous variation in access to high-skilled labor. Thus, if *Win Rate* is biased due to renewals or excess LCA filings, such bias is not significantly related to the observable firm-level and application-level characteristics included in the regressions.

5. H-1B Visa Lottery Outcomes and Additional Financing

5.1. H-1B Visa Lottery Outcomes and External Financing: Baseline Specifications

We run linear regressions to examine the effect of winning H-1B visa lotteries on the likelihood of receiving additional external funding.[22] The dependent variable in Table 3 is *Funded*, an indicator variable equal to 100 if the company receives additional external funding during the three-year period beginning October 1 following the H-1B visa lottery and zero otherwise.[23] In column (1), the specification does not include any controls or fixed effects. In column (2), the specification includes the baseline set of controls as well as industry-city-year fixed effects. We cluster standard errors by firm.

In both specifications, the coefficient estimate on *Win Rate* is positive and significant.[24] Firms that win in the H-1B lottery are more likely to receive additional funding than firms that lose. Further, the

[22] For robustness, Internet Appendix Table 4 reports results estimated using logit and conditional logit models.
[23] In additional robustness tests, we estimate the regressions separately for the 2008-2009 and 2014-2015 subperiods. Internet Appendix Table 5 shows that the results are similar for both subperiods.
[24] Throughout the paper, we calculate *Win Rate* using LCA applications filed during February and March. In robustness tests, we use LCAs filed during January-March and December-March as alternative windows. Internet Appendix Table 6 shows that using these alternative windows produce essentially the same results as in the baseline specification. We conduct two additional robustness tests. First, we address the possibility that renewals of existing H-1B visas contaminate the denominator. We define an LCA as a potential renewal if its start date is the day after

economic magnitude of the result is large. For example, the coefficient in column (2) implies that a one standard deviation increase in *Win Rate* is associated with a 4.3 percentage point increase in the likelihood that the firm is funded (a 10% increase relative to the baseline funding rate). This result suggests that winning an additional H-1B worker through the lottery enables start-up firms to secure future funding, which is consistent with the view that H-1B workers bring valuable human capital to the firms. It also suggests that firms that lose in the H-1B lottery either are unable to find a replacement for the desired foreign worker or have to hire a domestic worker who is a worse match for the position. A similar but less benign interpretation is that firms earn rents due to monopsony power over their H-1B employees,[25] a possibility we address in the next subsection.

The magnitude of the coefficient on *Win Rate* represents both direct and indirect effects of winning an H-1B visa. For example, besides the direct contribution of the high-skill worker to the firm, the worker may have positive externalities on the firm's workforce. For example, Bernstein, Diamond, McQuade, and Pousada (2019) find that the indirect spillover effects of immigrant inventors on innovation are more than twice as large as the immigrants' direct innovation contributions. Peri, Shih, and Sparber (2015) show that an increase in H-1B visa workers is associated with higher wages for native workers (particularly college-educated native workers), and conclude that H-1B workers raise total factor productivity. Kerr, Kerr, and Lincoln (2015) find that an increase in H-1B workers is associated with an overall increase in skilled employment within a firm. Further, a positive experience with one H-1B worker may encourage the firm to apply for more H-1B visas in future years, as we show in Section 7.

---

the end date of an LCA filed by the same firm in the prior three years and it shares the same occupation code as the prior LCA. We adjust our *Win Rate* variable by subtracting the number of potential renewals from the denominator. This adjustment affects the *Win Rate* value in less than 1% of our sample (19 out of 2,570 observations). Second, we adjust the numerator of *Win Rate* to include the 3.1% of H-1B visa applications that were selected in the lottery but then denied by the USCIS. This alternative *Win Rate* variable and the original variable have a correlation of 0.973. Data on denials is only available for the last two years of our sample. We repeat the regression in column (2) of Table 3 using these alternative versions of the *Win Rate* variable. Internet Appendix Table 7 shows that the results are little changed, suggesting that neither renewals nor denials bias our results.

[25] While we cannot rule out this possibility completely, the finding of Hunt and Xie (2019) that H-1B workers have similar job mobility as domestic workers mitigates this possibility to some extent.

The coefficient estimates are stable across the specifications. In column (1), the regression does not include any controls whatsoever. In this regression, the result shows how variation in *Win Rate* affects the likelihood of receiving additional funding among all firm-years in the sample. In column (2), the regression includes the baseline set of control variables and industry-city-year fixed effects. In this regression, the comparison group is limited to other firms with similar firm and H-1B application characteristics that operate in the same industry and are located in the same city during the same year. The coefficient on *Win Rate*, however, is not significantly different between the two columns (*p*-value = 0.46). The stability of the coefficient estimate across specifications is consistent with the argument that *Win Rate* captures random lottery outcomes and is uncorrelated with observable characteristics.

5.2. Probability of Receiving Subsequent Funding and Salary-to-Prevailing Wage Interactions

There are two possible (non-mutually exclusive) explanations for the finding that a higher win rate in H-1B visa lotteries leads to an increased likelihood of receiving subsequent funding. First, H-1B workers bring valuable human capital to the firms that is otherwise hard to obtain. This predicts that the effect we observe should be driven primarily by H-1B applicants that provide highly desirable skills. Second, if the prevailing wage requirements for the H-1B program are ineffectual, H-1B workers may provide cheap alternatives to domestic workers, enabling firms that win H-1B visa lotteries to earn rents due to monopsony power over their H-1B employees. Under this interpretation, H-1B workers do not necessarily possess unique skills, but hiring them allows firms to save on labor costs.

We use the ratio of salary to prevailing wage to shed light on whether prospective H-1B workers possess valuable human capital or merely provide cheap labor. If the reported prevailing wage truthfully reflects the market value of the counterfactual U.S. hire (who may be less skilled than the potential H-1B worker), a high value of the ratio indicates that the worker possesses highly valuable qualities desired by the firm. If, however, firms are able to shade the quoted prevailing wage downward so as to access cheap labor, the ratio is still likely to provide useful information about the value added by the worker. Since there is no point in shading down the quoted prevailing wage unless the firm intends to pay a low wage,

firms that choose to report low prevailing wages would also pay low salaries. Thus, these firms would have low salary-to-prevailing wage ratios. In this case, a high salary-to-prevailing wage ratio would again indicate H-1B workers who possess valuable skills. Therefore, even if the prevailing wage itself is not necessarily the same as the wage of the counterfactual U.S. hire, the ratio of salary-to-prevailing wage should shed light on the economic mechanisms underlying the positive relation between H-1B lottery outcomes and subsequent funding.

Accordingly, for a given position, more talented H-1B visa applicants likely command a higher salary relative to the prevailing wage. If H-1B workers bring valuable human capital to the firms, our results should be driven primarily by firms that sponsor H-1B workers with high salary-to-prevailing wage ratios. Alternatively, if H-1B workers merely provide cheap labor, the results should be driven by firms that sponsor H-1B workers with low salary-to-prevailing wage ratios, for which the low ratios could arise because the workers are of relatively low quality or the firms that pay low wages shade down the quoted prevailing wage.

We measure the salary-to-prevailing wage ratio (i.e., *salary/prevailing wage*) as the average salary-to-prevailing wage reported in the LCA filings. Since firms are legally required to pay at least the prevailing wage, the ratio is bounded below at one. We also define an indicator variable *high salary-to-prevailing wage*, which equals one if *salary/prevailing wage* is above the median in a given year and zero otherwise. We interact the two variables with *Win Rate* to examine the differential effect of winning H-1B lotteries on the probability of receiving subsequent funding across firms with different salary-to-prevailing wage ratios. We also include *salary/prevailing wage* as a control variable.[26]

Table 4 shows that the coefficient on the interaction term is positive and significant. Column (2) shows that the effect of *Win Rate* on *Funded* is about five times as large for firms with a high salary-to-

[26] Including *salary/prevailing wage* as a control (in addition to including it in the interaction term) removes the effect associated with firm quality. It is possible that certain firms generally hire better quality employees for a given occupation and that such firms generally perform better (i.e., better firms pay higher salaries relative to prevailing wages and are more likely to be successful). The direct effect of firm quality will be captured by *salary/prevailing wage*.

prevailing wage ratio than for firms with a low ratio. Thus, start-up firms benefit more from winning the right to employ H-1B workers with relatively high salary to prevailing wage ratios. The results from Table 4 also imply that *Win Rate* has no effect on future financing outcomes for start-up firms that propose to pay H-1B workers a low salary relative to the prevailing wage (consistent with these workers not adding value to the firm or simply displacing domestic workers).

A few caveats are in order in interpreting the results from Table 4. First, our results do not directly address whether H-1B workers displace U.S. workers, as we do not have sufficient data on firm employment to conduct such tests. Second, these tests assume that the salary-to-prevailing wage ratio provides a valid measure of the difference in the value of human capital between H-1B workers and workers with similar qualifications in similar positions. To the extent this assumption is satisfied, our findings are consistent with H-1B workers on average bringing valuable human capital to firms and hence enabling the firms to grow and secure funding.

5.3. H-1B Visa Lottery Outcomes and Financing by Venture Capital Firms

In column (1) of Table 5, we investigate how winning the H-1B lottery affects the likelihood of obtaining venture capital funding over the subsequent three years (as opposed to funding from other types of external investors). We regress an indicator for whether the firm obtains funding from a VC over the subsequent three years on *Win Rate*, control variables, and industry-city-year fixed effects. The coefficient estimate on *Win Rate* is positive and significant, suggesting that firms with a higher *Win Rate* are more likely to receive funding from VCs.

5.4. Successful Exits and Initial Public Offerings

In this section, we consider two alternative firm-level outcome variables. *IPO* is an indicator variable for firms that have an initial public offering. *Successful Exit* is an indicator variable for firms that either have an IPO or are acquired for at least $25 million (in inflation adjusted 2008 dollars). Prior studies use IPO and exit as measures of start-up firm success (e.g., Hochberg, Ljungqvist, and Lu, 2007; Sørensen, 2007; Kerr, Lerner, and Schoar, 2014; Bernstein, Giroud, and Townsend, 2016). We measure

these outcomes over the three-year period during which the H-1B visa is valid and regress each on *Win Rate*, control variables, and industry-city-year fixed effects.

In column (2) of Table 5, the dependent variable is *Successful Exit*. The coefficient on *Win Rate* is significant at the 10% level. The economic magnitude of the results is large. The coefficient estimate implies that a one standard deviation increase in *Win Rate* is associated with a 1.4 percentage point increase in the probability of a successful exit during the three-year post-lottery period (a 14% increase relative to the baseline *Successful Exit* rate).

In column (3) of Table 5, the dependent variable is *IPO*. The coefficient on *Win Rate* is significant at the 10% level. The economic magnitude of the result for IPOs is also large: A one standard deviation increase in *Win Rate* is associated with a 0.9 percentage point increase in the probability of going public during the three-year post-lottery period (a 21% increase relative to the baseline likelihood).

The magnitude of the effect of *Win Rate* on various firm outcomes, particularly outcomes like *Successful Exit* and *IPO*, represents the cumulative effect of the H-1B workers through multiple channels. For example, as we show earlier, winning the H-1B lottery increases the ability of the firm to obtain external financing, which could in turn increase the likelihood of a successful exit. Also, the coefficient on *Win Rate* captures both direct effects of H-1B workers on firm success as well as indirect effects through other channels, such as H-1B workers' positive effect on the firm's future demand for H-1B workers and their positive externalities on the productivity of other workers. Both the direct and indirect effects are caused by the variation in access to high-skilled labor generated by the H-1B lotteries.

6. Patenting and Innovation

6.1. Patent Applications and Patent Citations

High-skilled foreign workers may contribute to start-up firms' innovation success. Table 6 examines the relation between *Win Rate* and several measures of innovation. In all columns, we use our baseline specification that includes firm and applicant controls as well as industry-city-year fixed effects. We also control for lagged values of the patenting activity during the three-year period before the H-1B

visa lottery,[27] because it is a strong predictor of future activity. Panel A reports the results for the full sample. Panel B reports the results using only fiscal years 2008 and 2009, because the truncation biases discussed in Dass, Nanda, and Xiao (2017) and Lerner and Seru (2017) are less severe with older data. Panels A and B of Internet Appendix Table 8 show that the results are similar using conditional Poisson regressions (following Aghion, Van Reenen, and Zingales, 2013; Atanassov, 2016; Custodio, Ferreira, and Matos, 2019).

The dependent variables in columns (1) and (2) are log(1 + *Number of Patents*) and log(1 + *Adjusted Number of Patents*), respectively.[28] In both columns there is a significant and positive relation between *Win Rate* and the number of patents, and this holds for both the full sample and in the subsample of fiscal years 2008 and 2009. Further, the economic magnitudes are large. The coefficient estimates in Panel A imply that a one standard deviation increase in *Win Rate* increases the number of patents by 5.8% and the adjusted number of patents by 5.1%.

In column (3), the dependent variable is the logarithm of one plus the total number of adjusted citations received by patents filed during the three-year post-lottery period. The coefficient on *Win Rate* is positive and significant in both the full sample and in fiscal years 2008 and 2009 (but only marginally so in the full sample). The result using the full sample implies that a one standard deviation increase in *Win Rate* increases the adjusted number of patent citations by 3.9% and the implied magnitude is larger for the 2008 and 2009 subsamples (when truncation bias is less severe).

A firm's total number of citations can increase either because the number of patents increases or because the citations per patent increase.[29] To separate these possibilities, in column (4) the dependent

[27] For example, since the USCIS began accepting applications on April 1, 2007, for the visa lottery held for federal government fiscal year 2008, the control variables are constructed using approved patent applications filed from April 1, 2004 through March 31, 2007.

[28] Following Hirshleifer, Low, and Teoh (2012), Atanassov (2013), Brav, Jiang, Ma, and Tian (2018), and Custodio, Ferreira, and Matos (2019), we estimate linear regression models in which the dependent variables are the logarithm of one plus various patent outcomes.

[29] The effect of *Win Rate* on the average citations per patent is a priori unclear. On the one hand, hiring H-1B workers may enable firms to produce high-impact innovation and thus increase the average quality of innovation. On the other hand, if firms prioritize projects based on their potential value, relaxing the labor constraint would allow firms to pursue projects with lower marginal values, which would decrease the average quality of innovation.

variable is the natural logarithm of one plus the average number of adjusted citations per patent. The coefficient on *Win Rate* is small and insignificant in both panels of Table 6. This finding, combined with the results in the other columns, suggests that access to H-1B visa workers increases the total amount of innovative activity but not the average quality of innovation.

Our findings for patenting are consistent with those of Kerr and Lincoln (2010) who find a strong positive relation between H-1B visas and patenting. More generally, our results are consistent with Hunt and Gauthier-Loiselle (2010) and Bernstein, Diamond, McQuade, and Pousada (2019) who find that immigrants are responsible for a disproportionately large fraction of U.S. patents. Our results, however, differ from those of Doran, Gelber, and Isen (2020) who find little relation between firms' H-1B visa lottery outcomes and the number of patents, which may be because of two important differences between our paper and theirs. First, we examine a sample of high-tech start-up firms, while Doran et al. examine the overall universe of firms. Thus, the comparison between our results and those of Doran et al. suggests that the contributions of H-1B workers vary across firms, and the effects found in our sample of start-up firms are likely larger than would be found in the overall universe of firms. Second, as discussed in the literature section, we use four years during which all the visas are subject to the lotteries. In contrast, Doran et al. use two years during which only a small fraction of H-1B visas are allocated through lotteries among applications submitted on the final receipt date. The sample selection in Doran et al. could bias against finding significant positive effects of winning the lotteries.

6.2. Patent Applications by Likely H-1B Inventors

If H-1B workers are directly involved in the firms' innovative projects, H-1B lottery wins should be related to the characteristics of the inventors named in the firms' patent applications. Specifically, given that the majority of H-1B workers are from India and China, we would expect a positive relation between *Win Rate* and the number of patent filings with inventors whose names are classified as being from India or China but are not named in the firm's pre-lottery patent applications (i.e., likely H-1B inventors). The regressions in Table 7 follow our baseline specification that includes firm

and applicant controls as well as industry-city-year fixed effects. We also control for patenting activity of likely H-1B inventors during the three-year pre-lottery period. Panel C of Internet Appendix Table 8 shows that the results are similar using conditional Poisson regressions.

In column (1), the dependent variable is log(1 + *Number of Likely H-1B Inventors*) and in column (2) it is log(1 + *Number of Likely H-1B Inventor-Patent Pairs*). As discussed earlier, these variables are based on inventors who have not patented with the firm in years prior to the lottery. In both columns, there is a significant positive relation between *Win Rate* and patenting by likely H-1B inventors.

While these results are suggestive of H-1B workers contributing directly to firms' innovative activities and thus bringing valuable human capital to start-up firm, as stated earlier in Section 3.3, we do not directly observe whether an inventor is actually an H-1B worker. Our imputation may classify inventors that are U.S. citizens but with Indian or Chinese names as likely H-1B inventors if they happen to patent after an H-1B lottery but not before the lottery. However, for this potential measurement error to cloud the interpretation of our results, such inventors would have to be disproportionately present in the firms that win the H-1B lottery relative to those that lose. While possible, there is no apparent reason to believe this is the case.

7. Future H-1B Applications

A firm's experience in the H-1B lottery in one year could affect the firm's H-1B applications in subsequent years. On the one hand, losers could re-apply the next year in the hope of obtaining a worker. On the other hand, winners could increase subsequent applications for several reasons. First, a positive experience with one H-1B worker may induce a firm to apply for more H-1B workers. Second, H-1B employees may possess information and connections, which could reduce the firm's search costs to identify new H-1B applicants. Third, as we show above, obtaining H-1B visas increases the likelihood of obtaining VC funding, which could help firms grow and hence increase their demand for high-skilled labor. Thus, initial success in H-1B lotteries could start a positive cascade, increasing the demand for H-1B workers in the future.

Table 8 examines the relation between *Win Rate* and the number of future H-1B applications. We use our baseline specification that includes firm and applicant controls as well as industry-city-year fixed effects in all columns. We consider three windows: one, two, and three years following the lottery. Panel D of Internet Appendix Table 8 show the results are similar using conditional Poisson regressions.

Column (1) shows an insignificant relation between *Win Rate* and H-1B applications in the first year immediately following the H-1B lottery. This is inconsistent with the idea that lottery losers attempt to quickly offset lottery losses. Columns (2) and (3) show that *Win Rate* has a significant positive effect on the number of H-1B applications two and three years after the lottery. Further, the economic magnitude is large. For example, column (3) shows that a one standard deviation increase in *Win Rate* implies a 10.8% increase in the number of H-1B applications in the three-year post-lottery period.

These results suggest that initial success in H-1B lotteries increases future demand for high-skilled foreign workers, which in turn could further contribute to the success of the start-up firm. This result has implications for the interpretation of the coefficient on *Win Rate* in the previous sections. The observed effect of *Win Rate* captures both the direct effects of hiring an additional H-1B worker and indirect effects such as those arising from the increased demand for subsequent H-1B workers. Combined with the earlier results, this section shows how an initial lottery win can result in a snowball effect whereby firms with initial success in H-1B visa lotteries become more successful by attracting additional external funding and hiring more H-1B workers.

8. Robustness Checks

In this section, we discuss several robustness checks of our main results. We also provide more details on the timing of the lottery effect upon a firm's funding and patenting outcomes.

In Table 9, we present five robustness checks for six of our key outcome variables: *Funded*, *Successful Exit*, *IPO*, log(1 + *Number of Patents*), log(1+ *Adjusted Number of Patents*), and log(1+ *Number of Future H-1B Applications over next 3 years*). The first row of the table repeats our baseline results that include firm and applicant controls as well as industry-city-year fixed effects. The first

robustness check restricts the sample to firms that file LCAs for a single H-1B worker, for which the *Win Rate* is, by construction, either zero or one. The second robustness check replaces *Win Rate* with *Win Any* (an indicator variable for whether a firm wins at least one H-1B visa through the lottery that year) as the measure of firm lottery success. The third robustness check replaces the explanatory variable *log(number rounds of financing)* with separate indicator variables for each number of prior funding rounds. The fourth robustness check adds three prior funding indicators that represent whether the firm received financing over one-year, two-year, and three-year periods prior to the lottery. The fifth robustness check builds on the fourth by further adding controls for patenting activity over the prior one-year and two-year periods prior to the lottery (the baseline specification already controls for patenting activity over the three years prior to the lottery). While we already control for past funding activity (total number of rounds, total dollar amount raised, timing of first and most recent round) and past patenting activity (measured over the prior three years), these additional controls are meant to rule out that some recent trends in financing or patenting could explain the relation between lottery success and subsequent firm outcomes.

As can be seen in Table 9, the results for all the firm outcomes are fairly robust to these alternative specifications. Of the 30 different robustness-check regressions, all but four result in a positive and significant relation between *Win Rate* (or *Win Any*) and the firm outcome variable. Notably, the results are similar when a firm's lottery success is measured with *Win Any* (only the specification with *Number of Adjusted Patents* lacks a significant coefficient on *Win Any*). Also, the inclusion of indicator variables for the number of prior funding rounds and the inclusion of controls for recent funding and patenting success do not meaningfully affect the coefficient of *Win Rate* for any of the outcome variables (the lone exception is the regression of *IPO* with prior funding indicators where the coefficient maintains a similar magnitude but just misses on statistical significance). The results of these robustness tests are reassuring, but not surprising given the random nature of the H-1B lottery.

In one final analysis, we provide further insight into the dynamics of a firm's funding outcomes, patenting, and H-1B applications over the three years after the lottery as well as test for differential trends in these outcomes *before* the lottery. Specifically, we estimate regressions of *Funded*, log(1+ *Number of*

Patents), and log(1+ *Number of H-1B Applications*) measured over one year, two years, and three years after the lottery including firm and applicant controls as well as industry-city-year fixed effects. The coefficients on *Win Rate* for these three outcomes over the one, two, and three-year horizon are displayed graphically in the right side of Figure 3.[30] The effect of *Win Rate* (i.e., the difference in outcome for a firm with a 100% win rate versus a 0% win rate in the H1-B lottery) on firm outcomes is significantly different from zero for the three outcomes at all the future horizons with the exception of H-1B applications made the year following the lottery. Also, the effect of lottery success increases over time and does not reverse from 1 to 2 to 3 years.

We also examine whether *Win Rate* is significantly related to funding, patenting, and applications for H-1B visas for the firm one, two, and three years *prior* to the lottery outcome (the left side of Figure 3). In these regressions of prior firm outcomes, we measure whether lottery outcomes are related to funding or patenting occurring prior to the lottery.[31] Across all the outcomes, there is no statistically significant *Win Rate* coefficient for the past three-, two-, or one-year activity leading up to the lottery. Put differently, we cannot reject that there is zero pre-trend difference between subsequent H-1B lottery winners and losers for each of the outcomes. Besides being statistically indistinguishable from zero, the coefficients on *Win Rate* in the pre-lottery periods are also small in magnitude. For all three outcomes, the *Win Rate* effect in the two-year post-lottery period is significantly larger than the effect in the two-year pre-lottery period at the 10-percent level; comparing the three year pre- and post-lottery periods, the differences are significant at the 5-percent level.[32]

[30] The results in Figure 3 for funding and the number of patents measured three years after the lottery replicate the baseline results presented in Tables 3 and 6, respectively. The results for number of H-1B applications measured one, two, and three years after the lottery replicate the results presented in Table 8.

[31] In these regressions where we relate prior firm activity to the firm's lottery outcome, we only include industry-city-year fixed effects as the other controls measured at the time of the lottery are determined after or during the prior outcomes. Including these time-of-lottery controls in the regression of prior outcomes does not alter any of the conclusions drawn regarding the *Win Rate* effect on pre-lottery trends and the significance of the post vs. pre differences.

[32] While visually there is a noticeable spike in the difference in outcomes between lottery winners and losers moving from one year before to one year after the lottery, this difference is not significant for any of the three outcomes.

9. Conclusion

U.S. based firms can apply for H-1B visas that allow high-skill foreign workers to enter the country. There is a fixed quota of H-1B visas available to for-profit firms, and when the number of applications exceeds the quota the U.S. government holds a lottery that assigns H-1B visas based on computer-generated pseudo-random numbers. The outcome of these H-1B visa lotteries provides exogenous, random variation in firms' access to skilled foreign workers. In this paper, we examine a sample of start-up firms that applied for H-1B visas, and compare outcomes based on the firms' win rate in the H-1B lotteries.

We find that a firm's win rate in the H-1B visa lottery is strongly related to the firm's outcomes over the following three years. Relative to ex ante similar firms that also applied for H-1B visas, firms with higher win rates in the lottery are more likely to receive additional external funding and have an IPO or be acquired. Firms with higher win rates are also more likely to receive more patents and more patent citations. Overall, the results show that access to skilled foreign workers through the H-1B program has a strong positive effect on firm-level measures of success.

Gourio, Messer, and Siemer (2016) highlight the important role the number of start-ups in a region has in explaining the long-term economic development of that region. Our results show that access to skilled foreign workers leads to improved funding and patenting outcomes for start-up firms, suggesting that improved visa access for such firms could generate significant economic benefits.

References

Aghion, P., P. Howitt. 1992. A Model of Growth Through Creative Destruction. *Econometrica* 60, 323-351.

Aghion, P., J. Van Reenen, L. Zingales. 2013. Innovation and Institutional Ownership. *American Economic Review* 103, 277-304.

Ashraf, R., R. Ray. 2017. Human Capital, Skilled Immigrants, and Innovation. Working paper, Georgia State University.

Atanassov, J. 2013. Do Hostile Takeovers Stifle Innovation? Evidence from Antitakeover Legislation and Corporate Patenting. *Journal of Finance* 68, 1097-11331.

Atanassov, J. 2016. Arm's Length Financing and Innovation: Evidence from Publicly Traded Firms. *Management Science* 62, 128-155.

Bena, J., K. Li. 2014. Corporate Innovation and Mergers and Acquisitions. *Journal of Finance* 69, 1923-1960.

Bernstein, S., R. Diamond, T. McQuade, B. Pousada. 2019. The Contribution of High-Skilled Immigrants to Innovation in the United States. Working paper, Stanford University.

Bernstein, S., X. Giroud, R.R. Townsend. 2016. The Impact of Venture Capital Monitoring. *Journal of Finance* 71, 1591-1622.

Block, J.H., C.O. Fisch, A. Hahn, P.G. Sandner. 2015. Why Do SMEs File Trademarks? Insights from Firms in Innovative Industries. *Research Policy* 44, 1915-1930.

Brav, A., W. Jiang, S. Ma, X. Tian. 2018. How Does Hedge Fund Activism Reshape Corporate Innovation? *Journal of Financial Economics* 130, 237-264.

Chen, J., S. Hshieh, F. Zhang. 2019. The Role of High-Skilled Foreign Labor in Startup Performance: Evidence from Two Natural Experiments. Renmin University, Working paper.

Clemens, M. 2013. Why Do Programmers Earn More in Houston than Hyderabad? Evidence from Randomized Processing of U.S. Visas. *American Economic Review (P&P)* 103, 198-202.

Custodio, C., M. Ferreira, P. Matos. 2019. Do General Managerial Skills Spur Innovation? *Management Science* 65, 459-476.

Dalle, J-M, M. den Besten, C. Menon. 2017. Using Crunchbase for Economic and Managerial Research. Working paper, OECD.

Dass, N., V. Nanda, S.C. Xiao. 2017. Truncation Bias Corrections in Patent Data: Implications for Recent Research on Innovation. *Journal of Corporate Finance* 44, 353-374.

Doran, K., A. Gelber, A. Isen. 2020. The Effects of High-Skilled Immigration Policy on Firms: Evidence from Visa Lotteries. University of Notre Dame, Working paper.

Ghosh, A., A.M. Mayda, F. Ortega. 2016. The Impact of Skilled Foreign Workers on Firms: An Investigation of Publicly Traded U.S. Firms. Working paper, Georgetown University.

Gourio, F., T. Messer, M. Siemer. 2016. Firm Entry and Macroeconomic Dynamics: A State-level Analysis. *American Economic Review* 106, 214-218.

Hall, B.H., A. Jaffe, M. Trajtenberg. 2001. The NBER Patent Citations Data File: Lessons, Insights and Methodological Tools. NBER working paper 8498.

Hall, B.H., A. Jaffe, M. Trajtenberg. 2005. Market Value and Patent Citations. *RAND Journal of Economics* 36, 16-38.

Hirshleifer, D., A. Low, S.H. Teoh. 2012. Are Overconfident CEOs Better Innovators? *Journal of Finance* 67, 1457-1498.

Hochberg, Y.V., A. Ljungqvist, Y. Lu. 2007. Whom You Know Matters: Venture Capital Networks and Investment Performance. *Journal of Finance* 62, 251-301.

Howell, S.T. 2017. Financing Innovation: Evidence from R&D Grants. *American Economic Review* 107, 1136-1164.

Hunt, J., M. Gauthier-Loiselle. 2010. How Much Does Immigration Boost Innovation? *American Economic Journal: Macroeconomics* 2, 31-56.

Hunt, J., B. Xie. 2019. How Restricted is the Job Mobility of Temporary Work Visa Holders? *Journal of Policy Analysis and Management* 38, 41-64.

Kerr, W.R. 2008. The Ethnic Composition of US Inventors. HBS Working Paper 08-006.

Kerr, W.R., W.F. Lincoln. 2010. The Supply Side of Innovation: H-1B Visa Reforms and U.S. Ethnic Invention. *Journal of Labor Economics* 28, 473-508.

Kerr, S.P., W.R. Kerr, W.F. Lincoln. 2015. Skilled Immigration and the Employment Structure of U.S. Firms. *Journal of Labor Economics* 33, S147-S186.

Kerr, W.R., J. Lerner, A. Schoar. 2014. The Consequences of Entrepreneurial Finance: Evidence from Angel Financings. *Review of Financial Studies* 27, 20-55.

Kogan, L., D. Papanikolaou, A. Seru, N. Stoffman. 2017. Technological Innovation, Resource Allocation, and Growth. *Quarterly Journal of Economics* 132, 665-712.

Lerner, J., A. Seru. 2017. The Use and Misuse of Patent Data: Issue for Corporate Finance and Beyond. Working paper, Harvard Business School.

Lerner, J., M. Sørensen, P. Strömberg. 2011. Private Equity and Long-Run Investment: The Case of Innovation. *Journal of Finance* 66, 445-477.

Ling, Y. 2016. The Impact of Venture Capital on the Life Cycles of Startups. Working paper, University of Southern California.

Metrick, A., A. Yasuda. 2011. *Venture Capital and the Finance of Innovation 2nd Edition*, Wiley, New York, NY.

Peri, G., K. Shih, C. Sparber. 2015. Foreign and Native Skilled Workers: What Can We Learn from H-1B Lotteries? NBER working paper 21175.

Roberts, M.R., T.M. Whited. 2013. Endogeneity in Empirical Corporate Finance. G. Constantinides, M. Harris, R. Stulz (Eds.), *Handbook of the Economics of Finance*, Elsevier, Amsterdam, Netherlands, pp. 493-572.

Romer, P.M. 1990. Endogenous Technological Change. *Journal of Political Economy* 98, S71-S102.

Schumpeter, J.A. 1942. *Capitalism, Socialism, and Democracy*. New York: Harper and Brothers.

Seru, A. 2014. Firm Boundaries Matter: Evidence from Conglomerates and R&D Activity. *Journal of Financial Economics* 111, 381-405.

Sørensen, M. 2007. How Smart is Smart Money? A Two-Sided Matching Model of Venture Capital. *Journal of Finance* 62, 2725-2762.

Wang, X. 2017. Catering Innovation: Entrepreneurship and the Acquisition Market. Working paper, University of North Carolina at Chapel Hill.

Wang, X. 2020. US Permanent Residency, Job Mobility, and Earnings. *Journal of Labor Economics*, forthcoming.

Xu, S-J. 2018. Skilled Labor Supply and Corporate Investment: Evidence from the H-1B Visa Program. Working paper, University of Alberta.

Ye, J., Y. Hu, B. Coskun, M. Liu, H. Qin, S. Skiena. 2017. Nationality Classification using Name Embeddings. *Proceedings of the 2017 ACM on Conference on Information and Knowledge Management*, 1897-1906.

Ye, J., S. Skiena. 2019. The Secret Lives of Names? Name Embeddings from Social Media. *Proceedings of the 25th SKIGKDD Conference on Knowledge Discovery and Data Mining*.

Figure 1: Timeline of Application Process and Variable Measurement

This figure illustrates the timeline of our study using the lottery for fiscal year 2015 as an example. The H-1B visa lottery for fiscal year *t* are held in the first week of April of fiscal year *t*-1, which is when the win rate is observed. We measure the funding and patenting outcomes during the three-year period starting from October 1 of fiscal year *t* (i.e., the earliest start date of employment for workers granted an H-1B visa in the lottery for fiscal year *t*). We measure the control variables as of March 31 in fiscal year *t*-1.

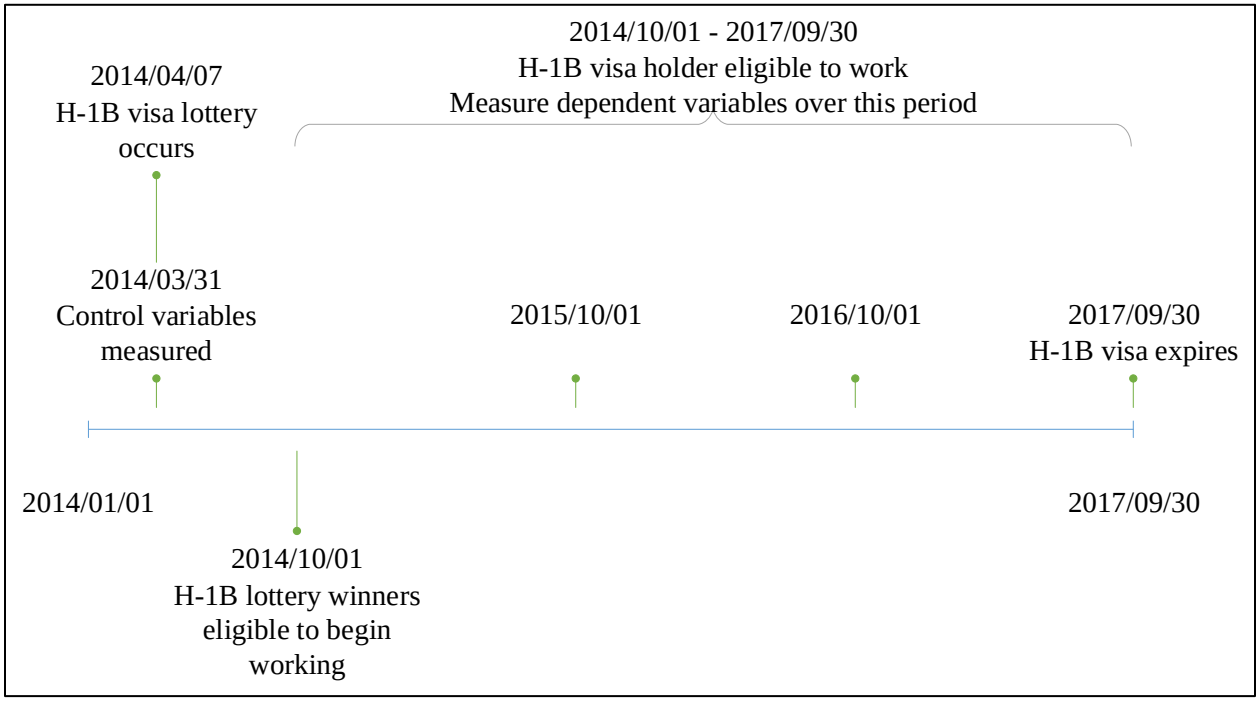


Figure 2: Histogram of H-1B Visa Lottery Win Rates and Funding Outcomes

Panel A shows a histogram of the distribution of *Win Rate* (the number of H-1B visas a firm wins through the lottery in a year divided by the number of applicants) for the 2,570 firm-year observations. Panel B shows a bar chart of the proportion of observations receiving external financing in the three-year post-lottery period for different levels of *Win Rate*. For Panel B we include only levels of *Win Rate* for which we have at least 100 firm-year observations (876 with *Win Rate* of 0, 243 with *Win Rate* of 0.5, and 1,123 with *Win Rate* of 1).

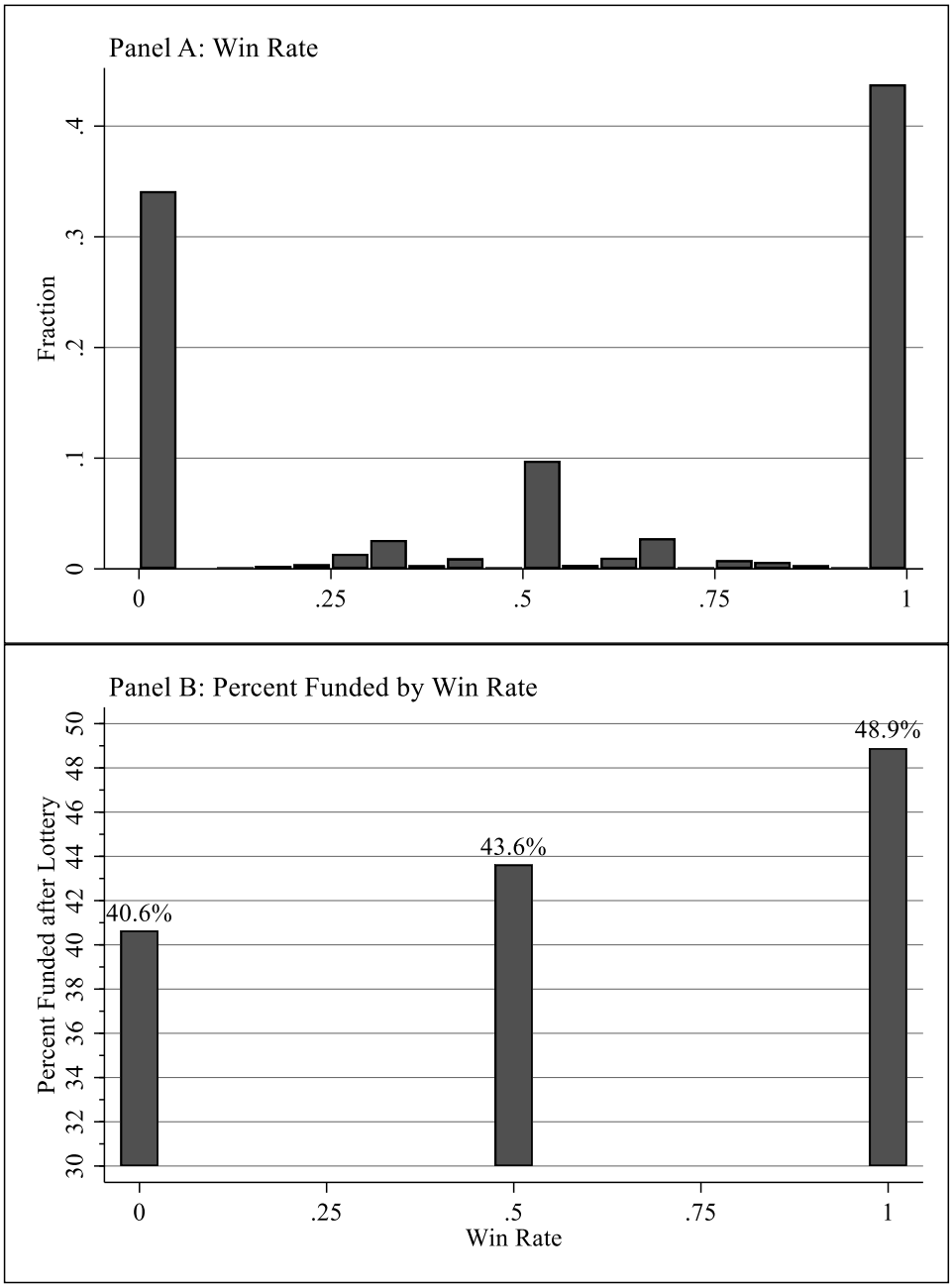
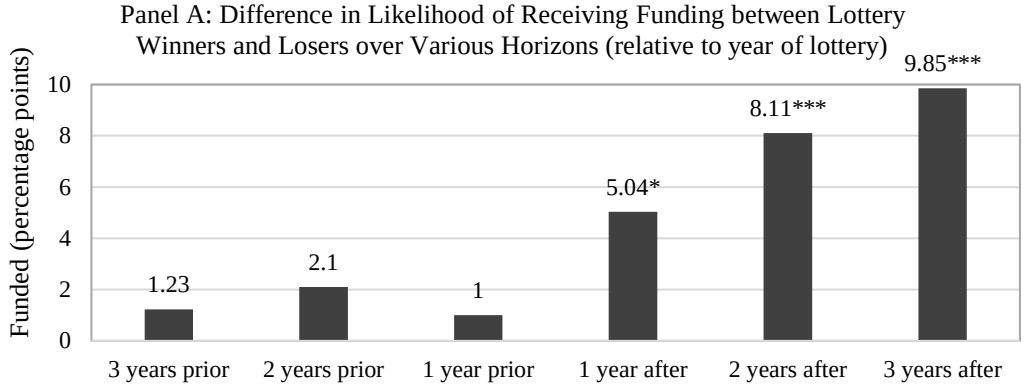
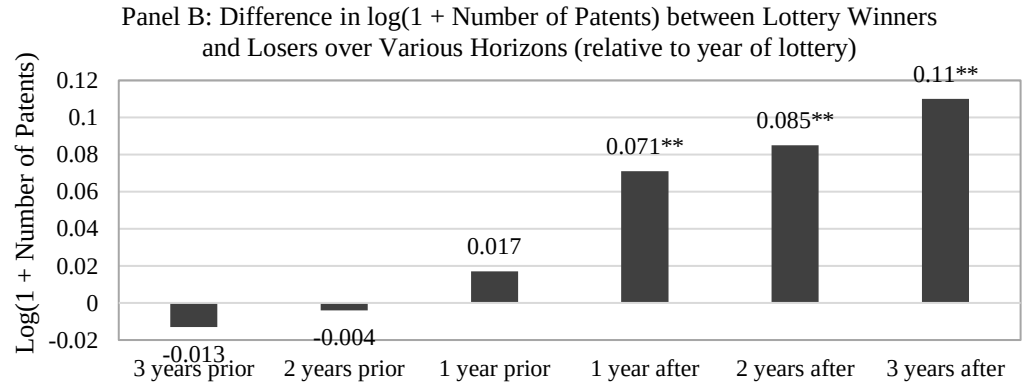


Figure 3: Differential Trends between H1-B Lottery Winners and Losers

This figure plots the difference in funding, patenting, and the number of H-1B applications over time between H-1B lottery winners and losers. We consider three windows before the lottery, i.e., three years, two years, and one year prior to the lottery. For each pre-lottery window, we regress firm outcomes measured over the window on *Win Rate* and industry-city-year fixed effects. We similarly consider three windows after the lottery, i.e., one year, two years, and three years after the lottery. For each post-lottery window, we regress firm outcomes measured over the window on *Win Rate*, the full set of controls, and industry-city-year fixed effects. Panels A, B, and C show the coefficient on *Win Rate* in the regressions for different windows with *Funded*, *log(1+ Number of Patents)*, and *log(1+ Number of H-1B Applications)* as the dependent variable, respectively. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.





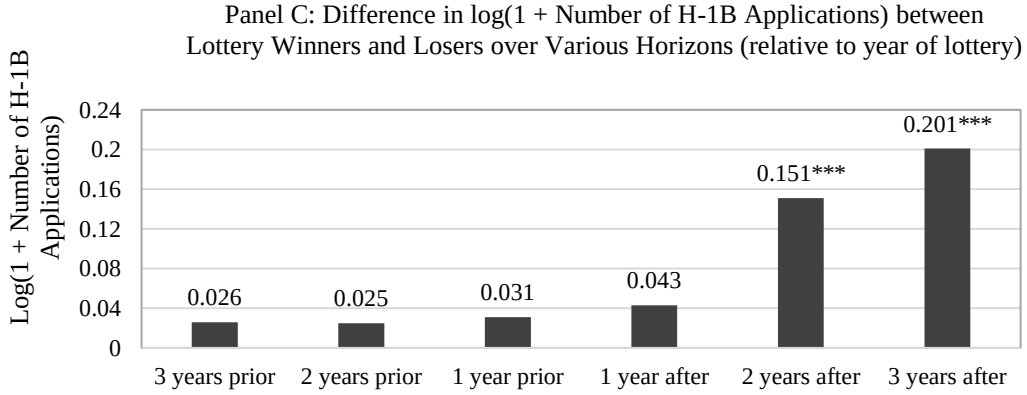


Table 1: Summary Statistics

This table reports the summary statistics for our sample of firm-years. The sample includes start-up firms in Crunchbase that sponsor H-1B petitions in fiscal years 2008, 2009, 2014, and 2015. *Number of Applications* is the number of H-1B applicants filed on a Labor Condition Application (LCA) by a firm in a year. *Win Rate* is the number of H-1B visas a firm wins through the lottery in a year divided by the number of applicants. *Win Any* is an indicator that equals one if a firm wins at least one H-1B visa through the lottery that year. *Salary* is the average annual salary of the applicants sponsored by a firm in a year. *Salary/Prevailing Wage* is the average ratio of salary to prevailing wage reported in the LCA applications. *Number of Prior Financing Rounds* is the number of funding rounds a firm receives before the lottery. *Prior Amount Raised* is the total amount of funds raised before the lottery. *Time Since First Round* is the number of months between the first round of funding and the lottery. *Time Since Last Round* is the number of months between the most recent round of funding and the lottery. *Funded* is an indicator that equals 100 if a firm receives subsequent external funding in the three years following the lottery and zero otherwise. *Funded by VC* is an indicator that equals 100 if a firm receives subsequent funding in the three years following the lottery from a VC firm and zero otherwise. *Successful Exit* is an indicator variable that equals 100 if the firm goes public or is acquired for at least $25 million (in 2008 inflation adjusted dollars) in the three years following the lottery and zero otherwise. *IPO* is an indicator variable that equals 100 if the firm goes public in the three years following the lottery and zero otherwise. *Any Patents* is an indicator variable that equals 100 if the firm is granted a patent that was applied for in the three years following the lottery and zero otherwise. *Number of Patents* is the number of patents granted to a firm in the three years following the lottery. *Number of Prior Patents* is the number of patents granted to a firm in the three years before the H-1B lottery. *Adjusted Number of Patents* is the category-year mean adjusted number of patents granted to a firm in the three years following the lottery. *Total Citations* is the number of citations to a firm's patents granted in the three years following the lottery. *Total Adjusted Citations* is the category-year mean adjusted number of citations summed across the firm's patents granted in the three years following the lottery. *Average Number of Citations* is the average number of citations to a firm's patents granted in the three years following the lottery. *Average Number of Adjusted Citations* is the average of the category-year mean adjusted citations on the firm's patents granted in the three years following the lottery. *Number of Likely H-1B Inventors* is the number of unique inventors who are classified as being from India or China and are named in a firm's three-year post-lottery patent filings but are not named in the firm's pre-lottery patent applications. *Number of Likely H-1B Inventor-Patent Pairs* is the number of likely H-1B inventor-patent combinations in a firm's three-year post-lottery patent filings for which the inventor is not named in the firm's prior pre-lottery patent filings. *Number of Future H-1B Applications* is the number of H-1B applicants filed on a Labor Condition Application (LCA) by a firm over the 1, 2, or 3-year period following the lottery. For each variable, we report the mean, standard deviation, 25^{th}, 50^{th}, and 75^{th} percentiles.

	Mean	Std. Dev.	25th%	Median	75th%
Number of H-1B Applications	2.5	5.1	1	1	2
Win Rate	0.55	0.44	0	0.55	1
Win Any	0.66	0.47	0	1	1
Salary ($)	85,100	29,700	65,000	80,000	100,000
Salary/Prevailing Wage	1.2	0.2	1.0	1.1	1.2
Number of Prior Financing Rounds	2.8	2.0	1	2	4
Prior Amount Raised ($M)	40.1	90.3	5	17	44
Time Since First Round (months)	56.0	41.7	23	46	81
Time Since Last Round (months)	26.3	30.5	7	15	34
$Funded_{(t,t+2)}$	44.7	49.7	0	0	100
Funded by $VC_{(t,t+2)}$	31.4	46.4	0	0	100
Successful $Exit_{(t,t+2)}$	10.3	30.4	0	0	0
$IPO_{(t,t+2)}$	4.3	20.2	0	0	0
Any $Patents_{(t,t+2)}$	32.2	46.7	0	0	100
Number of $Patents_{(t,t+2)}$	5.4	65.3	0	0	1
Number of Prior $Patents_{(t-3,t-1)}$	7.8	112	0	0	3
Adjusted Number of $Patents_{(t,t+2)}$	0.9	9.7	0	0	0.2
Total $Citations_{(t,t+2)}$	17.2	235.3	0	0	0
Total Adjusted $Citations_{(t,t+2)}$	5.9	60.4	0	0	0
Average Number of $Citations_{(t,t+2)}$	0.8	3.5	0	0	0
Average Number of Adj. $Citations_{(t,t+2)}$	0.3	1.2	0	0	0
Number of Likely H-1B $Inventors_{(t,t+2)}$	0.6	4.3	0	0	0
Number of Likely H-1B Inventor-Patent $Pairs_{(t,t+2)}$	1.1	8.2	0	0	0
Number of Future H-1B $Applications_{(t)}$	1.6	4.0	0	0	2
Number of Future H-1B $Applications_{(t,t+1)}$	3.2	8.0	0	1	3
Number of Future H-1B $Applications_{(t,t+2)}$	4.7	12.0	0	1	5

Table 2: *Win Rate* as Dependent Variable

This table reports linear regression analysis of the win rate in H-1B visa lotteries. The dependent variable is *Win Rate*, which is the number of H-1B visas a firm wins through the lottery in a year divided by the number of applicants. Column (1) includes federal government fiscal year fixed effects. Column (2) includes industry-city-year fixed effects. All columns include the following firm characteristics: log(number rounds of financing), log($ amount raised previously), log(months since first round), log(months since last round), log(number of H-1B applications), log($ salary for H-1B positions), and log(1 + number of prior patents). The numbers in brackets are *t*-statistics based on standard errors clustered by firm. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)
log(# rounds financing)	-0.02	-0.01
	[0.84]	[0.43]
log(amount raised)	0.01	0.01
	[0.91]	[0.96]
log(months since first round)	0.01	0.02
	[0.40]	[0.73]
log(months since last round)	-0.02	-0.02
	[1.34]	[0.89]
log(number of H-1B applications)	0.01	-0.01
	[0.84]	[0.50]
log(salary)	-0.07**	-0.04
	[2.35]	[0.77]
log(1 + number of prior patents)	0.01	-0.01
	[1.37]	[0.45]
Model *F*-Stat *p-value*	0.16	0.84
Year fixed effects?	Yes	Subsumed
Industry-City-Year fixed effects?	No	Yes
Adjusted-R^2	0.004	-0.002
Number of Observations	2,570	2,570

Table 3: H-1B Lottery *Win Rate* and the Probability of Receiving Subsequent Funding

This table reports linear regression analysis of the effect of win rate in H-1B visa lotteries on the probability of receiving subsequent funding. The dependent variable is *Funded*, which is an indicator that equals 100 if a firm receives subsequent external funding in the three years following the lottery and zero otherwise. The main independent variable is *Win Rate*, which is the number of H-1B visas a firm wins through the lottery in a year divided by the number of applicants. Column (1) does not include any control variables or fixed effects. Column (2) includes industry-city-year fixed effects and the following firm controls: log(number rounds of financing), log($ amount raised previously), log(months since first round), log(months since last round), log(number of H-1B applications), log($ salary for H-1B positions), and log(1 + number of prior patents). The numbers in brackets are *t*-statistics based on standard errors clustered by firm. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)
Win Rate	8.14***	9.85***
	[3.68]	[3.18]
log(number rounds financing)		14.86***
		[3.85]
log(amount raised)		1.87
		[1.61]
log(months since first round)		-12.33***
		[4.05]
log(months since last round)		-5.68***
		[2.64]
log(number of H-1B applications)		-3.44*
		[1.79]
log(salary)		6.84
		[1.37]
log(1 + number of prior patents)		2.05
		[1.37]
Industry-City-Year fixed effects?	No	Yes
Adjusted-R^2	0.005	0.124
Number of Observations	2,570	2,570

Table 4: Salary-to-Prevailing Wage Interactions

This table reports linear regression analysis of the effect of win rate in H-1B visa lotteries on the probability of receiving subsequent funding. The dependent variable is *Funded*, which is an indicator that equals 100 if a firm receives subsequent external funding of any form in the three years following the lottery and zero otherwise. *Win Rate* is the number of H-1B visas a firm wins through the lottery in a year divided by the number of applicants. *Salary/prevailing wage* is the average ratio of salary to prevailing wage reported in the LCA applications. *High salary-to-prevailing wage indicator* is an indicator that equals one if *Salary/prevailing wage* is above the median in a given year. Both columns include industry-city-year fixed effects and the following firm controls: log(number rounds of financing), log($ amount raised previously), log(months since first round), log(months since last round), log(number of H-1B applications), log($ salary for H-1B positions), and log(1 + number of prior patents). The numbers in brackets are *t*-statistics based on standard errors clustered by firm. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)
Win Rate	4.00	3.41
	[0.93]	[0.78]
Win Rate × Log(Salary/prevailing wage)	45.65**	
	[1.98]	
Win Rate × High salary-to-prevailing wage indicator		13.24**
		[2.10]
Log(Salary/prevailing wage)	1.17	
	[0.07]	
High salary-to-prevailing wage indicator		-2.51
		[0.56]
Control Variables?	Yes	Yes
Industry-City-Year fixed effects?	Yes	Yes
Adjusted-R^2	0.129	0.129
Number of Observations	2,570	2,570

Table 5: Venture Capital Funding, Successful Exit, and Initial Public Offerings

This table reports linear regression analysis of the effect of win rate in H-1B visa lotteries on funding by venture capital firms, having a successful exit, and having an initial public offering in the three years following the lottery. In column (1), the dependent variable equals 100 if the firm receives funding from a venture capital firm and zero otherwise. In column (2), the dependent variable equals 100 if the firm has an IPO or is acquired for at least $25 million (in 2008 inflation adjusted dollars) and zero otherwise. In column (3), the dependent variable equals 100 if the firm has an IPO and zero otherwise. The main independent variable is *Win Rate*, which is the number of H-1B visas a firm wins through the lottery in a year divided by the number of applicants. All specifications include industry-city-year fixed effects and controls for log(number rounds of financing), log($ amount raised previously), log(months since first round), log(months since last round), log(number of H-1B applications), log($ salary for H-1B positions), and log(1 + number of prior patents). The numbers in brackets are *t*-statistics based on standard errors clustered by firm. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	VC Funding	Successful Exit	IPO
	(1)	(2)	(3)
Win Rate	9.04***	3.21*	2.05*
	[3.07]	[1.85]	[1.77]
Control variables?	Yes	Yes	Yes
Industry-City-Year fixed effects?	Yes	Yes	Yes
Adjusted-R^2	0.129	0.062	0.033
Number of Observations	2,570	2,570	2,570

Table 6: Patenting Outcomes

This table reports linear regression analysis of the effect of win rate in H-1B visa lotteries on patenting outcomes. All of the patenting outcome variables are based on patents that were applied for, and eventually granted, during the three-year period following the H-1B lottery. The dependent variables are: log(1 + *Number of Patents*), log(1 + *Adjusted Number of Patents*), log(1 + *Number of Adjusted Citations*), and log(1 + *Average Number of Adjusted Citations*). The main independent variable is *Win Rate*, which is the number of H-1B visas a firm wins through the lottery in a year divided by the number of applicants. All specifications include industry-city-year fixed effects and control for log(number rounds of financing), log($ amount raised previously), log(months since first round), log(months since last round), log(number of H-1B applications), and log($ salary for H-1B positions). The specifications also control for the patenting activity used in the dependent variable in the three-year period before the H-1B visa lottery. Panel A includes observations for all sample years (2,570 firm-year observations). Panel B includes observations for federal government fiscal years 2008 and 2009 only (825 firm-year observations). The numbers in brackets are *t*-statistics based on standard errors clustered by firm. ***, **, and * indicate statistical significance at the 1-percent, 5-percent, and 10-percent levels, respectively.

Panel A: Full Sample

Dependent variable	log(1 + # Patents)	log(1 + Adj. # Patents)	log(1 + # Adj. Cites)	log(1 + Avg. # Adj. Cites)
	(1)	(2)	(3)	(4)
Win Rate	0.11**	0.06**	0.07*	0.01
	[2.53]	[2.59]	[1.73]	[0.46]
Log(patent activity during prior 3 years)	0.70***	0.76***	0.61***	0.42***
	[23.63]	[20.06]	[15.40]	[7.98]
Adjusted-R^2	0.580	0.600	0.506	0.265

Panel B: 2008 & 2009 Only

Dependent variable	log(1 + # Patents)	log(1 + Adj. # Patents)	log(1 + # Adj. Cites)	log(1 + Avg. # Adj. Cites)
	(1)	(2)	(3)	(4)
Win Rate	0.26***	0.15***	0.22**	0.03
	[2.65]	[3.06]	[2.25]	[0.75]
Log(patent activity during prior 3 years)	0.80***	0.89***	0.69***	0.43***
	[14.90]	[10.61]	[11.61]	[5.31]
Adjusted-R^2	0.520	0.550	0.468	0.206

Table 7: Patenting by Likely H-1B Inventors

This table reports linear regression analysis of the effect of win rate in H-1B visa lotteries on patenting based on the imputed nationality of the inventors named in the firms' approved patent applications. The dependent variables are based on patents that were applied for, and eventually granted, during the three-year period following the H-1B lottery. The dependent variables are log(1 + *Number of Likely H-1B Inventors*) and log(1 + *Number of Likely H-1B Inventor-Patent Pairs*). *Number of Likely H-1B Inventors* is the number of unique inventors who are classified as being from India or China and are named in a firm's three-year post-lottery patent filings but are not named in the firm's pre-lottery patent applications. *Number of Likely H-1B Inventor-Patent Pairs* is the number of likely H-1B inventor-patent combinations in a firm's three-year post-lottery patent filings for which the inventor is not named in the firm's prior pre-lottery patent filings. The main independent variable is *Win Rate*, which is the number of H-1B visas a firm wins through the lottery in a year divided by the number of applicants. All specifications include industry-city-year fixed effects and controls for log(number rounds of financing), log($ amount raised previously), log(months since first round), log(months since last round), log(number of H-1B applications), and log($ salary for H-1B positions). The specifications also control for the likely H-1B inventor measure used in the dependent variable in the three-year period before the H-1B visa lottery. The numbers in brackets are *t*-statistics based on standard errors clustered by firm. ***, **, and * indicate statistical significance at the 1-percent, 5-percent, and 10-percent levels, respectively.

Dependent variable	log(1 + # Likely H-1B Inventors)	log(1 + # Likely H-1B Inventor-Patent Pairs)
	(1)	(2)
Win Rate	0.06**	0.08**
	[2.28]	[2.16]
Log(patent activity during prior 3 years)	0.48***	0.42***
	[9.46]	[8.89]
Control Variables?	Yes	Yes
Industry-City-Year fixed effects?	Yes	Yes
Adjusted-R^2	0.320	0.286
Number of Observations	2,570	2,570

Table 8: Future H-1B Applications

This table reports linear regression analysis of the effect of the win rate in H-1B lotteries on the number of H-1B applicants filed on a Labor Condition Application (LCA) by a firm over the one-, two-, or three-year period following the lottery. The main independent variable is *Win Rate*, which is the number of H-1B visas a firm wins through the lottery in a year divided by the number of applicants. All specifications include industry-city-year fixed effects and controls for log(number rounds of financing), log($ amount raised previously), log(months since first round), log(months since last round), log(number of H-1B applications), log($ salary for H-1B positions), and log(1 + number of prior patents). The numbers in brackets are *t*-statistics based on standard errors clustered by firm. ***, **, and * indicate statistical significance at the 1-percent, 5-percent, and 10-percent levels, respectively.

Dependent Variable	log(1 + Number of Future H-1B Applications)		
	Future time horizon:		
	One Year	Two Years	Three Years
	(1)	(2)	(3)
Win Rate	0.04	0.15***	0.20***
	[1.11]	[3.08]	[3.62]
Control Variables?	Yes	Yes	Yes
Industry-City-Year fixed effects?	Yes	Yes	Yes
Adjusted-R^2	0.326	0.367	0.366
Number of Observations	2,570	2,570	2,570

Table 9: Robustness Checks

This table reports the coefficient on *Win Rate* obtained from linear regression analysis for various firm outcomes across various specifications. *Win Rate* is defined as the number of H-1B visas a firm wins through the lottery in a year divided by the number of applicants. The various firm outcomes, all measured over the three years following the lottery, are given in the columns and the type of specification is given in the rows. In column (1), *Funded* equals 100 if a firm receives subsequent external funding and zero otherwise. In column (2), *Successful Exit* equals 100 if the firm has an IPO or is acquired for at least $25 million (in 2008 inflation adjusted dollars) and zero otherwise. In column (3), *IPO* equals 100 if the firm has an IPO and zero otherwise. The dependent variable is log(1 + *Number of Patents*) in column (4) and log(1 + *Adjusted Number of Patents*) in column (5). In column (6), the dependent variables is log(1 + *Number of Future H-1B Applications over next 3 years*). Unless stated otherwise, all specifications include industry-city-year fixed effects and controls for log(number rounds of financing), log($ amount raised previously), log(months since first round), log(months since last round), log(number of H-1B applications), log($ salary for H-1B positions), and log(1 + number of prior patents). The first row of the table repeats our baseline results. The second row restricts the sample to firms that file LCAs for a single H-1B worker. The third row replaces *Win Rate* with *Win Any*. The fourth row replaces the explanatory variable log(number rounds of financing) with separate indicator variables for each number of prior funding rounds. The fifth row adds three prior funding indicators that represent whether the firm received financing over one-year, two-year, and three-year periods prior to the lottery. The sixth row builds on the fifth by further adding controls for patenting activity over the prior one-year and two-year periods prior to the lottery (the baseline specification already controls for patenting activity over the three years prior to the lottery). The numbers in brackets are *t*-statistics based on standard errors clustered by firm. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Specification	Funded (1)	Exit (2)	IPO (3)	Patents (4)	Adjusted Patents (5)	H-1B Apps (6)
(1) Baseline	9.85***	3.21*	2.05*	0.11**	0.06**	0.20***
	[3.18]	[1.85]	[1.77]	[2.53]	[2.59]	[3.62]
(2) Firms makes one H1-B visa application	11.20***	3.72*	2.52**	0.09*	0.04	0.07
	[2.77]	[1.86]	[2.15]	[1.77]	[1.52]	[1.07]
(3) Replace *Win Rate* with *With Any*	10.30***	3.46**	2.05*	0.07*	0.03	0.13**
	[3.35]	[2.08]	[1.92]	[1.69]	[1.41]	[2.58]
(4) Indicators for # of prior funding rounds	10.07***	2.96*	1.81	0.11**	0.06***	0.20***
	[3.24]	[1.68]	[1.51]	[2.59]	[2.67]	[3.63]
(5) Controls for funding in prior 1, 2, and 3 years	9.79***	3.20*	2.04*	0.11**	0.06**	0.20***
	[3.19]	[1.84]	[1.76]	[2.53]	[2.59]	[3.62]
(6) Controls for funding & patenting in prior 1, 2, and 3 years	9.77***	3.19*	1.95*	0.09**	0.04**	0.20***
	[3.18]	[1.84]	[1.70]	[2.26]	[2.19]	[3.58]

Internet Appendix

Internet Appendix Table 1:
Comparison of Crunchbase Firms that File versus Do Not File LCAs

This table compares firms in the Crunchbase dataset that file LCAs with those that do not file LCAs. LCA filers are the firms in our sample. Non-filers are firms in Crunchbase that satisfy the following conditions: (1) the firm is a private firm based in the U.S., (2) it has completed at least one round of external financing in the previous 60 months, (3) the dollar amount of the prior external financing is available, and (4) the firm does not file LCAs for new employment in the given fiscal year. The table reports the means for various characteristics of the two groups of firms. *Number of Prior Financing Rounds* is the number of funding rounds a firm receives before the lottery. *Prior amount Raised* is the total amount of funds raised before the lottery. *Time Since First Round* is the number of months between the first round of funding and the lottery. *Time Since Last Round* is the number of months between the most recent round of funding and the lottery. *Funded* is an indicator that equals 100 if a firm receives subsequent external funding in the three years following the lottery and zero otherwise. *IPO* is an indicator variable that equals 100 if the firm goes public in the three years following the lottery and zero otherwise. ***, **, and * (displayed in the second column) indicate the statistical significance of the difference in means between the two samples at the 1%, 5%, and 10% levels, respectively.

	LCA Filers	Non-Filers
Number of Prior Financing Rounds	2.8	2.1***
Prior Amount Raised ($M)	40.1	15.1***
Time Since First Round (months)	56.0	38.2***
Time Since Last Round (months)	26.3	20.5***
$\text{Funded}_{(t,t+2)}$	44.7	32.5***
$\text{IPO}_{(t,t+2)}$	4.3	1.1***

Internet Appendix Table 2:
Coverage of Applications for New Employment for Various LCA Sample Criteria

This table reports the number of LCAs filed for new employment for three samples using LCAs filed during fiscal year 2017 (the first year LCA data contains whether the LCA is for new employment). The first row summarizes all LCAs filed during government fiscal year 2017 (i.e., LCAs filed from September 2016 through April 2017). The second row summarizes LCAs filed during February and March of 2017. The third row summarizes LCAs filed during February and March of 2017 that have a start date for employment that is five to six months in the future. The table reports the total number of LCAs, the number of LCAs for new hires, and the number of LCAs that are not for new hires (e.g., transfers or renewals). The table also reports the percent of total LCAs during the full fiscal year 2017 that are contained in the given sample (by definition, this is 100% for the first sample) as well as the percent of LCAs for a given sample that are and are not for new employment.

Sample months LCA is filed	LCA has start date 5-6 months in future?	Number of LCAs	Number of LCAs for new hires	Number of LCAs NOT for new hires	% total LCAs for new hires in sample	% of sample LCAs that are new hires	% of sample LCAs that are NOT new hires
All months	No	5,634	3,598	2,036	100.0%	63.9%	36.1%
February & March	No	4,317	3,442	875	95.7%	79.7%	20.3%
February & March	Yes	3,675	3,345	330	93.0%	91.0%	9.0%

Internet Appendix Table 3:
Number of LCAs for New Employment and False Positive Rates by Submission Month

This table reports, for each month from September 2016 through April 2017, the number and percentage of workers filing LCAs for new employment and the false positive rate. LCAs filed in these months are the earliest data that contains information on whether an LCA is for new employment. A false positive is defined as an LCA with a start date five to six months in the future that is not for new employment.

	# of workers filing for new employment	% of total workers filing for new employment	False positive rate
September	4	0.1%	100.0%
October	28	0.8%	100.0%
November	21	0.6%	100.0%
December	21	0.6%	84.6%
January	64	1.8%	34.8%
February	1,150	32.0%	5.9%
March	2,292	63.7%	10.5%
April	18	0.5%	96.7%

Internet Appendix Table 4: Logit and Conditional Logit Regressions

This table reports robustness tests of the regression analysis of the effect of win rate in H-1B visa lotteries on the probability of receiving subsequent funding. The dependent variable is *Funded*, which is an indicator that equals 100 if a firm receives external funding in the three years following the lottery and zero otherwise. The main independent variable is *Win Rate*, which is the number of H-1B visas a firm wins through the lottery in a year divided by the number of applicants. Column (1) reports results from a logit model. Column (2) reports results from a conditional logit model that conditions out the effect of industry-city-year effects and includes the following firm controls: log(number rounds of financing), log($ amount raised previously), log(months since first round), log(months since last round), log(number of H-1B applications), log($ salary for H-1B positions), and log(1 + number of prior patents). The number in brackets is a robust *z*-score. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Estimation Method	Logit	Conditional Logit
	(1)	(2)
Win Rate	0.33***	0.44***
	[3.69]	[3.15]
Control Variables?	No	Yes
Industry-City-Year fixed effects?	No	Yes
Pseudo-R^2	0.004	0.125
Number of Observations	2,570	2,570

Internet Appendix Table 5:
H-1B Lottery *Win Rate* and the Probability of Receiving Subsequent Funding:
Sample Partition by Cohorts

This table reports linear regression analysis of the effect of win rate in H-1B visa lotteries on the probability of receiving subsequent funding for the first and second half of our sample years separately. Panel A uses firms in fiscal years 2008 and 2009, and Panel B uses firms in fiscal years 2014 and 2015. The dependent variable is *Funded*, which is an indicator that equals 100 if a firm receives subsequent external funding in the three years following the lottery and zero otherwise. The main independent variable is *Win Rate*, which is the number of H-1B visas a firm wins through the lottery in a year divided by the number of applicants. Column (1) does not include any control variables or fixed effects. Columns (2) includes industry-city-year fixed effects and the following firm controls: log(number rounds of financing), log($ amount raised previously), log(months since first round), log(months since last round), log(number of H-1B applications), log($ salary for H-1B positions), and log(1 + number of prior patents). The numbers in brackets are *t*-statistics based on standard errors clustered by firm. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A: 2008 and 2009		
	(1)	(2)
Win Rate	9.51**	9.87*
	[2.43]	[1.69]
Control Variables?	No	Yes
Industry-City-Year fixed effects?	No	Yes
Adjusted-R^2	0.007	0.094
Number of Observations	825	825
Panel B: 2014 and 2015		
	(1)	(2)
Win Rate	7.47***	9.65***
	[2.75]	[2.60]
Control Variables?	No	Yes
Industry-City-Year fixed effects?	No	Yes
Adjusted-R^2	0.004	0.142
Number of Observations	1,745	1,745

Internet Appendix Table 6:
H-1B Lottery *Win Rate* and the Probability of Receiving Subsequent Funding:
Alternative Application Windows

This table reports linear regression analysis of the effect of win rate in H-1B visa lotteries on the probability of receiving subsequent funding. The dependent variable is *Funded*, which is an indicator that equals 100 if a firm receives subsequent external funding in the three years following the lottery and zero otherwise. The main independent variable is *Win Rate*, which is the number of H-1B visas a firm wins through the lottery in a year divided by the number of applicants. In columns (1) and (2), the number of applications is measured using LCA filings in January through March of the prior fiscal year (as opposed to February through March as in Table 3). In columns (3) and (4), the number of applications is measured using LCA filings in December through March of the prior fiscal year. The even numbered columns include industry-city-year fixed effects and the following firm controls: log(number rounds of financing), log($ amount raised previously), log(months since first round), log(months since last round), log(number of H-1B applications), log($ salary for H-1B positions), and log(1 + number of prior patents). The numbers in brackets are *t*-statistics based on standard errors clustered by firm. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	January – March		December – March	
	(1)	(2)	(3)	(4)
Win Rate	8.67***	10.24***	8.62***	10.09***
	[3.97]	[3.33]	[3.94]	[3.27]
Control Variables?	No	Yes	No	Yes
Industry-City-Year fixed effects?	No	Yes	No	Yes
Adjusted-R^2	0.006	0.126	0.006	0.126
Number of Observations	2,615	2,615	2,617	2,617

Internet Appendix Table 7:
H-1B Lottery *Win Rate* and the Probability of Receiving Subsequent Funding:
Alternative Definitions of *Win Rate*

This table reports linear regression analysis of the effect of alternative definitions of the win rate in H-1B visa lotteries on the probability of receiving subsequent funding. The dependent variable is *Funded*, which is an indicator that equals 100 if a firm receives subsequent external funding in the three years following the lottery and zero otherwise. In column (1), *Win Rate Excludes Renewals* is calculated as the number of H-1B visas a firm receives through the lottery divided by the number of applications excluding potential renewals. We define an LCA as a potential renewal if its start date is the day after the end date of an LCA filed by the same firm in the prior three years and it shares the same occupation code as the prior LCA. In column (2), *Win Rate Includes Denied Applications* is calculated as the number of H-1B visas a firm receives through the lottery plus the number of selected-but-denied applications in a year divided by the number of applications. Column (2) contains observations for only the 2014 and 2015 government fiscal years, during which the denial rate data are available. Both columns include industry-city-year fixed effects and the following firm controls: log(number rounds of financing), log($ amount raised previously), log(months since first round), log(months since last round), log(number of H-1B applications), log($ salary for H-1B positions), and log(1 + number of prior patents). The numbers in brackets are *t*-statistics based on standard errors clustered by firm. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	Win Rate Excludes Renewals	Win Rate Includes Denied Applications
	(1)	(2)
Win Rate	9.73***	8.49**
	[3.14]	[2.24]
Control Variables?	Yes	Yes
Industry-City-Year fixed effects?	Yes	Yes
Adjusted-R^2	0.124	0.140
Number of Observations	2,564	1,745

Internet Appendix Table 8: Poisson Regressions for Count Dependent Variables

This table reports conditional Poisson regression analysis of the effect of win rate in H-1B visa lotteries on various count dependent variables. The patenting variables in Panels A, B, and C are based on patents that were applied for, and eventually granted, during the three-year period following the H-1B lottery. The dependent variables in Panels A and B are *Number of Patents*, *Adjusted Number of Patents*, *Number of Adjusted Citations*, and *Average Number of Adjusted Citations*. The dependent variables in Panel C are *Number of Likely H-1B Inventors* and *Number of Likely H-1B Inventor-Patent Pairs*. The dependent variables in Panel D are the number of H-1B applicants filed on an LCA by a firm over the one-, two-, or three-year period following the lottery. The main independent variable is *Win Rate*, which is the number of H-1B visas a firm wins through the lottery in a year divided by the number of applicants. All specifications include industry-city-year fixed effects and control for log(number rounds of financing), log($ amount raised previously), log(months since first round), log(months since last round), log(number of H-1B applications), and log($ salary for H-1B positions). The specifications in Panels A, B, and C also control for the patenting activity used in the dependent variable in the three-year pre-lottery period. Panels A, C, and D include observations for all sample years (2,570 firm-year observations). Panel B includes observations for federal government fiscal years 2008 and 2009 only (825 firm-year observations). The numbers in brackets are *t*-statistics based on standard errors clustered by firm. ***, **, and * indicate statistical significance at the 1-percent, 5-percent, and 10-percent levels, respectively.

Panel A: Full Sample Patenting Variables

Dependent variable	# Patents	Adj. # Patents	# Adj. Cites	Avg. # Adj. Cites
	(1)	(2)	(3)	(4)
Win Rate	0.52***	0.44**	0.60**	0.16
	[3.04]	[2.25]	[2.15]	[0.69]

Panel B: 2008 & 2009 Only Patenting Variables

Dependent variable	# Patents	Adj. # Patents	# Adj. Cites	Avg. # Adj. Cites
	(1)	(2)	(3)	(4)
Win Rate	0.91***	0.77**	1.05***	0.34
	[3.62]	[2.58]	[2.95]	[1.39]

Panel C: Patenting by Likely H-1B Inventors

Dependent variable	# Likely H-1B Inventors	# Likely H-1B Inventor-Patent Pairs
	(1)	(2)
Win Rate	0.52**	0.85**
	[2.54]	[2.45]

Panel D: Future H-1B Applications

Dependent variable	One Year	Two Years	Three Years
	(1)	(2)	(3)
Win Rate	0.22**	0.47***	0.51***
	[2.38]	[5.72]	[5.65]

INTERNET APPENDIX FOR

Give Me Your Tired, Your Poor, Your High-Skilled Labor: H-1B Lottery Outcomes and Entrepreneurial Success

Internet Appendix Table 1:
Comparison of Crunchbase Firms that File versus Do Not File LCAs

This table compares firms in the Crunchbase dataset that file LCAs with those that do not file LCAs. LCA filers are the firms in our sample. Non-filers are firms in Crunchbase that satisfy the following conditions: (1) the firm is a private firm based in the U.S., (2) it has completed at least one round of external financing in the previous 60 months, (3) the dollar amount of the prior external financing is available, and (4) the firm does not file LCAs for new employment in the given fiscal year. The table reports the means for various characteristics of the two groups of firms. *Number of Prior Financing Rounds* is the number of funding rounds a firm receives before the lottery. *Prior amount Raised* is the total amount of funds raised before the lottery. *Time Since First Round* is the number of months between the first round of funding and the lottery. *Time Since Last Round* is the number of months between the most recent round of funding and the lottery. *Funded* is an indicator that equals 100 if a firm receives subsequent external funding in the three years following the lottery and zero otherwise. *IPO* is an indicator variable that equals 100 if the firm goes public in the three years following the lottery and zero otherwise. ***, **, and * (displayed in the second column) indicate the statistical significance of the difference in means between the two samples at the 1%, 5%, and 10% levels, respectively.

	LCA Filers	Non-Filers
Number of Prior Financing Rounds	2.8	2.1***
Prior Amount Raised ($M)	40.1	15.1***
Time Since First Round (months)	56.0	38.2***
Time Since Last Round (months)	26.3	20.5***
$Funded_{(t,t+2)}$	44.7	32.5***
$IPO_{(t,t+2)}$	4.3	1.1***

Internet Appendix Table 2:
Coverage of Applications for New Employment for Various LCA Sample Criteria

This table reports the number of LCAs filed for new employment for three samples using LCAs filed during fiscal year 2017 (the first year LCA data contains whether the LCA is for new employment). The first row summarizes all LCAs filed during government fiscal year 2017 (i.e., LCAs filed from September 2016 through April 2017). The second row summarizes LCAs filed during February and March of 2017. The third row summarizes LCAs filed during February and March of 2017 that have a start date for employment that is five to six months in the future. The table reports the total number of LCAs, the number of LCAs for new hires, and the number of LCAs that are not for new hires (e.g., transfers or renewals). The table also reports the percent of total LCAs during the full fiscal year 2017 that are contained in the given sample (by definition, this is 100% for the first sample) as well as the percent of LCAs for a given sample that are and are not for new employment.

Sample months LCA is filed	LCA has start date 5-6 months in future?	Number of LCAs	Number of LCAs for new hires	Number of LCAs NOT for new hires	% total LCAs for new hires in sample	% of sample LCAs that are new hires	% of sample LCAs that are NOT new hires
All months	No	5,634	3,598	2,036	100.0%	63.9%	36.1%
February & March	No	4,317	3,442	875	95.7%	79.7%	20.3%
February & March	Yes	3,675	3,345	330	93.0%	91.0%	9.0%

Internet Appendix Table 3:
Number of LCAs for New Employment and False Positive Rates by Submission Month

This table reports, for each month from September 2016 through April 2017, the number and percentage of workers filing LCAs for new employment and the false positive rate. LCAs filed in these months are the earliest data that contains information on whether an LCA is for new employment. A false positive is defined as an LCA with a start date five to six months in the future that is not for new employment.

	# of workers filing for new employment	% of total workers filing for new employment	False positive rate
September	4	0.1%	100.0%
October	28	0.8%	100.0%
November	21	0.6%	100.0%
December	21	0.6%	84.6%
January	64	1.8%	34.8%
February	1,150	32.0%	5.9%
March	2,292	63.7%	10.5%
April	18	0.5%	96.7%

Internet Appendix Table 4: Logit and Conditional Logit Regressions

This table reports robustness tests of the regression analysis of the effect of win rate in H-1B visa lotteries on the probability of receiving subsequent funding. The dependent variable is *Funded*, which is an indicator that equals 100 if a firm receives external funding in the three years following the lottery and zero otherwise. The main independent variable is *Win Rate*, which is the number of H-1B visas a firm wins through the lottery in a year divided by the number of applicants. Column (1) reports results from a logit model. Column (2) reports results from a conditional logit model that conditions out the effect of industry-city-year effects and includes the following firm controls: log(number rounds of financing), log($ amount raised previously), log(months since first round), log(months since last round), log(number of H-1B applications), log($ salary for H-1B positions), and log(1 + number of prior patents). The number in brackets is a robust *z*-score. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Estimation Method	Logit	Conditional Logit
	(1)	(2)
Win Rate	0.33***	0.44***
	[3.69]	[3.15]
Control Variables?	No	Yes
Industry-City-Year fixed effects?	No	Yes
Pseudo-R^2	0.004	0.125
Number of Observations	2,570	2,570

Internet Appendix Table 5:
H-1B Lottery *Win Rate* and the Probability of Receiving Subsequent Funding:
Sample Partition by Cohorts

This table reports linear regression analysis of the effect of win rate in H-1B visa lotteries on the probability of receiving subsequent funding for the first and second half of our sample years separately. Panel A uses firms in fiscal years 2008 and 2009, and Panel B uses firms in fiscal years 2014 and 2015. The dependent variable is *Funded*, which is an indicator that equals 100 if a firm receives subsequent external funding in the three years following the lottery and zero otherwise. The main independent variable is *Win Rate*, which is the number of H-1B visas a firm wins through the lottery in a year divided by the number of applicants. Column (1) does not include any control variables or fixed effects. Columns (2) includes industry-city-year fixed effects and the following firm controls: log(number rounds of financing), log($ amount raised previously), log(months since first round), log(months since last round), log(number of H-1B applications), log($ salary for H-1B positions), and log(1 + number of prior patents). The numbers in brackets are *t*-statistics based on standard errors clustered by firm. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A: 2008 and 2009		
	(1)	(2)
Win Rate	9.51**	9.87*
	[2.43]	[1.69]
Control Variables?	No	Yes
Industry-City-Year fixed effects?	No	Yes
Adjusted-R^2	0.007	0.094
Number of Observations	825	825
Panel B: 2014 and 2015		
	(1)	(2)
Win Rate	7.47***	9.65***
	[2.75]	[2.60]
Control Variables?	No	Yes
Industry-City-Year fixed effects?	No	Yes
Adjusted-R^2	0.004	0.142
Number of Observations	1,745	1,745

Internet Appendix Table 6:
H-1B Lottery *Win Rate* and the Probability of Receiving Subsequent Funding:
Alternative Application Windows

This table reports linear regression analysis of the effect of win rate in H-1B visa lotteries on the probability of receiving subsequent funding. The dependent variable is *Funded*, which is an indicator that equals 100 if a firm receives subsequent external funding in the three years following the lottery and zero otherwise. The main independent variable is *Win Rate*, which is the number of H-1B visas a firm wins through the lottery in a year divided by the number of applicants. In columns (1) and (2), the number of applications is measured using LCA filings in January through March of the prior fiscal year (as opposed to February through March as in Table 3). In columns (3) and (4), the number of applications is measured using LCA filings in December through March of the prior fiscal year. The even numbered columns include industry-city-year fixed effects and the following firm controls: log(number rounds of financing), log($ amount raised previously), log(months since first round), log(months since last round), log(number of H-1B applications), log($ salary for H-1B positions), and log(1 + number of prior patents). The numbers in brackets are *t*-statistics based on standard errors clustered by firm. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	January – March		December – March	
	(1)	(2)	(3)	(4)
Win Rate	8.67***	10.24***	8.62***	10.09***
	[3.97]	[3.33]	[3.94]	[3.27]
Control Variables?	No	Yes	No	Yes
Industry-City-Year fixed effects?	No	Yes	No	Yes
Adjusted-R^2	0.006	0.126	0.006	0.126
Number of Observations	2,615	2,615	2,617	2,617

Internet Appendix Table 7:
H-1B Lottery *Win Rate* and the Probability of Receiving Subsequent Funding:
Alternative Definitions of *Win Rate*

This table reports linear regression analysis of the effect of alternative definitions of the win rate in H-1B visa lotteries on the probability of receiving subsequent funding. The dependent variable is *Funded*, which is an indicator that equals 100 if a firm receives subsequent external funding in the three years following the lottery and zero otherwise. In column (1), *Win Rate Excludes Renewals* is calculated as the number of H-1B visas a firm receives through the lottery divided by the number of applications excluding potential renewals. We define an LCA as a potential renewal if its start date is the day after the end date of an LCA filed by the same firm in the prior three years and it shares the same occupation code as the prior LCA. In column (2), *Win Rate Includes Denied Applications* is calculated as the number of H-1B visas a firm receives through the lottery plus the number of selected-but-denied applications in a year divided by the number of applications. Column (2) contains observations for only the 2014 and 2015 government fiscal years, during which the denial rate data are available. Both columns include industry-city-year fixed effects and the following firm controls: log(number rounds of financing), log($ amount raised previously), log(months since first round), log(months since last round), log(number of H-1B applications), log($ salary for H-1B positions), and log(1 + number of prior patents). The numbers in brackets are *t*-statistics based on standard errors clustered by firm. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	Win Rate Excludes Renewals	Win Rate Includes Denied Applications
	(1)	(2)
Win Rate	9.73***	8.49**
	[3.14]	[2.24]
Control Variables?	Yes	Yes
Industry-City-Year fixed effects?	Yes	Yes
Adjusted-R^2	0.124	0.140
Number of Observations	2,564	1,745

Internet Appendix Table 8: Poisson Regressions for Count Dependent Variables

This table reports conditional Poisson regression analysis of the effect of win rate in H-1B visa lotteries on various count dependent variables. The patenting variables in Panels A, B, and C are based on patents that were applied for, and eventually granted, during the three-year period following the H-1B lottery. The dependent variables in Panels A and B are *Number of Patents*, *Adjusted Number of Patents*, *Number of Adjusted Citations*, and *Average Number of Adjusted Citations*. The dependent variables in Panel C are *Number of Likely H-1B Inventors* and *Number of Likely H-1B Inventor-Patent Pairs*. The dependent variables in Panel D are the number of H-1B applicants filed on an LCA by a firm over the one-, two-, or three-year period following the lottery. The main independent variable is *Win Rate*, which is the number of H-1B visas a firm wins through the lottery in a year divided by the number of applicants. All specifications include industry-city-year fixed effects and control for log(number rounds of financing), log($ amount raised previously), log(months since first round), log(months since last round), log(number of H-1B applications), and log($ salary for H-1B positions). The specifications in Panels A, B, and C also control for the patenting activity used in the dependent variable in the three-year pre-lottery period. Panels A, C, and D include observations for all sample years (2,570 firm-year observations). Panel B includes observations for federal government fiscal years 2008 and 2009 only (825 firm-year observations). The numbers in brackets are *t*-statistics based on standard errors clustered by firm. ***, **, and * indicate statistical significance at the 1-percent, 5-percent, and 10-percent levels, respectively.

Panel A: Full Sample Patenting Variables

Dependent variable	# Patents	Adj. # Patents	# Adj. Cites	Avg. # Adj. Cites
	(1)	(2)	(3)	(4)
Win Rate	0.52***	0.44**	0.60**	0.16
	[3.04]	[2.25]	[2.15]	[0.69]

Panel B: 2008 & 2009 Only Patenting Variables

Dependent variable	# Patents	Adj. # Patents	# Adj. Cites	Avg. # Adj. Cites
	(1)	(2)	(3)	(4)
Win Rate	0.91***	0.77**	1.05***	0.34
	[3.62]	[2.58]	[2.95]	[1.39]

Panel C: Patenting by Likely H-1B Inventors

Dependent variable	# Likely H-1B Inventors	# Likely H-1B Inventor-Patent Pairs
	(1)	(2)
Win Rate	0.52**	0.85**
	[2.54]	[2.45]

Panel D: Future H-1B Applications

Dependent variable	One Year	Two Years	Three Years
	(1)	(2)	(3)
Win Rate	0.22**	0.47***	0.51***
	[2.38]	[5.72]	[5.65]