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Marked for Life?: Mobility Constraints and Entrepreneurship Decisions by Foreign Graduates in Science and Engineering

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Abstract

Existing literature maintains that the acquisition of relevant knowledge shapes the entrepreneurial propensities of individuals. Prior studies further show that the accumulation of experience in a more flexible and less constrained organizational context enables transitions to entrepreneurship. As opposed to studying constraints within organizations, I focus on the constraints affecting the acquisition of knowledge as individuals make employment choices and move across organizations. I hypothesize that such constraints will be negatively associated with entrepreneurship and that the detrimental effect will be more pronounced for self-employment relative to growth-oriented entrepreneurship. I test the predictions in the context of foreign graduates of U.S. universities in science and engineering. This setting allows me to design a quasi-experiment while isolating the effect of the constraints from the self-selection. I find that green card timing does not affect the overall rate of entrepreneurship. However, the student green card holders tend to be self-employed (e.g., in consulting) more often than the post-graduation green card recipients, transition faster and enter different domains. Immigrants who receive green cards shortly post-graduation are more likely to start a growth-oriented business in a field related to their degree (mostly in high-tech industries). The study helps to refine the views found in prior literature by suggesting that temporary constraints may not be as detrimental as previously thought. The potential positive role that the constraints play in fostering growth-oriented entrepreneurship underscores often overlooked benefits of the current employer-based immigration system.

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Keywords: Entrepreneurship, mobility, highly skilled immigrants, growth-oriented entrepreneurship, high-technology entrepreneurship, self-employment.

Existing literature posits that the acquisition of relevant knowledge shapes the entrepreneurial propensities of individuals. Researchers have recently examined a variety of contextual factors that affect the acquisition of such relevant knowledge, including knowledge about the focal industries, markets and technologies (Helfat and Lieberman, 2002; Agarwal, Echambadi, Franco and Sarkar, 2004; Klepper and Thompson, 2010; Chen, 2013a, b; Braguinsky, Klepper and Ohyama, 2013). A related stream of research has focused on the acquisition of skills that are generally useful in entrepreneurship such as diverse knowledge in running a business (Lazear, 2004; 2005). In support of these arguments, scholars have reported in multiple studies that organizational context is an important determinant of acquired knowledge with implications for entrepreneurship. Several studies (Sørensen, 2007; Elfenbein, Hamilton and Zenger, 2010; Sørensen and Phillips, 2011; Tag, Astebro and Thompson, 2013) report the importance of small firms as training grounds for future entrepreneurs, presumably because the flexible organizational context in small firms allows rapid acquisition of diverse knowledge relevant for entrepreneurship. These scholars theorize that context in large organizations that is less flexible, more hierarchical and specialized is detrimental for the acquisition of entrepreneurial knowledge and skills. Tag et al. (2013) explicitly show that even after controlling for firm size, more hierarchical firms are spawning fewer entrepreneurs than less hierarchical firms.

Prior work thus implies that *constraints within* organizations that are driven by hierarchy, bureaucracy or size impede the acquisition of knowledge relevant for entrepreneurship. However, aspiring entrepreneurs may also acquire relevant knowledge through movements across organizations. Beyond the finding that employees of small firms tend to change employers more often (e.g., Elfenbein et al., 2009), we know very little about how *mobility constraints*

across organizations affect entrepreneurship. Answering this question is important because it may inform the debate that persists in the literature about the underlying mechanisms responsible for the relationship between the prior organizational context and entrepreneurship. For instance, a significant discussion has emerged on the question as to what extent are the observed empirical relationships driven by self-selection versus contextual imprinting (Elfenbein et al., 2009; Sørensen and Phillips, 2011; Chen 2013b). Many studies have highlighted the role of self-selection in explaining the relationships (Chen, 2013a, b; Tag et al., 2013) while others posit that, even after controlling for self-selection, constraints associated with context significantly impede entrepreneurial propensities (Elfenbein et al., 2009). The relative role of self-selection versus the role of context in the acquisition of relevant knowledge thus remains an open question.

Building on the above literature, I develop a theory connecting mobility constraints with the likelihood of transitioning to entrepreneurship. The key research question of my study is: Do constraints imposed on the employment choices and mobility of individuals impede the acquisition of knowledge relevant for entrepreneurship? Individuals whose mobility is constrained (e.g., due to the immigration process) may not be able to optimize the acquisition of relevant knowledge and thus should exhibit a lower likelihood of entrepreneurship. Examining the role of mobility constraints may shed new light on the role of contextual imprinting – namely how it is associated with mobility *across* organizations.

I develop and test a set of hypotheses connecting mobility constraints with the likelihood of transitioning to entrepreneurship. I utilize a unique context consisting of foreign graduates of U.S. universities in science and engineering by using the NSF dataset SESTAT and its 2003 survey in which the NSF inquired about multiple immigration details. I focus on foreign graduates of U.S. universities and their first employment for multiple reasons. The immigration

process provides a quasi-experimental setting that allows me to isolate the effects of self-selection from the effects of the context associated with mobility constraints. Further, focusing on the phenomenon of highly skilled immigrants is important in its own right because of the important role that these individuals play in the U.S. economy (Hunt, 2009, 2013; Mithas and Lucas, 2010; Kerr and Foley, 2013). A significant debate on U.S. immigration reform is currently taking place in the public policy domain and is related to the immigration overhaul proposed by the current administration. Focusing on how mobility constraints affect entrepreneurship rates among highly skilled immigrants may lead to important policy implications relevant for this policy discussion.

More specifically, I examine the long-term likelihood of entering entrepreneurship as a function of the timing of permanent residency. To empirically identify the causal relationship, I compare individuals who entered the U.S. with a student visa but received permanent residency (i.e., a green card) during their studies with those who received it shortly post-graduation. This design allows me to focus only on those individuals whose green cards are not associated with employment, thus disentangling the ability-related selection effects. The empirical design further exploits the fact that the exact timing of receiving a green card tends to be uncertain and immigrants are unlikely to know whether they will receive the card before or shortly after they graduate. I further address potential remaining endogeneity issues with a set of instrumental variables. The instruments are based on the length of the country-specific waiting times for permanent residency and the likelihood of winning a green card in a lottery. Under a reasonable set of assumptions (i.e., conditioning on the school rank and degree as I discuss below), I expect the instruments to be uncorrelated with the individual ability and entrepreneurial propensity while predicting the green card timing.

To foreshadow the results, I find that individuals who receive permanent residency pre-graduation while on a student visa, thus leaving their initial mobility options and labor market search unconstrained, do not exhibit a higher overall likelihood of transitioning to entrepreneurship than those who receive the green card shortly after graduation. Nevertheless, I find that the *types* of entrepreneurship for these two groups differ. The individuals who receive a green card during their studies and thus have unconstrained mobility options tend to exhibit a higher likelihood of entering self-employment (e.g., being an independent consultant, not being incorporated), changing fields (relative to the field of their degree) and transitioning early relative to individuals who receive a green card shortly post-graduation. In turn, receiving a green card post-graduation is associated with a higher likelihood of starting a company (i.e., being incorporated), remaining in the field of the highest degree and transitioning later post-degree.

The study contributes to prior research on how context drives entrepreneurship by refining the view that constraints necessarily impede the entrepreneurial propensity. The study shows that context is an important driver of entrepreneurship because it affects the type of knowledge that individuals acquire and thus also the form of the start-up. Prior literature suggests that knowledge acquired in a flexible setting enables entrepreneurship (Lazear, 2004, 2005; Sorenson, 2007; Elfenbein et al., 2009). While my findings partially reinforce this view, I also highlight a counterbalancing mechanism. If mobility options are unconstrained, immigrants may have a tendency to enter new domains or transition to entrepreneurship early. Such tendencies may interfere with the ability of individuals to acquire deeper knowledge. Deeper knowledge may be required for growth-oriented entrepreneurship - particularly in a high technology setting. Scholars have argued that technological innovation requires both breadth and

depth in the acquired knowledge (Gardner, 1993; Helfat, 1994; Martin and Mitchell, 1998; Fleming, 2001; Jones, 2009a, b; Schilling and Green, 2010). Braguinsky et al. (2013) maintain that the complementarity between education and industry experience is particularly important for technology-based entrepreneurship. My study contributes to the literature on the contextual micro-foundations of entrepreneurship by showing that mobility constraints may help individuals to acquire deeper relevant knowledge that enables growth-oriented entrepreneurship in a high-technology setting.

In the context of the recent immigration policy debate, the study has important implications as well. The study indicates that the less flexible and constrained acquisition of knowledge associated with employment sponsorship of permanent residency may lead to socially more desirable outcomes. If one prefers to induce individuals to seek employment in their field of degree and facilitate the emergence of growth-oriented start-ups, the study suggests unforeseen benefits of the constraints that are imposed on immigrant mobility. The study highlights the role of “corporate apprenticeship” that the current immigration system provides. Such an implication may be even more pronounced in the context of immigrants who lack cultural and social skills. When the immigration process is tied to an employer it may provide a training ground for foreign graduates. These implications are particularly important in light of the recent debates on immigration reform. Several other countries, such as Canada, have a permanent residency process that is not tied to a specific employer but rather depends on the individual’s education, experience and skills. My study suggests that the U.S. system may be better in helping individuals to acquire knowledge and skills that they may not acquire otherwise.

Mobility constraints and entrepreneurship

Existing research suggests that prior experience and knowledge acquisition is an important determinant of entrepreneurship decisions (Agarwal, Echambadi, Franco and Sarkar, 2004; Elfenbein et al., 2009; Klepper and Thompson, 2010). Scholars have found that organizational context, among other factors, can enable or impede the likelihood that individuals transition to entrepreneurship. For instance, several studies found that individuals working for larger organizations are less likely to transition to entrepreneurship than employees of smaller firms (Sørensen, 2007; Elfenbein et al., 2009; Sørensen and Phillips, 2012). Prior work has attributed this observed pattern to two underlying mechanisms. The first mechanism relates to selection. Less entrepreneurial individuals may self-select into larger, more hierarchical and bureaucratic firms (Elfenbein et al., 2009; Chen and Thompson, 2012). The second mechanism emerges from a contextual effect in which the bureaucratic and hierarchical nature of large organizations may interfere with the acquisition of skills and knowledge that are needed for transitioning to entrepreneurship (Sørensen, 2007; Elfenbein et al., 2009; Sørensen and Phillips, 2012).

The contextual effect mirrors the “jack-of-all-trades” hypothesis (Lazear, 2004, 2005), which suggests that entrepreneurship requires a diverse set of skills that is best acquired in a flexible organizational setting such as in a small firm. Consistent with the arguments on imprinting, Tag, Astebro and Thompson (2013) found that, even after controlling for firm size, more hierarchical organizations generate fewer employee entrepreneurs. This is again, presumably, because knowledge and skills that are relevant in entrepreneurship are not easily acquired within a less flexible organizational setting.

The implication of the literature above is that inflexible and hierarchical organizational settings in which individuals are constrained into more specialized jobs will be less able to build

the varied skill set required for entrepreneurship. However, prior literature focuses on the constraints *within* organizations. We know relatively little about the effects of constraints imposed while individuals make employment choices – i.e. the effect of constraints imposed on individuals *across* organizations. Mobility across organizations may serve an equally important role in the process of acquiring knowledge and skills relevant for entrepreneurship. Elfenbein et al. (2009) provide evidence consistent with this argument by showing that employees of small firms are not only more likely to be entrepreneurial but are also more likely to change employers. Similarly, Tag et al. (2013) find that after controlling for firm size, a lower likelihood of mobility is associated with the prior employer being more hierarchical.

If the constraints imposed *within* an organization have a negative impact on entrepreneurship, a similar affect should extend to constraints that are imposed on mobility *across* organizations when employees make employment choices. Employment choices and mobility may provide an even more important source for the acquisition of knowledge relevant for entrepreneurship than within organization movements. Individuals may more easily acquire a varied skill set when moving across organizations as they increase the breadth of their acquired knowledge. A related literature on innovations maintains that breadth in the knowledge acquisition process is critically important when creating novel products and services (Fleming, 2001; Fleming, Mingo and Chen, 2007; Schilling and Green, 2011). Similarly, some individuals may deliberately focus on targeting organizations that promote entrepreneurial values and culture. When making employment decisions, aspiring entrepreneurs may opt for organizations that provide them with the best skill set for their future entrepreneurship.

If individuals' employment choices and mobility are constrained due to reasons that are not related to the acquisition of skills relevant for entrepreneurship (such as due to the

requirements of the immigration system), the future entrepreneurial propensity of these individuals should decline. Analogous to the constraints imposed within organizations due to the hierarchy or bureaucratic nature of large organizations, constraints imposed on the employment and mobility choices should negatively affect the acquisition of relevant knowledge and thus have a negative impact on the propensity of transitioning to entrepreneurship:

Hypothesis 1: when an individual's employment and mobility choices are constrained and the individual prioritizes factors that are not relevant for entrepreneurship when making employment choices, the long-term likelihood of transitioning to entrepreneurship will decrease.

Mobility constraints and the form of entrepreneurship

While the constraints imposed on their employment choices should reduce the ability of individuals to acquire knowledge relevant for entrepreneurship and consequently decrease the risk of entrepreneurship, the effect may not be homogenous across all individuals. Prior studies started examining the heterogeneity of the contextual effects on entrepreneurship (Andersson and Klepper, 2012; Tag et al., 2013). More specifically, the constraints existing within organizations such as those driven by hierarchy or bureaucracy have been found to affect individuals differently depending on the form of entrepreneurship that the individuals pursue. Tag et al. (2013) find that after controlling for firm size, the negative effect of organizational hierarchy is more pronounced for growth-oriented businesses than for self-employment.¹ The authors attribute this finding mostly to preference sorting (i.e., individuals with a preference for hierarchical organizations will likely self-select into such organizations) and partially to knowledge acquisition. Similarly, Andersson and Klepper (2012) report that the likelihood of

¹ Self-employment entrepreneurship among high-skilled individuals typically involves single owner firms or partnerships performing consulting or contract-based work. Growth-oriented entrepreneurship includes those start-ups that are founded by one or more individuals and are focused on hiring additional individuals. As I discuss below, I empirically distinguish between self-employment and growth-oriented entrepreneurship by the start-up's legal form (incorporated (LLC, C-corp, S-corp) versus non-incorporated (sole proprietorship or partnership)). This is consistent with prior work of other scholars (Tag et al., 2013; Levine and Rubinstein, 2013).

transitioning to self-employment decreases with the firm size of the prior employer while the likelihood of starting a growth-oriented incorporated business increases with the size of the prior employer. This pattern may again exist because of sorting and because of the acquisition of relevant knowledge. Acquisition of knowledge suitable for self-employment may be best accomplished in small organizations, while knowledge more relevant for growth-oriented businesses is available in larger organizations.

Since the acquisition of knowledge and the associated constraints within organizations play an important role in explaining entrepreneurship, analogous arguments should extend to the employment choices across organizations. In particular, entrepreneurs who run all aspects of their businesses, such as in self-employment, may need to acquire broader knowledge. This logic is consistent with the argument that a diverse skill set is valuable for entrepreneurship (Lazear, 2004, 2005). Self-employment may also require applying specific knowledge that the individual holds in multiple industries and firms, such as in the case of consulting. Consequently, being able to prioritize the acquisition of skills and not facing mobility and employment constraints may be more important for self-employment than for starting a growth-oriented business. Since founders of growth-oriented businesses typically recruit other employees or co-founders with complementary human capital, lack of a focal founder's knowledge and skills in a particular area may be supplemented by the knowledge of another member of the start-up team (Campbell et al., 2012). Consequently, the constraints on mobility and employment choices should more negatively affect the ability of a focal individual to transition to self-employment than to growth-oriented entrepreneurship.

Hypothesis 2: the negative effect of employment and mobility constraints on the long-term likelihood of entrepreneurship will be stronger for entrepreneurship that relies more heavily on a varied skill set such as in self-employment relative to growth-oriented entrepreneurship.

Context, Data and Methodology

To study how mobility constraints affect the rates of entrepreneurship, I examine how timing of permanent residency (i.e., a “green card”) among immigrants who entered the U.S. on a student visa and studied in science and engineering affects the long-term rates of entrepreneurship among these individuals. This setting allows me to design a quasi-experiment while isolating the effect of individual characteristics from the hypothesized effects of mobility constraints. In the United States, permanent residency is typically tied to sponsoring family members who are citizens or permanent residents, a green card lottery or a sponsoring employer.² I focus only on green card timing in the subsample of immigrants who are unlikely to receive permanent residency due to factors that are related to their individual ability and individual characteristics. More specifically, students who enter the United States on a temporary student visa (e.g., F1) and receive permanent residency while in a student status or shortly post-graduation are likely to receive the green card through family ties or the diversity visa lottery rather than due to reasons related to their individual ability such as in the case of employer-sponsored permanent residency. To further alleviate concerns related to self-selection and to test for the exogeneity of the main explanatory measure, I complement the analysis by using an instrumental variable approach.

Focusing on foreign graduates in science and engineering provides an additional benefit beyond the methodological advantage. Immigrants, particularly in science and engineering fields, play an increasingly important role in the U.S. economy (Hunt, 2009, 2013). Consistent with the efforts of U.S. policy makers to design an immigration system that is receptive toward highly skilled immigrants, a significant public debate on the topic of immigration reform has emerged. One of the fundamental questions related to immigration reform is whether to eliminate

² A small proportion of permanent residencies are tied to asylum or sizeable investments in the U.S. economy (www.uscis.gov).

the employment sponsorship of permanent residency (AFP Press, April 2013). Some countries do not tie the permanent residency application to a specific employer. For instance, in the case of Canada, employment sponsorship is not required and permanent residency is based on education, experience and skills. Calls for a similar system emerged in the U.S. as Senate legislation has been introduced eliminating the employer sponsorship requirement (AFP Press, April 2013).

I test the hypotheses utilizing the 2003 Survey of the SESTAT data set collected by the National Science Foundation (NSF). In the SESTAT surveys (collected every two years starting in 1993), the NSF collects information about graduates of U.S. universities in the science and engineering fields, including foreign graduates. In the 2003 survey, the NSF collected multiple details related to the immigration background of foreign graduates, allowing me to perform the analysis. The analysis is designed as cross-sectional with respondents of the 2003 survey who, a) are foreign graduates in science and engineering fields, b) entered the United States on a student visa (F1 or J1) and, c) are permanent residents or naturalized citizens at the time of the 2003 survey. I further constrain the sample to individuals who received their green card either during their studies (≤ 6 years to account for the typical length of a doctoral program) or shortly post-graduation (2, 3 or 6 years).³ The final sample used in the regression includes at most 1,999 individuals; 1,363 with a PhD (68%), 458 with a Master's (23%) and 178 with a Bachelor's (9%) degree. The findings reported in this study have been reviewed by the National Science Foundation to ensure that no confidential information is being disclosed.

Brief overview of the immigration process

Foreign nationals can obtain permanent residency in the United States through one of several channels, including family sponsorship, employer sponsorship, asylum, diversity visa lottery or

³ The reason for these particular cutoffs is explained below when discussing the immigration process. The results are robust to different cutoffs.

through an investment (www.uscis.gov). Permanent residency is a requirement for a long-term stay in the U.S. and employment in the country combined with five years of permanent residence is a pre-requirement for a citizenship application. Family sponsorship typically requires an immediate family member such as a spouse, sibling or a parent with U.S. citizenship or a green card. A general rule applied to the family-based application process is that the more distant the family relationship of the sponsoring party the longer the wait time as determined by the backlog of applications. The backlog is driven by the annual quota associated with each sponsorship category. For instance, the backlog time can range from zero in the case of the spouse of a U.S. citizen to 15 years or more for a sibling of an adult U.S. citizen.⁴ An average processing time of a family-based green card with a zero backlog is about one year (www.uscis.org).

Immigrants can alternatively obtain permanent residency through employer sponsorship. However, students who graduate from U.S. universities can first request a one-year practical training work permit (OPT) that does not require an employer sponsorship. The OPT permit allows foreign graduates to search for a job and provides the employer with time to obtain a temporary visa (typically H1B) for the foreign employee. Consequently, students will search for an employer that is willing to sponsor them for the temporary visa. The temporary visas (such as H1B's) require employer sponsorship and are issued for a limited amount of time.⁵ While the immigrant is on the temporary visa, the employer can sponsor the immigrant for permanent residency. The application for an employer-based permanent residency usually takes several

⁴ The backlogs vary greatly by the country of origin. I exploit this variation when constructing the instruments.

⁵ H1B visa is issued initially for three years. Employers can petition for an additional three years. The application process for the H1B visa typically takes between six months and one year.

years as well. It further includes a process called the labor certification, in which the employer must show that there are no available U.S. candidates for the position.⁶

Both the temporary visa and the permanent residency applications are tied to a specific employer. When an immigrant changes employment, both the existing temporary visa issued and the green card application are invalid and the process has to be initiated from the beginning. Consequently, mobility is associated with significant costs for the immigrant in terms of time and effort and possibly in terms of financial resources (in many cases, employers do not fully cover the legal and administrative costs of the immigration process, which totals at least \$10,000).

An additional pathway to obtain permanent residency that is relevant for the individuals in my sample is the diversity visa lottery.⁷ Foreign nationals of most countries (countries exceeding a certain quota of green cards issued each year are excluded – e.g., China, India and Mexico) can submit an entry to the lottery. The likelihood of winning a green card through the diversity visa lottery varies by country and depends on the number of applications submitted by the individuals in the country and in the region. This is because the objective of the program is to increase the national diversity of the U.S. immigrant population. Between 2007 and 2012, the years for which the data is available, the country-level average likelihood weighted by the

⁶ In case of individuals with exceptional ability (EB-1 category) such as prominent scholars, the labor certification process is not required. However, recent graduates, including PhDs, are unlikely to fall under this category since a track record of distinction is required. Zhang and Associates (2013) compiled a sample of approved petitions under the EB-1 category and found that the median number of publications was 14 and citations 159.

⁷ A green card can also be obtained through asylum or an investment. However, asylum is granted to individuals who are persecuted in their home country and is thus unlikely to apply to foreigners who entered on a student visa. Similarly, an investment-based green card requires an investment exceeding \$1 million (\$0.5 million in a rural area) and the creation of 10 full-time jobs. It is unlikely that such individuals would enter on a student visa (and only about 1,000 of such green cards are issued each year in the U.S.).

number of applications was 0.7% but with a significant country-level heterogeneity (5th percentile is 0 and 95th percentile is 10%).⁸

Dependent Variable

Entrepreneurship, self-employment, growth-oriented entrepreneurship. The dependent variable *Entrepreneurship* captures sample individuals' responses to the question of "Which of the following best describes your principal employer?" as of the 2003 survey. The dependent variable *Entrepreneurship-self* is coded as 1 if the respondent selected "self-employed or a business owner in a non-incorporated business" and zero otherwise. Non-incorporated businesses are sole proprietors or simple partnerships. The dependent variable *Entrepreneurship-incorporated* is coded as 1 if the respondent selected "self-employed or a business owner in an incorporated business" and zero otherwise. Incorporated businesses are those that represent an independent legal entity such as LLC, C, S-corporations or limited partnerships. Individuals typically incorporate if they anticipate hiring employees or obtaining outside funding. Consistent with prior work (Tag et al., 2013; Levine and Rubinstein, 2013), I assume that the incorporation of a start-up is a strong proxy for its orientation toward growth as opposed to the lifestyle nature of non-incorporated businesses.

Explanatory variable

Green card received while being a student. The main explanatory variable of the study is an indicator variable coded as 1 if the focal individual received permanent residency while on a student visa. The window is constrained to at most six years to accommodate for the length of a doctoral program as 68% of the sample are PhD recipients. The variable is coded as 0 for foreign graduates who received the green card two, three or six years post-graduation (various cutoffs are used as robustness tests). The key logic underlying the construction of this variable is that a

⁸ See the diversity visa section of the www.uscis.gov for more details.

green card received while on a student visa or during the first several years post-graduation was not granted through an employment sponsorship. Consequently, the timing of the pre- versus shortly post-graduation is likely to be exogenous from the perspective of individual characteristics that may affect self-selection into employment and entrepreneurship, such as individual ability. I further address potential residual endogeneity issues with a set of instrumental variables, which also allows me to test for the exogeneity of the main explanatory variable.

Control Variables

Steps were taken to control for factors that may correlate with both the likelihood of transitioning to entrepreneurship and the likelihood of obtaining a green card early versus late. I include a control for the number of *Years since graduation at the time of survey* (as well as this variable squared) to control for the vintage differences among individuals in the cross-section. Indicator variables *PhD degree* and *Master's degree* (Bachelor's degree is omitted) control for the educational level differences. *Male* and *Married* are demographic indicators. To control for the research quality of the program attended by the immigrant, I include the *School rank in S&E*, which is based on the National Research Council's ranking (Golderberger et al., 1995). To control for the effects related to immigrant networks in a focal area that may help the foreign national in the labor market search, I include the variable "*Density of immigrants of the same country in the region.*" This control is calculated as the number of immigrants of the same nationality as the focal individual in the region of the university. I further include the field of degree dummies (Computer, Mathematical, Biological, Engineering, etc.) and the school region dummies (nine regions of the U.S.).

Instrumental variables

Due to the estimation design, it is reasonable to expect that the exogeneity of the main explanatory variable, *Green card received while being a student*, is not violated. In theory, however, it is possible that immigrants with low expectations of labor market success may seek permanent residency through, for instance, marriage and spousal sponsorship. Similarly, it may be theoretically possible for some students with extremely high ability to obtain employer sponsored green cards in the first few years post-graduation. Even though it is unlikely that such instances are frequent and drive the results, I construct a set of instrumental variables to further strengthen the confidence in my findings. The instruments also allow testing for the exogeneity of the explanatory variable. To construct the instruments, I rely on the country-level heterogeneity in the likelihood of winning the green card through lottery, country-specific size of the waiting list and average length of the wait time. Utilizing the data provided by the U.S. Citizenship and Immigration Services (USCIS) for the 2007-2012 period, I construct three variables: a) *Probability of a lottery win for a focal country* is calculated as the average number of winning applications divided by all applications for the focal country over the 2007-2012 period. I use a time-invariant measure as an instrument since year-by-year variations tend to be small and the individuals in my sample received their green cards before or in 2003. b) Similarly, I calculate the time invariant variable *Waitlist size for a given country in a family based category* as the number of individuals being waitlisted for permanent residency through family sponsorship from a given country. c) *Backlog (time) for a given country in a family based category* is calculated as the average length of the wait time in years for a given country.⁹ I utilize both the backlog size and the time length because the variables may contain slightly different information (the correlation is still high at 0.85). Since all family members are

⁹ The wait list size and length are based on the “Annual Report of Immigrant Visa Applicants in the Family-sponsored and Employment-based preferences Registered at the National Visa Center” published by the USCIS over 2009-2012. Year-by-year changes in the backlog measures are <1%.

processed at the same time, it is possible that countries with a larger average family size on the waiting list have a similar waiting time as a country with a smaller family size. Consequently, the size of the backlog conditional on the wait time is an (imperfect) proxy for the distance to the sponsoring family member. For instance, average waiting times for the Philippines and Mexico are similar (15 and 16 years) while there are about 0.5 million immigrants on the waiting list from the Philippines and over 1.1 million from Mexico.

The logic behind the instruments is that the backlog characteristics and the likelihood of winning in a diversity visa lottery will predict the likelihood of obtaining the green card earlier. The exclusion restriction will be satisfied if the only effect on entrepreneurship of these variables is through the green card timing. This is likely the case if the country-level backlog characteristics and the lottery likelihoods are uncorrelated with unobserved individual characteristics that may predict entrepreneurship. Even though such an assumption is strong in the general population, it is reasonable to assume that it holds in the sample of foreign nationals with a student visa. In other words, the assumption of instruments being uncorrelated with the error term in the main regression implies that, conditional on the observables (i.e., being a student, degree level, field, demographics and school rank), the differences in the individual level characteristics that may predict entrepreneurship are uncorrelated with the country-level instruments.

Estimation methods

I employ a set of standard methods when estimating the relationship between the green card timing and the transition to entrepreneurship, including its types. I report the results from the linear probability models, Probit, 2SLS, and Instrumental Variables Probit (IV Probit). Further, I conduct Sargan-Hansen over-identification tests, Stock-Yogo instrument strength tests, and Wald

(Probit) and Hausman (2SLS) instrument exogeneity tests. The summary statistics and pair-wise correlations are reported in Table 1.

Results

The results of the main estimation are reported in Table 2. I estimate all specifications for both three- and six-year windows post-graduation. The longer window provides more observations but at the risk of including some individuals who managed to obtain green cards through employer sponsorship. Given the length of the temporary visa and green card applications processes, the likelihood of including immigrants who obtained green cards through employer sponsorship is very low in the three-year time window post-graduation.¹⁰ In Table 2, the effect of the control variables on the long-term entrepreneurship rate tends to be weak. This is not surprising given that the sample represents a homogenous population of highly skilled immigrants who entered the United States on a student visa (68 percent are doctoral degree recipients, 72 percent are male and 81 percent are married). Regarding the significant coefficients on the controls, in model 1, the time since graduation tends to have a convex relationship with the overall rate of entrepreneurship and PhDs have a lower likelihood of transitioning to entrepreneurship (this effect is not significant for the different forms of entrepreneurship). In models 1 and 4 (6- and 3-year windows), the green card timing does not have a statistically significant relationship with the overall rate of entrepreneurship. Consequently, *hypothesis 1* is not supported as stated in the theoretical section. However, the green card timing has a statistically significant impact on entrepreneurship when I separate the dependent variable into non-incorporated and incorporated entrepreneurship. In Table 2, I report the results of Probit and linear probability models for both six- and three-year time windows

¹⁰ I also estimated the models with a two-year post-graduation window. The findings are robust and the results are currently undergoing a disclosure review process.

post-graduation. I find that a green card received while being on a student visa is associated with a higher long-term likelihood of transitioning to self-employment (models 2, 5, 7, and 9). This relationship is statistically significant at the five percent level in Probit and the ten percent level in OLS. Receiving a green card while being a student increases the likelihood of self-employment by 73 percent relative to the baseline self-employment likelihood of 2 percent. The magnitude of the effect is very stable regardless of the estimation window or the estimation method. Consequently, *hypothesis 1* is supported if I estimate the relationship between the green card timing and self-employment only. In models 3, 6, 8 and 10, I report the relationship between the green card timing and growth-oriented entrepreneurship (using different time windows for both Probit and OLS). I find that a green card received while being on a student visa is associated with a *lower* long-term likelihood of transitioning to growth-oriented entrepreneurship. The relationship is statistically significant at the five percent level in Probit with three-year window and both linear probability models and at the ten percent level in Probit with a six-year window. Receiving a green card while being a student decreases the likelihood of growth-oriented entrepreneurship by about 42 percent relative to the baseline likelihood of starting a growth-oriented business of 5.7 percent. The magnitude of the effect is again stable regardless of the estimation window or the method. The estimated relationship between the green card timing and growth-oriented entrepreneurship is *contrary to hypothesis 1*. Even though the effect of the early green card on growth-oriented entrepreneurship is negative, the findings are fully consistent with *hypothesis 2*. Due to the difference in the coefficient signs of green card timing for self-employment versus growth-oriented entrepreneurship (which is statistically significant at five percent or less), the results imply that receiving a green card post-graduation is

less detrimental to the likelihood of long-term transitioning to growth-oriented entrepreneurship (this likelihood is in fact positive) relative to the likelihood of transitioning to self-employment.

Robustness tests and additional analysis

It is reasonable to expect that the main explanatory variable of the study is uncorrelated with the unobserved individual characteristics that may predict entrepreneurship in the focal estimation sample. As discussed above, I implement a set of instrumental variables to further analyze the results. The findings are reported in Table 3. Overall, the findings are robust and are consistent with the conclusions based on the analysis in Table 2, albeit some of the estimated relationships are statistically weaker. This is not surprising as the post-estimation tests imply that a weak instrument problem is present.¹¹ The weakness of the instruments also explains the differences in the magnitude of the coefficient estimates on the main explanatory variable in Table 3 relative to Table 2. The 2SLS with weak instruments in finite samples is consistent but inefficient and biased (Stock and Yogo, 2002). The instruments strongly pass the over-identification restriction tests (models 3, 4, 7 and 8). At the same time, the exogeneity of the main explanatory variable of green card timing is not rejected in all models ($p > 0.1$) in Table 3, except model 1 ($p = 0.03$) and model 3 where it is not rejected at 5 percent ($p = 0.054$). This evidence suggests that the assumption of exogeneity of the main explanatory variable in the focal sample is reasonable.

In conjunction with the instrumental variables estimation, I performed a series of robustness tests reported in Table 4. Table 4 model 1 shows the estimation of the likelihood of transitioning to growth-oriented entrepreneurship relative to self-employment and shows results consistent with *hypothesis 2*. In models 2 and 3, I examine whether the results are driven by the countries that represent the highest number of immigrants in the US. The results remain robust to

¹¹ Based on the Stock-Yogo critical values, the relative bias is about 25% with six-year windows and about 30% with three-year windows.

the exclusion of immigrants from India, China, Mexico and the Phillipines. In models 4 and 5, I show that the results remain robust (albeit the relationship is weaker for growth-oriented entrepreneurship) after the exclusion of bio-medical fields. As I discuss below, some bio-medical doctorate recipients may have a professional degree (such as an MD) from a foreign country and they may have an option to open an independent health practice if they have a green card. In models 6 and 7, I rerun the instrumental variables estimation by excluding all high-immigrant countries. I define high-immigrant countries as those that are above the threshold determined by the USCIS of 7 percent of immigrant visas issued. Immigrants from these countries cannot participate in the green card lottery (probability of winning is zero) and face green card processing backlogs.¹² The results strengthen substantially in this sample.

In models 8-9, I examine whether there are observable quality differences in terms of salary (as of the time of the survey) and the school rank among the individuals in the sample (including non-entrepreneurs) as a function of the green card timing. Models 8-9 show that there are no significant differences in salary or school rank as a function of green card timing among the individuals in the sample.

Supplemental analysis

In light of the findings above and the fact that the consistency of the results with *hypothesis 1* depends on the form of entrepreneurship, I conducted additional analysis. My primary objective was to understand how the startups founded by immigrants differ as a function of the green card timing, potentially leading to insights on why the results on growth-oriented entrepreneurship are not consistent with *hypothesis 1*. From the SESTAT survey, one can obtain some details about the current businesses owned by immigrants including the industry and the year when the current company was founded. Table 5 provides descriptive information on the

¹² Due to the sample size loss, I utilize a ten-year post-graduation window in this regression.

industry of the startup as a function of the green card timing. The table reveals several patterns. A green card received early is associated with a much higher proportion of start-ups founded in non-science and engineering sales and services such as in financial consulting (26 versus 16 percent), health services (32 versus 11 percent). Further, early green cards are associated with a zero likelihood of starting a company in the pharmaceutical and chemical industries (while this likelihood is 8 percent in the post-graduation green card category) and a lower likelihood of starting a company in traditional science and engineering industries such as computer, electronics, mechanical components and equipment (13 versus 25 percent). Information provided in a separate survey question reinforces these findings. In the early green card category, 24 percent of individuals responded that they work in a field unrelated to their highest degree, while this proportion was only 15 percent in the post-graduation green card category (for both three- and six- year post-graduation windows). The results also indicate that individuals who are observed to be self-employed tend to transition to entrepreneurship earlier post-graduation than the individuals starting growth-oriented businesses.¹³ While 61 percent of self-employed entrepreneurs transitioned within the first two years post-degree, this proportion was only 37 percent in the incorporated category (median is five years). This is consistent with the pattern in Table 5 that self-employment may not require extensive work experience in an industry related to their field of degree. For these individuals, a short experience such as in sales and services prior to becoming self-employed may be sufficient. A similar mechanism may operate for biomedical professionals. An early green card is associated with a higher likelihood of starting an independent health services practice. Through an early green card, individuals may quickly acquire a skill set that enables them to open an independent practice. Nevertheless, due to the

¹³ I compare self-employment with growth-oriented entrepreneurship as opposed to early with later green cards when examining timing. Timing of the entrepreneurial transition and green card timing may be trivially positively related.

initial lock-in and constraints associated with a post-graduation green card (and perhaps subsequent path-dependencies), bio-medical professionals receiving a permanent residency post-graduation are significantly less likely to start their own independent practice. These arguments are consistent with *hypothesis 1*. Table 5 also highlights a downside of removing the mobility constraints, which is contrary to *hypothesis 1*. By entering a different field or industry or transitioning to entrepreneurship too soon, individuals may forgo the necessary depth of knowledge needed to start a growth-oriented business. Mobility constraints may facilitate the process of such knowledge acquisition.

In further analysis, I also examined the salary differences while in entrepreneurship. Findings in my sample are consistent with prior work (e.g., Levine and Rubinstein, 2013). I found that self-employment is associated with a lower salary compared to growth-oriented entrepreneurship (I observe a difference of about \$3,000 relative to the mean salary of about \$50,000). The difference was observed even with the caveat that I only measure salaries and not profit distributions from incorporated businesses. The returns from growth-oriented start-ups are likely to be underestimated relative to the observed returns from self-employment. The salary comparison, in conjunction with prior results, implies that entry into self-employment (that may be enabled by an early green card) may be associated with lower financial returns relative to an alternative career path leading to growth-oriented entrepreneurship.

Discussion and Conclusion

The objective of my study is to examine how mobility constraints affect transitions to entrepreneurship. I develop a set of predictions by extending existing theoretical perspectives that focus on the constraints *within* organizations. I propose that mobility constraints (i.e., constraints *across* organizations) will lower the likelihood of transitioning to entrepreneurship

and that the detrimental effect will be more pronounced for self-employment than for growth-oriented entrepreneurship. The mobility constraints may interfere with the acquisition of relevant general knowledge and, while constrained, individuals may prioritize other factors than the acquisition of knowledge relevant for entrepreneurship. I test these predictions in the context of foreign graduates of U.S. universities in science and engineering. I focus on the timing of permanent residency of these individuals and use the variation of whether the immigrants receive a green card while being on a student visa or shortly post-graduation. This design provides a quasi-experimental setting in which the timing of the permanent residency is not related to employer sponsorship and is less likely to be driven by unobserved quality characteristics of the focal individual. Consequently, the empirical design allows the isolation of the effect of mobility constraints from self-selection effects. Separation of the contextual from the self-selection effects when studying transitions to entrepreneurship has been identified as one of the key challenges in the literature (Sørensen, 2007; Elfenbein et al., 2009; Chen, 2013a; Tag et al., 2013). Prior studies frequently employ indirect approaches when estimating the separate effects of the context versus the self-selection. Focusing on high-skilled immigrants in technical fields further yields relevant policy implications and contributes to the current debate on immigration reform.

Performing the empirical analysis, I find only a partial support for the theorized predictions. This partial consistency provides an opportunity to refine the existing theoretical views on how context and knowledge acquisition shapes entrepreneurial propensities. In addition to hypotheses testing, I perform an additional analysis that generates insights on why the observed relationships differ from the hypothesized predictions. I find that mobility constraints (as measured by receiving a green card shortly post-graduation relative to while being on a student visa) are associated with a lower likelihood of transitioning to self-employment

(consistent with *hypothesis 1*) but with a higher likelihood of founding a growth-oriented business (contrary to *hypothesis 1*). I find that the effect of green card timing on the overall rate of entrepreneurship (aggregated self-employment and growth-oriented entrepreneurship) is not significant. The results are fully consistent with *hypothesis 2*, predicting that the mobility constraints will be more detrimental for the likelihood of transitioning to self-employment than for growth-oriented entrepreneurship. In a supplemental analysis, I find that a green card received while being on a student visa (relative to receiving it shortly post-graduation) is associated with a higher likelihood of starting a business in a field unrelated to the educational degree. Self-employment relative to growth-oriented entrepreneurship is further associated with a faster transition to entrepreneurship and a lower salary.

These findings refine our understanding of how context shapes entrepreneurship in several ways. Prior literature emphasized the role of the acquisition of general and diverse knowledge in a flexible setting when explaining entrepreneurship (Lazear, 2004, 2005; Sørensen, 2007; Elfenbein et al., 2009). While my results partially reinforce this view, I also show that, in a flexible setting without facing mobility constraints, individuals may have a tendency to either enter self-employment early or enter completely new domains and industries in which they may not fully capitalize on their acquired education. However, starting a growth-oriented business may necessitate developing a certain depth of acquired knowledge. When individuals start a business in an area related to their education they may acquire depth in the knowledge creation process by exploiting the complementarities between their education and the focal industry. These notions are consistent with several prior studies. Jones (2009a) argues that modern technological innovations extend rather than replace existing knowledge. The growing body of relevant knowledge then requires depth and specialization by individuals during the knowledge

creation process. Lack of diversity of individual-level knowledge may be mitigated by creating founding teams consisting of founders with complementary human capital (e.g., Campbell et al., 2013). Similarly, Schilling and Green (2011) argue that depth and breadth of knowledge and novel connections are all equally important aspects underlying breakthrough innovations. Specifically focusing on the application of education to entrepreneurship, Braguinsky, Klepper and Ohyama (2013) build and test a model around the notion that successful entrepreneurship in high-tech industries is a function of the complementarity between education and the relevant work experience. The findings of my study are also consistent with Andersson and Klepper (2012), who report that experience in less flexible larger organizations is associated with benefits for growth-oriented businesses while experience in small organizations appears still useful for self-employment. Further, Hellman (2007) builds a model in the context of an employment relationship around the notion that individuals have a tendency to over-explore. Employers may find it optimal to curb some of that over-exploration by rejecting ideas that fall outside of the scope of the assigned tasks.

My study highlights the potential benefits associated with constraints leading to the accumulation of deeper knowledge in a particular area. As Schilling and Green (2011) propose, a balance between breadth and depth in the knowledge acquisition process is needed. The exact proportion between the depth and breadth may depend on the industry and the type of entrepreneurship. It appears that growth-oriented entrepreneurship in a high-tech setting requires relatively more depth and, thus, accumulating work experience in the field of educational degree is important. Our theorizing in the entrepreneurship literature should thus acknowledge these tradeoffs associated with the acquisition of knowledge.

Given the study is implemented in the context of highly skilled immigrants, several policy implications emerge. High-skilled immigration can be regulated by the government either through employer sponsorship (i.e., the status quo in the U.S.) or through a system in which points are awarded for educational and work experience achievements by potential immigrants. Under the latter system, permanent residency would be granted above a certain threshold and the employer sponsorship is not required (e.g., as in the Canadian immigration system). Reflecting an ongoing debate on immigration reform in the United States, there are active calls to abandon the employer sponsorship requirement for high-skilled immigration, including the introduction of such legislation in the Senate (Couronne, 2013). My study highlights perhaps unanticipated benefits of the use of employer sponsorship for immigrant visas. The employer sponsorship increases the likelihood that foreign graduates apply their education in a way which leads to the creation of high-growth businesses. This is presumably because immigrants not facing such employment constraints may decide to transition to entrepreneurship (self-employment) too soon or enter domains in which they do not fully utilize their degrees. These benefits of the employer sponsorship immigration system for highly skilled immigrants complement arguments made by Kerr et al. (2013), who suggest that the employer sponsorship system is useful because the immigration is driven by the market demand of the domestic firms as opposed to a government policy awarding points. High-growth entrepreneurship by immigrants plays an important role in the U.S. economy (Hunt, 2009, 2013) so more research is needed to evaluate the overall effect of the employer sponsorship system relative to other forms of awarding permanent residency to highly skilled immigrants.

Further, it is important to note that even though I focus on the labor market mobility constraints associated with the immigration process, similar mechanisms may apply to other

types of labor markets and mobility constraints. For instance, extensive prior work has focused on the non-compete laws (Saxenian, 1994; Marx et al., 2010), trade secret laws (Png and Samila, 2013) and other legal levers such as patent enforcement (Agarwal, Ganco, Ziedonis, 2009; Ganco, Ziedonis, Agarwal, 2013) that operate as constraints reducing mobility and associated knowledge spillovers. If we speculatively extend findings of this study, the results may imply that retaining employees by using these legal levers reduces employee entrepreneurship only temporarily and does not fundamentally affect the long-term propensity. However, by keeping employees captive, the chance that they will utilize more knowledge from the prior firm with a negative competitive impact increases. Mobility constraints can take many forms and clearly more research is needed to study these important questions.

Conclusion

The study examines the effect of mobility constraints on the propensity to engage in entrepreneurship. I proxy the mobility constraints with the timing of a green card - i.e., whether foreign graduates of U.S. universities in science and engineering receive their permanent residency while on a student visa or shortly post-graduation. This empirical design allows me to isolate the self-selection effects from the contextual effect associated with the mobility constraints. As an outcome variable, I examine the long-term rate of entrepreneurship and its form – i.e., self-employment versus growth-oriented entrepreneurship. I find that a green card received while the immigrant is still a student is associated with a higher rate of self-employment, while a green card received shortly post-graduation is beneficial for growth-oriented entrepreneurship. Supplementary analysis shows that this is likely because early green cards are associated with transitioning to self-employment early and entering a field not related to the degree. Modern high-tech entrepreneurship requires a depth of knowledge in conjunction

with generality. Knowledge depth and generality are associated with tradeoffs in the knowledge acquisition process. If individuals have a natural tendency to exploit, some of this exploitation may not be fruitful. Providing limited constraints such as in the form of mobility constraints imposed by the employer sponsorship of permanent residency of highly skilled immigrants may provide an environment in which the immigrants may acquire the necessary depth of relevant knowledge while enabling future growth-oriented entrepreneurship. I hope my study not only refines the existing views on knowledge acquisition and entrepreneurship but also stimulates future work in this area.

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Table 1. Summary statistics and pair-wise correlations (N=1,999; 6-year window)

Variable	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1 Entrepreneurship	0.076	0.264	1.000													
2 Entrepreneurship (self-employment)	0.019	0.136	0.485	1.000												
3 Entrepreneurship (incorporated)	0.057	0.231	0.857	-0.034	1.000											
4 Green card received while being a student	0.240	0.427	-0.007	0.059	-0.042	1.000										
5 Years since graduation at the time of survey	11.55	7.08	0.097	0.051	0.081	0.061	1.000									
6 Years since graduation at the time of survey (squared)	183.7	239.1	0.116	0.072	0.090	0.079	0.943	1.000								
7 PhD degree	0.688	0.464	-0.136	-0.064	-0.118	-0.015	-0.079	-0.058	1.000							
8 Master's degree	0.233	0.423	0.118	0.027	0.119	-0.005	0.042	0.021	-0.818	1.000						
9 Male	0.716	0.451	0.021	-0.002	0.025	-0.091	0.092	0.070	0.009	0.005	1.000					
10 Married	0.812	0.390	0.007	-0.046	0.035	-0.037	-0.057	-0.063	-0.046	0.078	0.071	1.000				
11 School rank in science and engineering	45.9	26.7	0.003	0.001	0.003	-0.027	0.009	-0.016	-0.038	0.033	0.012	0.035	1.000			
12 Density of immigrants of the same country in the region	0.024	0.056	-0.010	-0.037	0.010	-0.070	0.024	0.034	0.064	-0.097	0.033	-0.010	0.018	1.000		
13 Probability of lottery win for a focal country	0.008	0.015	-0.009	0.051	-0.039	0.102	0.097	0.092	0.021	-0.089	-0.060	-0.066	-0.068	-0.151	1.000	
14 Waitlist size for a given country in a family based category	99196	145529	0.005	-0.033	0.025	-0.095	-0.098	-0.082	-0.028	0.098	0.006	0.056	0.039	0.202	-0.391	1.000
15 Backlog (time) for a given country in a family based category	3.855	4.438	-0.001	-0.065	0.037	-0.135	-0.169	-0.160	-0.014	0.131	0.025	0.095	0.053	0.235	-0.512	0.854

Table 2. Main results

Model	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
Dep. Var. (Entrepreneurship, Self-employment, Incorporated Entrepreneurship)	Entrep.	Self.	Inc.	Entrep.	Self.	Inc.	Self.	Inc.	Self.	Inc.
Method	Probit	Probit	Probit	Probit	Probit	Probit	OLS	OLS	OLS	OLS
Post-graduation window (years)	6	6	6	3	3	3	6	6	3	3
Green card received while being a student	-0.047 (0.10)	0.278** (0.14)	-0.203* (0.12)	-0.09 (0.11)	0.307** (0.15)	-0.255** (0.13)	0.014* (0.01)	-0.024** (0.01)	0.014* (0.01)	-0.029** (0.01)
Years since grad. at the time of survey	-0.018 (0.02)	-0.043* (0.03)	-0.003 (0.02)	-0.014 (0.02)	-0.047* (0.03)	0.001 (0.02)	-0.003 (0.00)	-0.002 (0.00)	-0.003 (0.00)	-0.001 (0.00)
Years since grad. (squared)	0.001** (0.00)	0.001** (0.00)	0.001 (0.00)	0.001* (0.00)	0.001* (0.00)	0.001 (0.00)	0.000 (0.00)	0.000 (0.00)	0.000 (0.00)	0.000 (0.00)
PhD degree	-0.302* (0.16)	-0.312 (0.23)	-0.22 (0.17)	-0.273 (0.18)	-0.283 (0.26)	-0.148 (0.21)	-0.022 (0.02)	-0.026 (0.02)	-0.027 (0.02)	-0.023 (0.02)
Master's degree	0.089 (0.15)	-0.213 (0.22)	0.25 (0.16)	0.028 (0.18)	-0.162 (0.26)	0.204 (0.20)	-0.018 (0.02)	0.036 (0.02)	-0.021 (0.02)	0.024 (0.03)
Male	0.061 (0.10)	0.125 (0.15)	0.036 (0.11)	0.07 (0.12)	0.087 (0.17)	0.076 (0.13)	0.004 (0.01)	0.003 (0.01)	0.002 (0.01)	0.008 (0.01)
Married	0.025 (0.11)	-0.292* (0.16)	0.187 (0.13)	0.041 (0.13)	-0.247 (0.19)	0.181 (0.16)	-0.014 (0.01)	0.018 (0.01)	-0.01 (0.01)	0.017 (0.02)
School rank in science and engineering	0.001 (0.00)	0.003 (0.00)	0.000 (0.00)	0.001 (0.00)	0.003 (0.00)	-0.001 (0.00)	0.000 (0.00)	0.000 (0.00)	0.000 (0.00)	0.000 (0.00)
Density of immigrants of the same country in the region	0.31 (1.03)	-7.143 (5.72)	1.507 (1.29)	0.083 (1.28)	-10.793 (9.09)	1.162 (1.41)	-0.124* (0.07)	0.183 (0.14)	-0.156 (0.11)	0.161 (0.21)
Filed of degree dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
School region dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Constant	-1.42*** (0.31)	-1.72*** (0.50)	-1.80*** (0.34)	-1.24*** (0.34)	-1.45*** (0.54)	-1.68*** (0.38)	0.050* (0.03)	0.043 (0.04)	0.063* (0.04)	0.059 (0.04)
Pseudo-R2	0.057	0.109	0.058	0.048	0.12	0.055	0.03	0.03	0.03	0.028
Log likelihood	-507	-164	-412	-352	-116	-279	1183	121	745	80
Observation (N)	1,999	1,787	1,999	1,355	1,171	1,355	1,999	1,999	1,171	1,355

* p<.1, ** p<.05, *** p<.01, double-sided tests.

Table 3. Instrumental variables estimation

Model	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
Dep. Var. (Entrep., Self-employment, Incorporated Entrep.)	Self.	Inc.	Self.	Inc.	Self.	Inc.	Self.	Inc.	GC while student
Method	IVProbit	IVProbit	2SLS	2SLS	IVProbit	IVProbit	2SLS	2SLS	OLS (IV 1 st . stage)
Post-graduation window (years)	6	6	6	6	3	3	3	3	6
Green card received while being a student	1.972***	-1.308*	0.133**	-0.158†	1.678	-1.317**	0.127*	-0.159†	
	(0.40)	(0.67)	(0.06)	(0.10)	(2.13)	(0.66)	(0.07)	(0.11)	
Years since graduation at the time of survey	-0.023	-0.005	-0.003	-0.002	-0.042	0.008	-0.003	0.00	-0.007
	(0.03)	(0.02)	(0.00)	(0.00)	(0.05)	(0.02)	(0.00)	(0.00)	(0.00)
Years since graduation at the time of survey (squared)	0.001	0.001*	0.00	0.000*	0.001	0.00	0.00	0.00	0.000**
	(0.00)	0.00	0.00	0.00	(0.00)	(0.00)	0.00	0.00	0.00
PhD degree	-0.034	-0.272	-0.003	-0.037	-0.09	-0.245	-0.012	-0.038	-0.053
	(0.20)	(0.17)	(0.02)	(0.03)	(0.46)	(0.21)	(0.03)	(0.03)	(0.05)
Master's degree	0.036	0.118	0.001	0.023	-0.003	0.069	-0.008	0.011	-0.001
	(0.17)	(0.18)	(0.02)	(0.03)	(0.22)	(0.20)	(0.02)	(0.03)	(0.05)
Male	0.174	-0.011	0.01	-0.003	0.134	0.031	0.007	0.003	-0.051**
	(0.12)	(0.12)	(0.01)	(0.01)	(0.16)	(0.14)	(0.01)	(0.02)	(0.02)
Married	-0.105	0.161	-0.01	0.018	-0.021	0.147	-0.001	0.014	-0.001
	(0.14)	(0.13)	(0.01)	(0.01)	(0.38)	(0.17)	(0.01)	(0.02)	(0.03)
School rank in science and engineering	0.003	-0.001	0.00	0.00	0.004	-0.001	0.00	0.00	0.00
	(0.00)	(0.00)	0.00	0.00	(0.00)	(0.00)	0.00	0.00	0.00
Density of immigrants of the same country in the region	-2.38	0.568	-0.038	0.11	-11.305	-0.119	-0.053	-0.004	-0.114
	(2.48)	(1.42)	(0.09)	(0.18)	(33.21)	(1.47)	(0.16)	(0.29)	(0.28)
Instruments:									
Probability of lottery win for a focal country									1.252+
									(0.86)
Waitlist size for a given country in a family based category									0.00+
									(0.00)
Backlog (time) for a given country in a family based category									-0.015***
									(0.01)
Constant	-1.909***	-1.316**	-0.001	0.083	-1.746**	-1.099	0.009	0.108*	0.339***
	(0.51)	(0.63)	(0.03)	(0.05)	(0.73)	(0.73)	(0.04)	(0.07)	(0.08)
Over-identification test (Sargan-Hansen, p)			0.88	0.94			0.90	0.83	
Exogeneity test (Wald, Wu-Hausman, p)	0.03	0.17	0.054	0.22	0.14	0.19	0.12	0.28	
Weakness test (Cragg-Donald Wald F)			7.69	7.7			4.59	4.59	
Log likelihood	-1030	-1360	1048	39	-791	-1051	641	31	-979
Observations (N)	1,643	1,844	1,851	1,851	1,072	1,243	1,246	1,246	1,851

Note: all regressions include field of degree and school region dummies.

* p<.1, ** p<.05, *** p<.01 double-sided tests, † p<0.1 single-sided test. Instruments are jointly significant in Model 9 at 0.001% level (F=8.92).

Table 4. Robustness tests

Model	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
Dependent variable	Inc.	Self	Inc.	Self.	Inc.	Self.	Inc.	Log Salary	Log Salary	School Rank
Method	Probit	IVProbit	IVProbit	Probit	Probit	IVProbit	IVProbit	OLS	OLS	OLS
Post-graduation window (years)	6	6	6	6	6	10	10	6	6	6
Sub-sample	versus Self. (cond. on ent.)	Excluding India, China, Mexico, Phillipines	Excluding India, China, Mexico, Phillipines	Excl. bio- medical	Excl. bio- medical	Low immig. count. only	Low immig. count. only	Ent.=1 (cond.)		
Green card received while being a student	-0.726**	2.055*	-2.195**	0.297*	-0.208†	2.366***	-2.248***	-0.205	-0.04	-2.318
	(0.35)	(1.26)	(0.17)	(0.15)	(0.13)	(0.32)	(0.30)	(0.27)	(0.05)	(2.25)
Years since graduation at the time of survey	0.019	0.021	-0.019	-0.034	0.007	0.027	-0.027	-0.032	0.018*	1.203***
	(0.05)	(0.03)	(0.02)	(0.03)	(0.02)	(0.02)	(0.02)	(0.03)	(0.01)	(0.40)
Years since graduation at the time of survey (squared)	0.00	0.00	0.001	0.001**	0.001	-0.001	0.001	0.001	0.00	-0.036***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	0.00	(0.01)
PhD degree	0.589	-0.023	0.013	-0.01	0.145	-0.129	-0.017	0.228	0.211***	-19.734
	(0.51)	(0.34)	(0.16)	(0.26)	(0.19)	(0.24)	(0.16)	(0.36)	(0.07)	(14.39)
Master's degree	0.627	-0.157	0.239	-0.157	0.311*	-0.168	0.264	-0.444*	-0.008	-4.648
	(0.45)	(0.35)	(0.24)	(0.23)	(0.17)	(0.21)	(0.17)	(0.24)	(0.08)	(15.03)
Male	-0.063	-0.015	-0.14	0.041	-0.003	0.031	-0.151	0.331	0.245***	1.408
	(0.31)	(0.20)	(0.10)	(0.16)	(0.12)	(0.16)	(0.10)	(0.23)	(0.05)	(2.21)
Married	0.899***	-0.085	0.037	-0.317*	0.193	-0.119	0.106	-0.363*	0.073	3.181
	(0.31)	(0.32)	(0.21)	(0.17)	(0.15)	(0.19)	(0.18)	(0.18)	(0.06)	(2.37)
School rank in science and engineering	-0.010*	0.001	-0.003	0.002	-0.001	0.001	-0.003	-0.008	-0.001	
	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	
Density of immigrants of the same country in the region	12.099	17.366	-1.309	-9.636	1.359	3.112	-3.787	-2.548	-1.019	18.98
	(8.96)	(34.79)	(3.88)	(6.33)	(1.33)	(5.39)	(5.89)	(1.94)	(1.08)	(52.93)
Filed of degree dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
School region dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Constant	-0.342	-1.427	0.318	-1.691***	-1.928***	-1.08	0.202	11.374***	10.633***	43.009***
	(0.97)	(1.15)	(0.78)	(0.53)	(0.37)	(0.75)	(0.76)	(0.68)	(0.14)	(15.18)
Over-identification test (Sargan-Hansen, p)										
Exogeneity test (Wald, p)		0.63	0.29			0.36	0.20			
Pseudo-R2	0.186			0.128	0.049					
Log likelihood	-67	-368	-479	-148	-370	-449	-523	-203	-2700	-5625
Observations (N)	140	480	598	1,215	1,328	659	696	149	2,005	1,152

* p<.1, ** p<.05, *** p<.01, double-sided tests, † p<0.1 single-sided test.

Table 5. Industry of the start-up by green card timing

	Green card while student		Green card post-graduation (<6 years)	
Non- science and engineering sales and services (mostly financial)	10	26%	18	16%
Health services (mostly PhDs with foreign MD)	12	32%	12	11%
IT/engineering/R&D services/consulting	13	34%	37	32%
Pharma, chemical and related	0	0%	9	8%
Computer, electronic and mechanical equip. and components	<5	<13%	29	25%
Information missing	<5	<13%	9	8%
Total	38		114	

Notes: 61% of the non-incorporated entrepreneurs transitioned within the first two years post graduation. 37% of the incorporated entrepreneurs transitioned within the first two years post-graduation with most transitioning 4-6 years post-graduation.