U.S. Immigration Policies and the STEM Entrepreneurial Workforce

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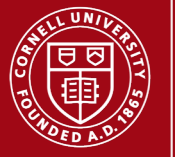
Work in Progress



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Motivation

- **STEM workforce**
  - Concerns over STEM foreign workers displacing U.S. workers, particularly with respect to H-1B and entry-level STEM jobs
  - Less is known about competition between foreign and U.S. STEM workers in first-time employment, and especially in employment between startups and established firms

- **Immigrant Entrepreneurship**
  - Public discourse on the need for immigration policies that foster entrepreneurship to stimulate innovation and economic growth, especially job creation
  - While attention has been on reducing barriers to founding companies, less attention directed toward startup hiring and competition with est. firms in recruiting talent
  - If immigration policies make it harder for startups to hire foreign workers, especially in STEM, then this may impact startups' ability to grow and succeed

What we do in this study

- **Examine supply-side of first-time employment of S&E PhDs**
  - Survey and LinkedIn data on recent S&E doctorates from U.S. universities
  - Examine whether foreign and U.S. workers differ in their likelihood of working in a startup (we find that foreign workers are 50% less likely)
  - If so, what might explain sorting patterns: demographics, ability, labor market conditions, and ex ante stated career preferences
- **Intended contribution (but not there yet)**
  - Inform policy debates on work visas for foreign graduate students with U.S. STEM degrees; STAPLE Act, OPT (rescinding 2 year extension), and H-1B
  - Currently we cannot precisely identify whether visas drive sorting, but evidence is suggestive and we are conducting follow-on survey

Are Startups at a Disadvantage?

- **Startups may be less likely to hire STEM foreign workers**
  - Compared to large firms, the financial costs and time required to sponsor foreign worker visa can be a burden on startups
    - $6-$10K for filing and attorney fees
    - Must pay prevailing wage, which is comparable to higher wages in est. firms
  - Uncertainty in H-1B lottery makes hiring STEM foreign workers riskier, especially in the short term, although OPT with STEM 24-month extension can provide leeway

- **STEM foreign workers may be less likely to take startup jobs**
  - May be reluctant to seek out or accept offers from startups given risk of failure
  - Even if they want to work in a startup – or become an entrepreneur themselves – foreign workers may take jobs in established firms that are more likely to sponsor for green card

Share of Private Sector PhD Workforce

PhD degree field	Foreign workers
Biological sciences	24%
Physical sciences	38%
Engineering	56%
Computer science	45%

Source: NSF Survey of Doctoral Recipients, graduated 2005-2011

Preview of Key Findings

- **Foreign STEM PhDs significantly less likely to work in startups**
  - Also show that foreign STEM PhDs are more interested in working in startups, but find no evidence of preference-based sorting into startups
  - However, strong evidence of preference-based sorting for U.S. workers
- **No difference in startup job applications or job offers**
  - PhDs with ex ante startup career interests are more likely to apply
- **No difference in wages between foreign and U.S. workers**
  - Foreign workers earn the same in startups and established firms
  - Startup wage gap is primarily for U.S. workers; may be taste-based compensating differential

Data

Data Sources

- **Science & Engineering PhD Panel Survey (SEPPS)**
  - Career survey of 10,781 S&E Ph.D. students and postdocs at 39 top-tier U.S. universities
  - Follow respondents in three waves over time: 2010, 2013 and 2016
  - Detailed micro data on stated preferences, individual characteristics, social context, research and commercial activities, demographics, etc. while in grad school
  - ***Foreign worker*** – temporary visa (e.g. F-1) prior to employment (33% China, 22% India)
  - ***U.S. worker*** – U.S. citizens and permanent residents (7% of non-U.S. citizens)
- **Employment outcomes**
  - Survey-reported employment status, employer size and age, and work activities
  - Matched LinkedIn data on job title and employer name, age & size
  - Employment outcomes for >90% of sample, including non-respondents to second survey

Sample

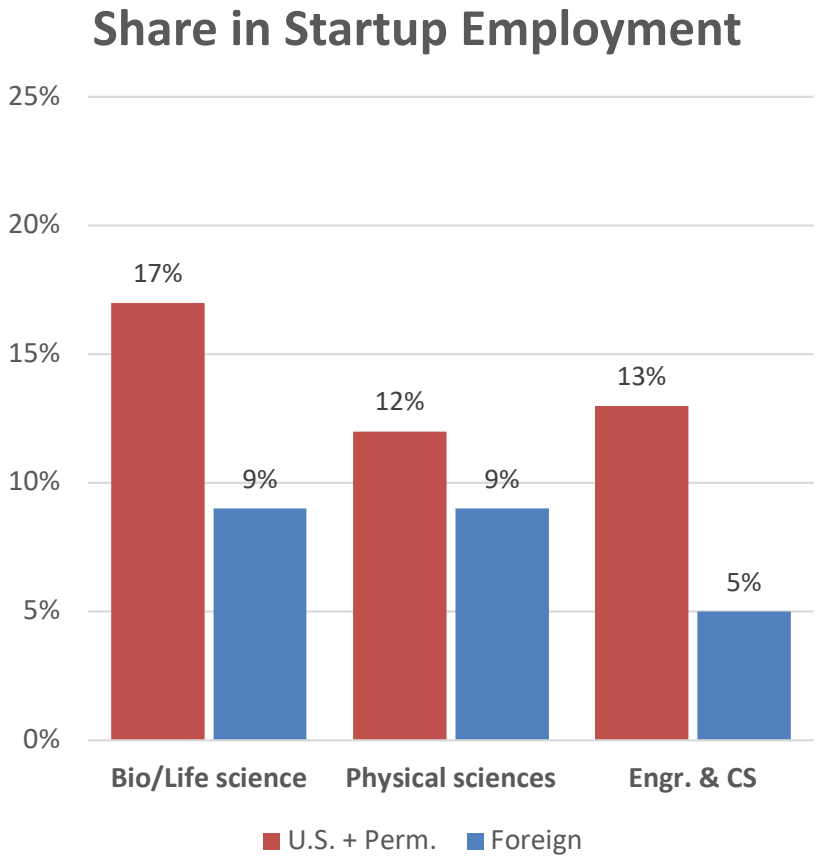
- **U.S. private sector R&D employees**
  - R&D-related jobs based on SEPPS work activities or LinkedIn job title (e.g., research scientist, research engineer, software engineer, etc.); 84% of private sector employees
  - Exclude consultants, financial analysts, non-R&D managers, etc.
  - Exclude founders; 5% of private sector employees
  - 2,203 PhDs who entered U.S. workforce between 2010-2016, primarily in technology firms
  - 23% completed a postdoc prior to industry employment; include as control
- **Advantages of cohort data**
  - Similar PhD and job search experience at roughly same point in time
  - Observe first-time employment after graduation when visa issues are most relevant
  - Relatively homogenous w.r.t. education level, work experience and possible sources of unobserved heterogeneity not captured by our detailed micro data

Benchmarking SEPPS to SESTAT

	SEPPS (2010-2016)		*SDR (2005-2011)*	
	Foreign	U.S.+Perm.	Foreign	U.S.+Perm.
Obs.	752	1,526	934	1321
Share of sample	33%	67%	39%	61%
Startup employee	7%	14%	10%	16%
Male	75%	67%	68%	58%
Prior postdoc	21%	24%	-	-
Life sciences	13%	26%	19%	37%
Physical sciences	21%	31%	9%	12%
Engineering	39%	30%	41%	27%
Computer Science	27%	13%	31%	24%

Measuring Employment Outcomes

- **Survey + LinkedIn**
  - SEPPS second-wave respondents reported age and number of employees
  - Matched LinkedIn data for respondents and non-respondents on firm founding year and number of employees
  - Startup if employer age is <=5 years and size is <=100 employees at time of employment
  - 11% of S&E PhDs are employed in startups; U.S. population is 3% (Haltiwanger et al. 2013)



Employer Characteristics

	Startup	Est. firm
Firm size		
<10 employees	27.3%	1.2%
11-50 employees	35.2%	4.3%
52-100 employees	37.5%	7.9%
101-500 employees	-	8.9%
501-1,000 employees	-	4.3%
1,001-5,000 employees	-	11.5%
>5,000 employees	-	61.9%
Firm age		
<5 years	100%	2.7%
6-10 years	-	10.1%
>10 years	-	87.2%

Employer Industries

Industry	% of Startup Employees	% of Est. firm Employees
Biomedical	27.6%	16.7%
Internet/Telecommunications	12.1%	13.9%
Instruments/Devices	9.1%	6.5%
Semiconductors	8.2%	8.7%
Software	6.0%	7.8%
Computers/Computer systems	5.6%	8.4%
Energy	2.6%	3.3%
Hardware/Machinery	1.7%	4.3%
Chemicals	0.9%	4.8%

Most Frequent Est. Firm Employers

1. **Google**
2. **Intel**
3. **IBM**
4. **Dow Chemical**
5. **Microsoft**
6. **Qualcomm**
7. **Amazon**
8. **General Electric**
9. **Samsung**
10. **Merck**

Employment Sorting

(preliminary results)

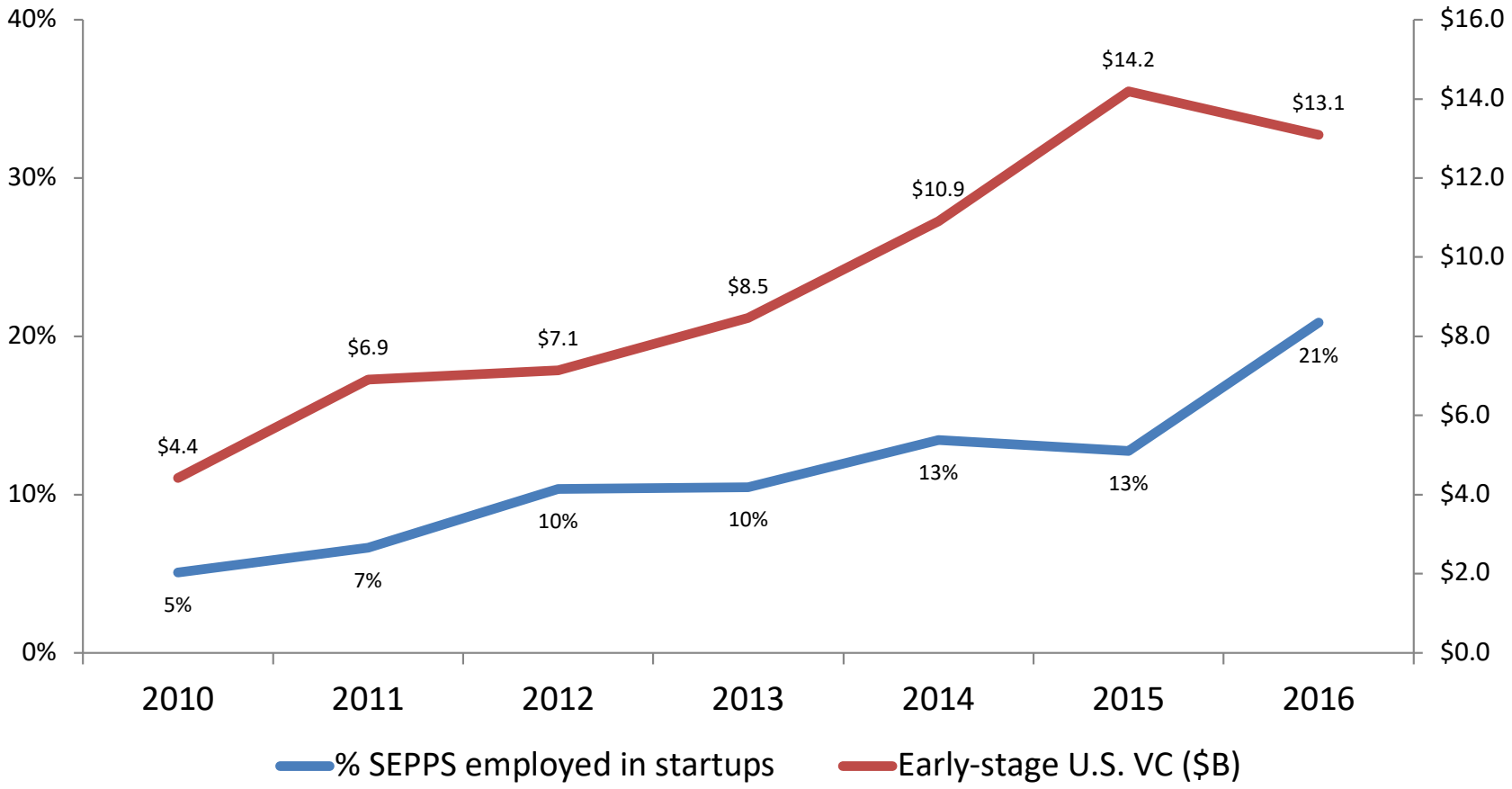
Likelihood of Startup Employment

- **Baseline specification**
  - Foreign worker (1 if temp. visa, 0 if U.S. citizen or perm. visa); 33% are foreign PhDs
  - Male, married, and number of children
  - Postdoc prior to entering private sector workforce; 23% did a postdoc
  - Control for PhD degree field (17) and year entered workforce (2010-2016)
- **Full specification**
  - Includes career preferences, individual ability and startup job availability (discussed later)

Preferences, Ability & Job Availability

- ***Ex ante startup career interests***
  - Asked while in graduate school attractiveness of career in foreign startups, respectively; dichotomized to “attractive (4)” or “extremely attractive (5)”
  - Foreign PhDs significantly more likely to be interested in startup career
- ***Ability***
  - Self-perceived ability relative to peers
  - NRC ranking of PhD department
  - Number of publications at graduation
- ***Startup job availability***
  - U.S. early-stage VC funding in year respondent starts job
  - Control for annual GDP growth rate

VC Funding & Startup Employment



Likelihood of Startup Employment

Logistic regression	Startup employment				Ex ante startup interest	Foreign
Sample	Full	U.S.+Perm.	Foreign	Ex ante startup interest		
Model	(1)	(2)	(3)	(4)	(5)	(6)
Foreign worker	**-0.67** (0.20)			**-0.77** (0.23)	**0.37** (0.11)	
Male	0.10 (0.16)	0.14 (0.16)	-0.43 (0.43)	-0.01 (0.18)	**0.65** (0.09)	-0.08 (0.14)
Married	0.14 (0.17)	0.10 (0.17)	0.30 (0.36)	-0.05 (0.17)	0.07 (0.08)	0.16 (0.11)
Num. children	-0.15 (0.12)	-0.24 (0.13)	-0.10 (0.22)	-0.13 (0.13)	0.03 (0.06)	0.04 (0.08)
Prior postdoc	0.17 (0.13)	0.21 (0.15)	-0.34 (0.40)	0.13 (0.15)	-0.21 (0.13)	0.15 (0.18)
Ex ante interest in startup job		**0.78** (0.17)	0.32 (0.37)			**0.32** (0.12)
Ex ante interest in est. firm job		**-0.61** (0.22)	-0.29 (0.54)			0.30 (0.19)
Ex ante self-perceived ability		-0.06 (0.03)	-0.04 (0.08)	0.01 (0.04)	**0.10** (0.03)	**0.16** (0.03)
NRC univ. dept. rank		0.14 (0.09)	**0.53** (0.17)	**0.20** (0.09)	0.02 (0.03)	**-0.37** (0.09)
Publications at graduation		**0.09** (0.05)	0.08 (0.07)	0.05 (0.04)	-0.01 (0.02)	**0.06** (0.03)
U.S. early-stage VC funding (log)		**1.03** (0.25)	**1.88** (0.69)	**1.08** (0.25)		
U.S. GDP growth rate		0.18 (0.18)	0.14 (0.43)	0.30 (0.18)		
PhD degree field FE	Y	Y	Y	Y	Y	Y
Job start year FE	Y				Y	Y
Observations	2203	1475	723	1483	2203	2201
Log pseudolikelihood	-724.56	-539.31	-145.84	-514.53	-1341.77	-1216.35

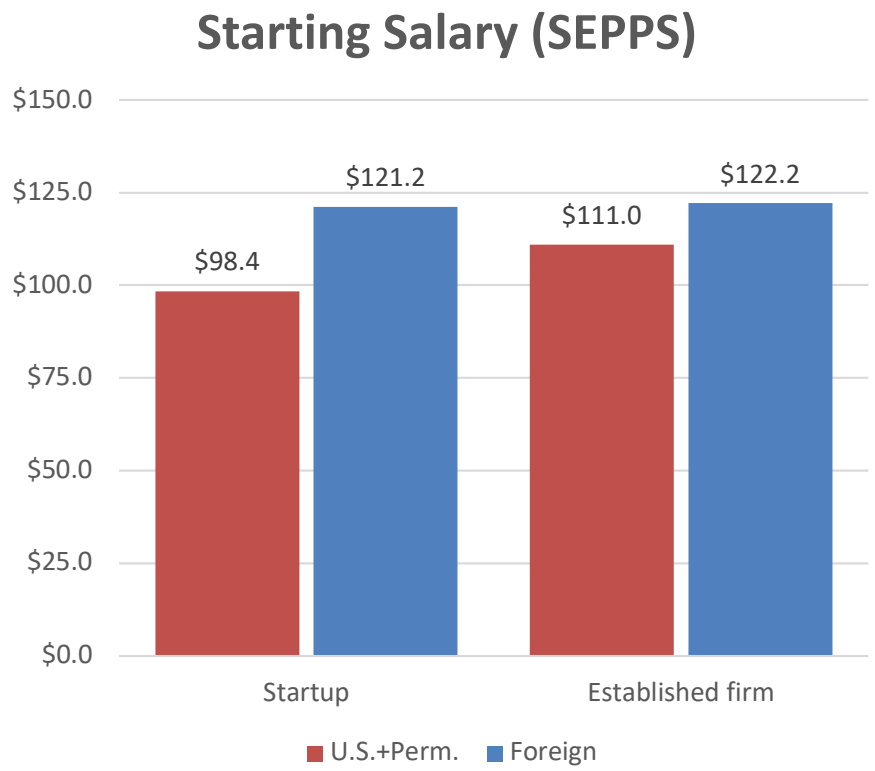
Robust standard errors clustered on university in parentheses; significant coefficients ($p < 0.05$) in bold

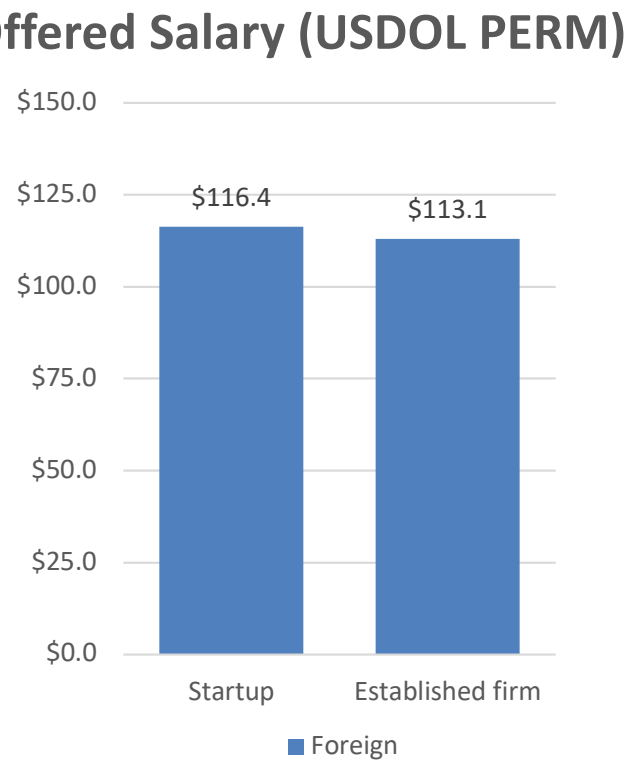
Additional Results (see working paper for details)

- **Robustness tests**
  - PhDs from S.F. and Boston more likely to work in startup, but foreign still less likely
  - Negative sorting is strongest in engr. & CS; does not seem that est. firms are hiring more
  - Chinese & Indians even less likely to work in startup, although they are more interested
- **Job applications and offers**
  - 41% of foreign and 44% of U.S.+perm. workers applied to startup jobs; PhDs with ex ante startup career interests were more likely to apply
  - 71% of foreign and 69% of U.S.+perm. workers received startup job offers
  - Logistic regressions show no significant difference in likelihood of applying or offers
- **Ex post most preferred job type**
  - Among established firm employees, 25% of foreign workers reported that their most preferred job is in a startup, compared to 19% of U.S.+perm. workers
  - Logistic regressions confirm that foreign workers are significantly different

Wage Comparisons

Average Annual Salary





Labor certification data matched to our sample by PhD university, degree field & year, and occupation

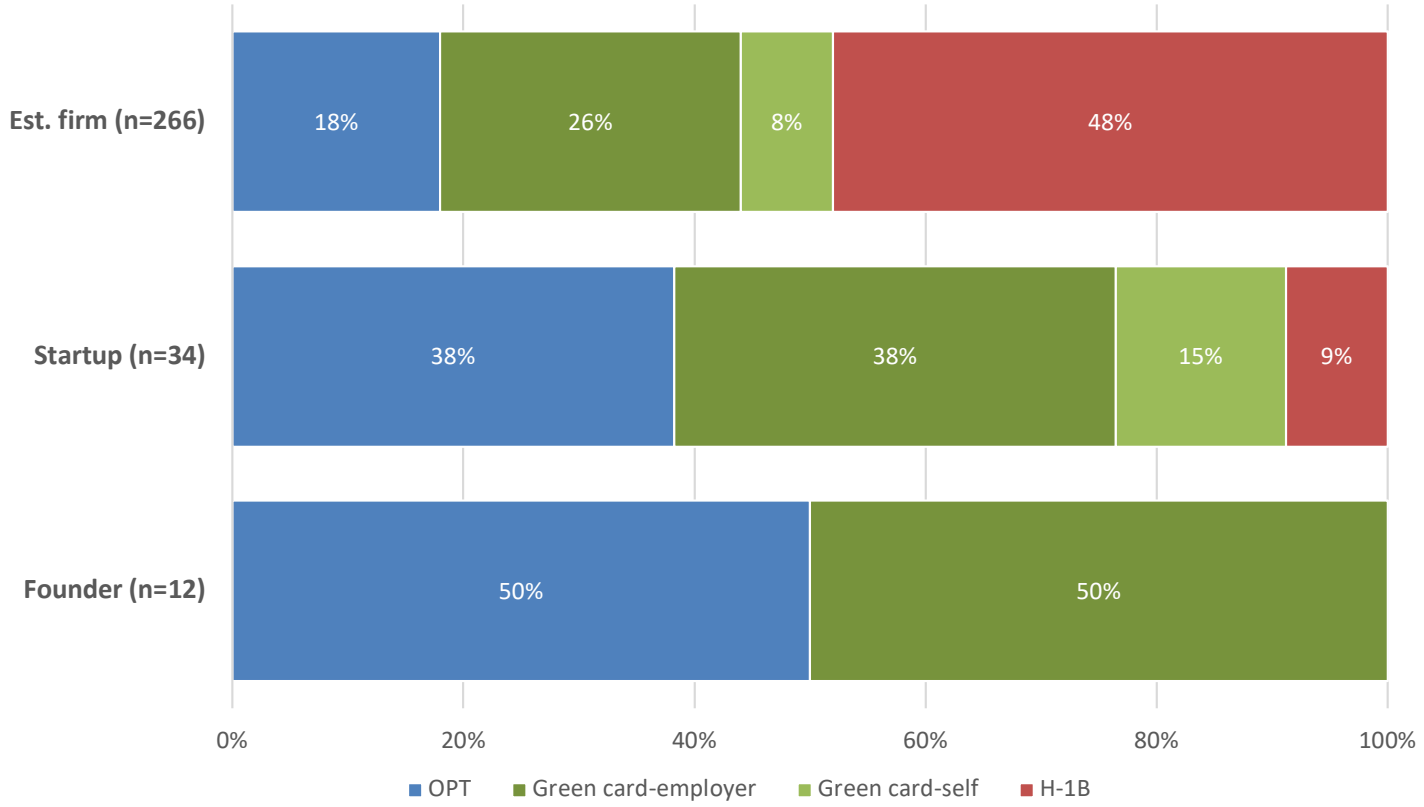
Salary Regressions – OLS

DV: ln(starting salary)						
Sample	**Full**	**Startup empl.**	**Est. firm empl.**	**Foreign**	**U.S.+Perm.**	**Engr & CS**
Model	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Startup employee	**-0.12** (0.03)			-0.09 (0.08)	**-0.12** (0.03)	**-0.15** (0.04)
Foreign workers	0.02 (0.02)	0.11 (0.07)	0.02 (0.02)			0.01 (0.03)
Male	**0.08** (0.02)	0.05 (0.06)	**0.08** (0.02)	0.09 (0.05)	**0.08** (0.03)	0.06 (0.03)
Married	-0.03 (0.02)	0.02 (0.05)	**-0.04** (0.02)	-0.07 (0.04)	-0.02 (0.02)	-0.02 (0.02)
Num. children	0.01 (0.01)	-0.02 (0.04)	0.01 (0.01)	-0.04 (0.04)	0.02 (0.01)	-0.01 (0.02)
Prior postdoc	0.02 (0.02)	0.04 (0.07)	0.01 (0.02)	-0.07 (0.05)	0.05 (0.03)	0.05 (0.04)
Self-perceived ability (ex ante)	**0.02** (0.01)	0.03 (0.02)	**0.02** (0.01)	0.00 (0.02)	**0.03** (0.01)	0.01 (0.01)
NRC department ranking	**0.07** (0.01)	0.03 (0.02)	**0.08** (0.01)	**0.09** (0.02)	**0.07** (0.01)	**0.08** (0.02)
Publications at graduation	**0.02** (0.00)	0.03 (0.02)	**0.02** (0.00)	**0.03** (0.01)	**0.01** (0.00)	**0.02** (0.01)
Early-stage U.S. VC funding (log)	**0.17** (0.04)	**0.28** (0.12)	**0.16** (0.04)	**0.31** (0.07)	**0.13** (0.04)	**0.19** (0.06)
U.S. GDP growth rate	0.02 (0.03)	0.04 (0.06)	0.02 (0.03)	0.10 (0.05)	-0.02 (0.03)	0.06 (0.04)
PhD degree field FE	Y	Y	Y	Y	Y	Y
Observations	942	128	814	232	710	477
R-squared	0.319	0.452	0.316	0.334	0.325	0.349

Robust standard errors clustered on university in parentheses; significant coefficients ($p < 0.05$) in bold

Visa Types

Visa Status by Firm Type (very preliminary!)



Summary

Summary of Key Findings

- **Immigrant STEM PhDs significantly less likely to work in startups**
  - Foreign STEM PhDs are more interested in working in startups, but find no evidence of preference-based sorting into startups
  - However, strong evidence of preference-based sorting for U.S. & perm. workers
- **No difference in wages between foreign and U.S.+perm. workers**
  - No evidence that immigrants take lower wages in exchange for visa
  - Startup wage gap is primarily for U.S. and may be taste-based compensating differential
- **Implications for STEM workforce & U.S. immigration policies**
  - Reducing costs to hire foreign STEM workers may enable startups to grow faster and increase their likelihood of survival
  - Permanent resident status for doctorates from U.S. universities (STAPLE Act) may have particular benefit for startups by reducing barrier to startup employment
  - OPT may be important pathway to work in startups; rescinding STEM extension may disproportionately impact startups

Thank you

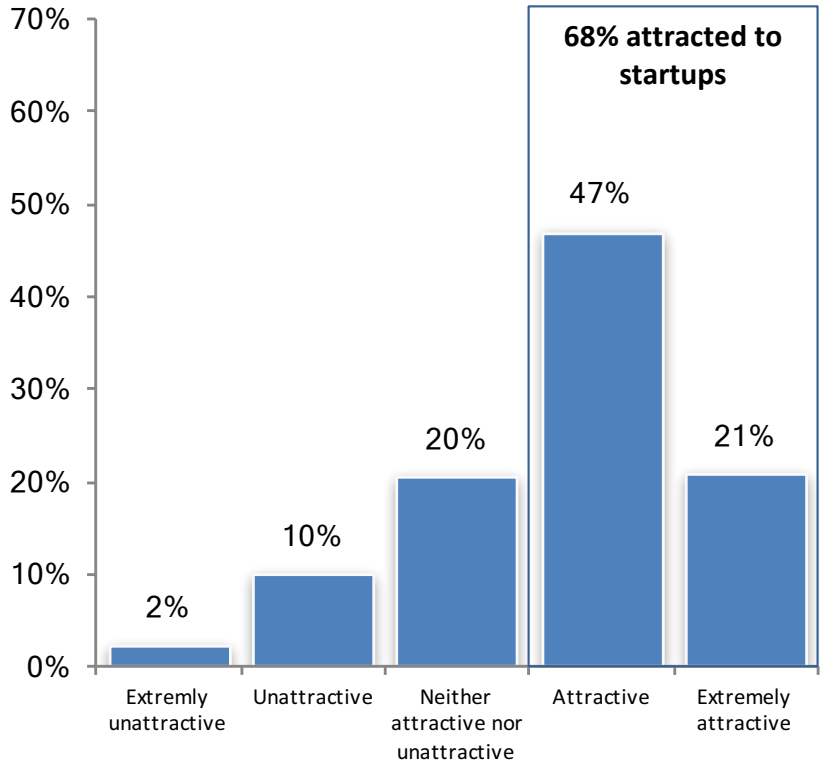
Appendix

Attractiveness of Different Careers

- **We asked graduate students: "Putting job availability aside, how attractive do you personally find the following careers?"**
  - University faculty with an emphasis on research or development
  - University faculty with an emphasis on teaching
  - Government job with an emphasis on research or development
  - ***Startup firm job*** with an emphasis on research or development
  - ***Established firm job*** with an emphasis on research or development
  - 5-point Likert scale from "extremely unattractive" to "extremely attractive"
- **Advantages of survey items**
  - Doesn't force tradeoff between careers and allows for indifference between careers
  - Asks about careers in general, does not prime respondents to think about entrepreneurship
  - Not driven by labor market conditions or whether or not they think they can get that job (Roach & Sauermann 2017); thus proxy for "true" career interests

Distribution of Career Attractiveness

Attractiveness of working in a startup



Attractiveness of working in an established firm