

Nationalistic Labor Policies Hinder Innovation

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Debate on Nationalistic Labor Policies

Proponents

- *Hiring American workers for limited available jobs should be a top priority for businesses taking taxpayer money through the TARP bailout program. [...] there is no need for companies to hire foreign guest workers through the H-1B program when there are plenty of qualified Americans looking for jobs. Senator C. Grassley (EAWA proponent) (February 6, 2009)*

Opponents

- *Big banks in the U.S., which have been seeking to hire more foreign workers in recent years under the H-1B visa program, are now being forced to reconsider their approach after the Trump administration made it harder to obtain the work permits. Bloomberg News (February 22, 2018)*

This paper

- To what extent can domestic firms substitute foreign nationals w/ domestic labor for highly skilled and innovative position?
- Does restricting domestic firms from hiring high-skilled immigrants stifle innovation?
- Exploit Employ American Workers Act (EAWA)
 - ▶ Unexpectedly restricted US financial institutions that entered the TARP program during 2008-2009 Financial Crisis from hiring **new foreign workers** until after TARP funds are paid back in full
 - ▶ Cancel "EAWA" allowed banks to **resume** foreign hires

Main Findings

- U.S. banks produce a lot of innovation
 - ▶ Cybersecurity, robo advising, data analytics, payment systems
- U.S. banks heavily relied on high-skilled immigrants (i.e., STEM)
 - ▶ Sponsored 15% H-1B visas (2001-2014)
 - ▶ 50% foreign nationals are STEM jobs
- Exploit differential pre-crisis exposure of TARP banks
 - ▶ EAWA reduced quantity & quality of patents
- Banks paid higher wage premia to retain pre-crisis foreign hires
 - ▶ Contrary to EAWA proponent's view: banks did not hire domestic workers
- Unintended negative consequences of nationalistic labor policies on innovation

Plan For the Rest of the Talk

- Data Sources and Summary Statistics
- What is Innovation by Banks?
- EAWA and High-Skilled Immigrants
- Baseline Analysis: Patenting Around EAWA
- Labor Market Outcomes (Wages)
- An Anatomy of STEM Jobs' Skill and Knowledge Sets


Data Sources

- Patent Data: USPTO filings (Jan. 2002–June 2015)
 - ▶ Extract info on file date, applicant (assignee), outcome
 - ▶ Trace individual inventors' career path
- TARP and EAWA effects: US Treasury
 - ▶ Info on dates entered/exited TARP by financial institutions
- H-1B visa Data: USCIS
 - ▶ Info on H-1B sponsor (firm), beginning/end dates jobs, wage offered, prevailing wage, application outcome
 - ▶ Job codes: STEM vs. non-STEM
 - ▶ No demographic info about individuals
- Hurdle: None of these sources includes a common bank-level identifier
 - ▶ Start from list of US commercial banks in Bankscope
 - ▶ Automated script to match (1) patent assignees & (2) H-1B sponsors

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Neglected Fact: U.S. Banks Produce A Lot of Innovation

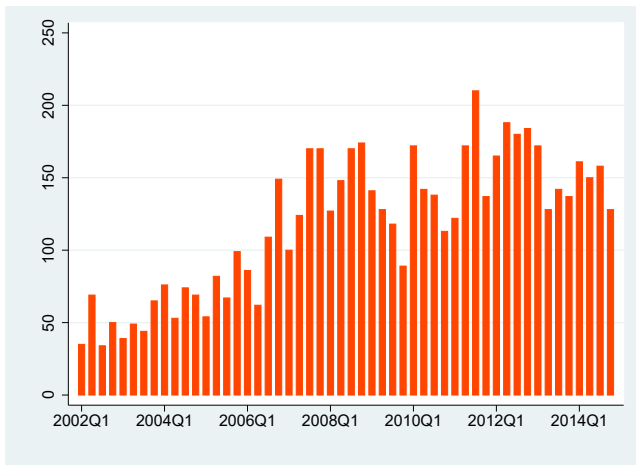


FINTECH'S BRAVE NEW WORLD
Top 20 Global Fintech Hubs

FINTECH RANK	City	Total Score
1	San Francisco Bay	80.136
2	London	54.888
3	New York	36.889
4	Singapore City	23.621
5	Sao Paulo	18.805
6	Los Angeles	17.867
7	Bangalore	16.093
8	Boston	15.795
9	Berlin	15.616
10	Mumbai	15.063
11	Hong Kong	14.778
12	Toronto	14.616
13	Sydney	14.470
14	Chicago	14.419
15	Paris	14.293
16	New Delhi	13.958
17	Tokyo	13.783
18	Tel Aviv	13.628
19	Atlanta	13.150
20	Miami	13.097

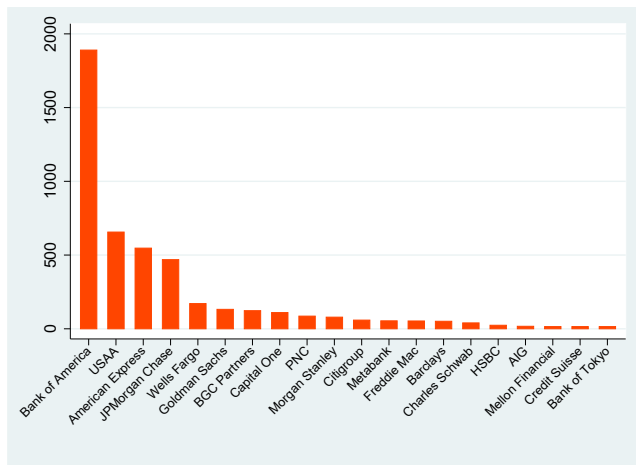
- Spurring innovation in response to FinTech competition—"disintermediate" incumbent banking systems
 - ▶ 4,669 patents & 5,782 inventors
 - ▶ FinTech, cybersecurity, & payment systems

Banks? Producing Innovation?!



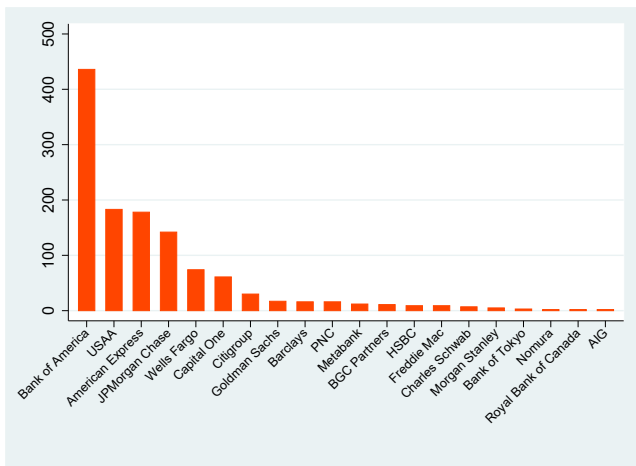
- Patent filings grew substantially between 2002–2014

Top 20 Innovative Banks



- Patents filed over 2002-2014
- Few large banks dominate in innovation

Top 20 Innovative Banks in FinTech



- FinTech Patents filed over 2002-2014
- Cybersecurity, Mobile transaction, Data analytics, Blockchain, Peer-to-peer, Robo-advising, Internet of things

Top 20 Patent Classifications

Classification	Description	#Patents
705	Data processing: financial, business practice, management, or cost/price determination	2,440
235	Registers	416
709	Electrical computers and digital processing systems:	231
709	Multi-computer data transferring	
726	Information security	222
707	Data processing: database and file management or data structures	219
382	Image analysis	132
370	Multiplex communications	118
717	Data processing: software development, installation, and management	109
714	Error detection/correction and fault detection/recovery	103
713	Electrical computers and digital processing systems: support	90
398	Optical communications	89
379	Telephonic communications	82
375	Pulse or digital communications	81
715	Data processing: presentation processing of document, operator interface processing, and screen saver display processing	76
455	Telecommunications	75
706	Data processing: artificial intelligence	60
340	Communications: electrical	48
718	Electrical computers and digital processing systems:	38
	virtual machine task or process management or task management/control	
703	Data processing: structural design, modeling, simulation, and emulation	37

What Type of Innovation? Patent Title Examples

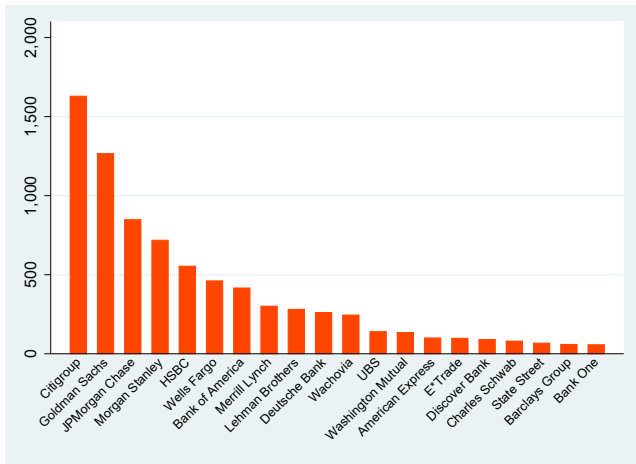
- Cybersecurity in Transactions
 - ▶ Processes for **reducing fraud risk** in credit transactions
- Cybersecurity in Accessing Systems
 - ▶ A system and methods for biometric security using **signature recognition biometrics** in a smartcard-reader system
- Consumer Profiling 1
 - ▶ A system, computer product and method for profiling consumers to recommend a financial transaction instrument having benefits tailored to **psychographic characteristics** of the consumer.
- Consumer Profiling 2
 - ▶ A method using big data to predict customers' **political affiliations** based on where they shop

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Top 20 Banks Hired STEM, Pre-Crisis

- STEM H1-B visas
 - ▶ Science, technology, engineering, mathematics



Employ American Worker Act

- Oct 3, 2008, U.S. President George W. Bush signed into law the Troubled Asset Relief Program (TARP)
 - ▶ Allowed government to purchase toxic assets from banks
- Feb 17, 2009, President Obama signed the Employ American Workers Act (EAWA) into law
 - ▶ H-1B petitioning under EAWA much costlier
 - ▶ Applies to **new foreign employee** hires
 - ▶ Did NOT apply to workers seeking to **extend** H-1B visa
 - ▶ Foreign workers cannot carry H-1B visa from one company to other
 - ▶ Valid until November 17, 2011

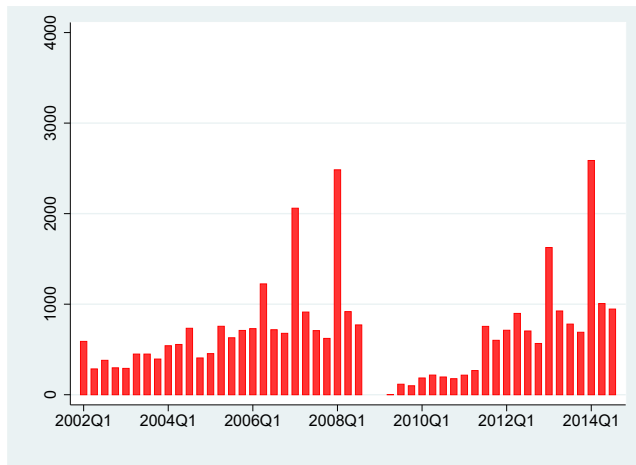
Staggered Timing EAWA Binding

	TARP begins	TARP ends	EAWA begins	EAWA ends
American Express	Jan 9, 2009	July 29, 2009	Feb 17, 2009	Jul 29, 2009
Bank of America	Oct 28, 2008	Mar 9, 2010	Feb 17, 2009	Mar 9, 2010
Capital One	Nov 14, 2008	Dec 9, 2009	Feb 17, 2009	Dec 9, 2009
JPMorgan Chase	Oct 28, 2008	Dec 16, 2009	Feb 17, 2009	Dec 16, 2009
Citigroup Inc	Oct 28, 2008	Jan 31, 2011	Feb 17, 2009	Jan 31, 2011

- Banks enter TARP in waves
- EAWA in effect *after* most banks had already accessed TARP
 - ▶ Most banks did not know EAWA would have been imposed when they decided to enter TARP
- EAWA stops to bind when bank exits TARP
 - ▶ EAWA period does not capture same business cycle for all banks

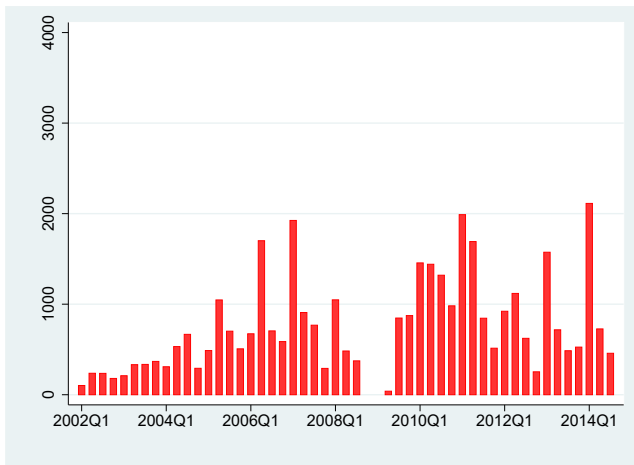
H-1B STEM Workers: Banks over 2002-2014

- STEM H1-B visas
 - ▶ Science, technology, engineering, mathematics



H-1B Non-STEM Workers: Banks over 2002-2014

- Non-STEM H-1B visas
 - ▶ Loan officers, analysts, portfolio managers, accountants



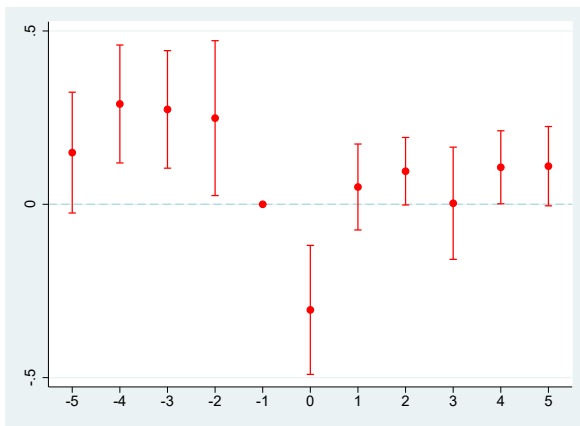
EAWA and H-1B Hiring

$$\begin{aligned} \text{STEM H1B}_{i,t} = & \alpha + \sum_{t=n}^m \beta_t \times \text{Period}_{i,t} \times \text{Treated}_i \\ & + \sum_{t=n}^m \gamma_t \times \text{Period}_{i,t} + X' \times \gamma + \eta_i + \eta_t + \epsilon_{i,t}, \end{aligned}$$

- **STEM H1B** : A dummy variable equal to 1 if institution i submits H-1B visa applications in year-month s for at least one STEM worker
- **Treated _{i}** — Banks' reliance on H-1B STEM workers
 - ▶ $\frac{\#STEMH1B}{\#H1B}$ during January 2004 — December 2006
- **Period _{i,t}**
 - ▶ Event period dummies before (after) bank i is subject to EAWA
- η_i , η_t : bank, time fixed effects

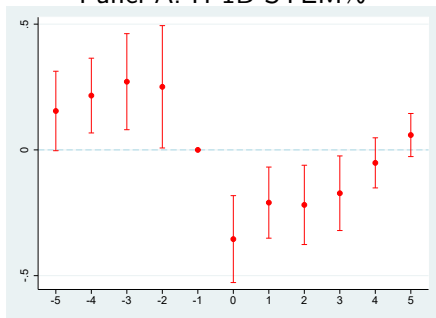
Parallel-Trends Assumption

$$\text{STEM H1B}_{i,t} = \alpha + \sum_{t=n}^m \beta_t \times \text{Period}_{i,t} \times \text{Treated}_i + \sum_{t=n}^m \gamma_t \times \text{Period}_{i,t} + \mathbf{X}' \times \boldsymbol{\gamma} + \eta_i + \eta_t + \epsilon_{i,t},$$

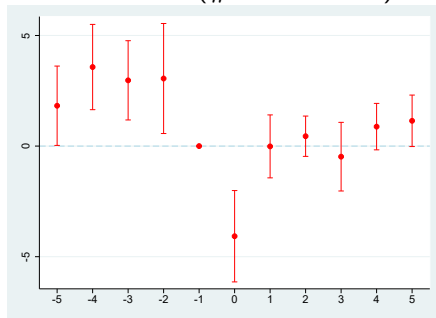


Parallel-Trends Assumption: Robustness

Panel A: H-1B STEM%



Panel B: Ln(#H-1B STEM)



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- **Baseline Analysis: Patenting Around EAWA**
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Sample Descriptive Statistics

- Bank-Year-Month Panel: Jan 2007–Dec 2014

	N	Mean	St.dev.
Ln(#STEM)	11,808	0.229	0.753
STEM	11,808	0.111	0.314
Patent Filed	11,808	0.083	0.276
Biz-Meth	11,808	0.056	0.230
Non-Biz-Meth	11,808	0.057	0.231
FinTech	11,808	0.040	0.196
First Filer	11,808	0.054	0.226
First Filer & Lead Inventor	11,808	0.029	0.169
STEM% ₀₄₀₆	11,808	0.208	0.318
STEM% ₀₄₀₆ > 0	11,808	0.382	0.486
EAWA	11,808	0.039	0.193
Post	11,808	0.139	0.346

Extensive Margin of Patenting: Jan 2007-Dec 2014

$$\text{Patent Filed}_{i,s} = \alpha + \beta_1 \times \text{EAWA}_{i,s} + \beta_2 \times \text{EAWA}_{i,s} \times \text{Treated}_i + \beta_3 \times \text{Post}_{i,s} \\ + \beta_4 \times \text{Post}_{i,s} \times \text{Treated}_i + X_i' \times \theta + \eta_i + \eta_t + \epsilon_{i,s}.$$

- $\text{Patent Filed}_{i,s}$: if bank i files patents (granted) in month s
- $\text{EAWA}_{i,s}$: if bank i subject to EAWA in month s
- Treated
 - ▶ Banks' pre-crisis exposure to EAWA ban
 - ▶ version 1: # STEM as a percentage of # H-1B visas
 - ▶ version 2: # STEM hired > 0
- η_i , η_t : bank, time fixed effects

Extensive Margin of Patenting: Jan 2007-Dec 2014

$$\begin{aligned}
 \text{Patent Filed}_{i,s} = & \alpha + \beta_1 \times \text{EAWA}_{i,s} + \beta_2 \times \text{EAWA}_{i,s} \times \text{Treated}_i + \beta_3 \times \text{Post}_{i,s} \\
 & + \beta_4 \times \text{Post}_{i,s} \times \text{Treated}_i + X_i' \times \theta + \eta_i + \eta_t + \epsilon_{i,s}.
 \end{aligned}$$

	Continuous Treatment				Discrete Treatment			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
EAWA	0.0178 (0.93)	0.0192 (1.06)	0.0182 (1.01)	0.0157 (0.87)	0.0220 (1.03)	0.0274 (1.43)	0.0251 (1.31)	0.0225 (1.19)
EAWA × Treated	-0.1700*** (-2.83)	-0.1877*** (-3.13)	-0.1849*** (-3.05)	-0.1877*** (-3.07)	-0.0914** (-2.43)	-0.1069*** (-3.19)	-0.1035*** (-3.05)	-0.1045*** (-3.06)
Post		0.0024 (0.20)	0.0004 (0.03)	-0.0010 (-0.08)		0.0085 (0.95)	0.0024 (0.28)	0.0011 (0.12)
Post × Treated		-0.0262 (-0.49)	-0.0067 (-0.13)	-0.0062 (-0.12)		-0.0235 (-0.88)	-0.0066 (-0.27)	-0.0064 (-0.26)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	No	Yes	Yes	Yes	No
Year-Month FE	No	No	No	Yes	No	No	No	Yes
N	11,808	11,808	11,808	11,808	11,808	11,808	11,808	11,808
adj. R ²	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57

- A std ↑ in **Treated** → drop in likelihood of filing patents 5.5%
- 14.5% of a std of likelihood of filing patents

Financial Constraint or Labor Constraint?

- TARP participants' deteriorated balance sheet?
 - ▶ Firms lose talents when approaching bankruptcy
- Does labor constraint still matter by controlling financial condition?
 - ▶ *TARP Fund*_{*i*} – amount of “troubled assets” purchased by U.S. Department of the Treasury over total assets in 2009
- Horse-race test by only including TARP participants

Financial Constraint or Labor Constraint?

$$\begin{aligned}
 \text{Patent Filed}_{i,s} = & \alpha + \beta_1 \times \text{EAWA}_{i,s} + \beta_2 \times \text{EAWA}_{i,s} \times \text{Treated}_i + \beta_3 \times \text{EAWA}_{i,s} \\
 & \times \text{TARP Fund}\%_i + \beta_4 \times \text{Post}_{i,s} + \beta_5 \times \text{Post}_{i,s} \times \text{Treated}_i \\
 & + \beta_6 \times \text{Post}_{i,s} \times \text{TARP Fund}\%_i + X_i' \times \theta + \eta_i + \eta_s + \epsilon_{i,s}.
 \end{aligned}$$

	Continuous Treatment				Discrete Treatment			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
EAWA	-0.0059 (-0.22)	-0.0073 (-0.23)	-0.0126 (-0.37)	-0.0468 (-1.40)	-0.0029 (-0.09)	0.0002 (0.00)	-0.0054 (-0.15)	-0.0397 (-1.20)
EAWA × Treated	-0.1694*** (-2.89)	-0.1862*** (-3.17)	-0.1861*** (-3.04)	-0.1895*** (-2.98)	-0.0914** (-2.46)	-0.1071*** (-3.27)	-0.1050*** (-2.97)	-0.1055*** (-2.94)
EAWA × TARP Fund%	0.4727 (0.87)	0.6541 (1.58)	0.6543 (1.56)	0.7018* (1.71)	0.5399 (0.91)	0.7116 (1.46)	0.7144 (1.45)	0.7655 (1.58)
Post		-0.0007 (-0.04)	-0.0117 (-0.51)	-0.0332 (-1.29)		0.0067 (0.35)	-0.0060 (-0.22)	-0.0274 (-0.91)
Post × Treated		-0.0257 (-0.47)	-0.0122 (-0.23)	-0.0126 (-0.24)		-0.0241 (-0.88)	-0.0130 (-0.47)	-0.0127 (-0.46)
Post × TARP Fund%		0.2872 (0.75)	0.2912 (0.76)	0.2843 (0.74)		0.2720 (0.70)	0.2827 (0.71)	0.2760 (0.70)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	No	Yes	Yes	Yes	No
Year-Month FE	No	No	No	Yes	No	No	No	Yes
N	2,976	2,976	2,976	2,976	2,976	2,976	2,976	2,976
adj. R ²	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59

Why Are New (Foreign) Hires So Relevant?

- Can lack of new hires be so important for patenting activities?
 - ▶ EAWA only restricted on sponsoring **new** H-1B visas
 - ▶ Renewal of visas not affected
- “Pre-invention assignment agreement”
 - ▶ Assigns to employers ownership of inventions created by employees

$$\text{First Filer}_{i,s} = \alpha + \beta_1 \times \text{EAWA}_{i,s} + \beta_2 \times \text{EAWA}_{i,s} \times \text{Treated}_i + \beta_3 \times \text{Post}_{i,s} + \beta_4 \times \text{Post}_{i,s} \times \text{Treated}_i + X'_i \times \theta + \eta_i + \eta_t + \epsilon_{i,s},$$

- **First Filer**: if at least one inventor files for the first time
- **First Filer&Lead Inventor**: first inventor + lead inventor
 - ▶ 58% patents have non-alphabetical name orders

Why Are New (Foreign) Hires So Relevant?

$$\text{First Filer}_{i,s} = \alpha + \beta_1 \times \text{EAWA}_{i,s} + \beta_2 \times \text{EAWA}_{i,s} \times \text{Treated}_i + \beta_3 \times \text{Post}_{i,s} + \beta_4 \times \text{Post}_{i,s} \times \text{Treated}_i + X_i' \times \theta + \eta_i + \eta_t + \epsilon_{i,s}.$$

	Continuous Treatment		Discrete Treatment	
Panel A. First Filer				
	(1)	(2)	(3)	(4)
EAWA × Treated	-0.1565*** (-3.14)	-0.1583*** (-3.18)	-0.0976*** (-3.51)	-0.0985*** (-3.51)
N	11,808	11,808	11,808	11,808
adj. R ²	0.48	0.48	0.48	0.48
Panel B. First Filer & Lead Inventor				
	(1)	(2)	(3)	(4)
EAWA × Treated	-0.1275* (-1.86)	-0.1294* (-1.89)	-0.0668** (-2.36)	-0.0678** (-2.39)
N	11,808	11,808	11,808	11,808
adj. R ²	0.40	0.40	0.40	0.40
Controls	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes
Year FE	Yes	No	Yes	No
Year-Month FE	No	Yes	No	Yes

Extensions

- Business methods, non-business methods, FinTech
- Patent citations

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Labor Market Outcomes (Wages)

- Labor market dynamics for foreign STEM workers
 - ▶ Foreign workers cannot carry H-1B visa from one company to the other
 - ▶ TARP banks retain existing foreign workers hired before crisis

$$\begin{aligned} \text{Wage Premium}_{i,k,l,d} = & \alpha + \beta_1 \times EAWA_{i,d} + \underbrace{\beta_2 \times EAWA_{i,d} \times Treated_j}_{\text{Existing foreign hirers}} \\ & + \beta_3 \times Post_{i,d} + \beta_4 \times Post_{i,d} \times Treated_j + X' \times \beta_5 \\ & + \eta_k + \eta_l + \eta_i + \eta_t + \epsilon_{i,k,l,d}, \end{aligned}$$

- *Wage Premium*_{*i,k,l,d*}: proposed wage scaled by prevailing wage
- H-1B STEM vs. H-1B Non-STEM workers

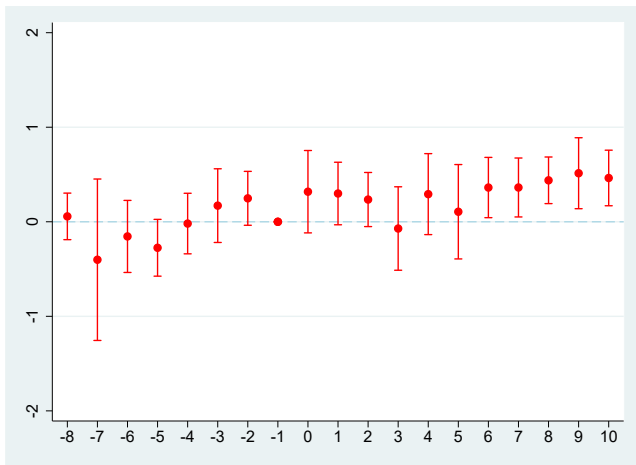
Wage Premia to Foreign STEM Workers

	STEM		Non-STEM	
	(1)	(2)	(3)	(4)
EAWA	-0.0946 (-1.53)	-0.0840 (-1.31)	-0.0915 (-1.33)	-0.0807 (-1.05)
EAWA \times Treated	0.3094** (2.51)	0.2909** (2.22)	0.2290 (1.45)	0.2034 (1.09)
Post	-0.0728 (-1.51)	-0.0758 (-1.56)	-0.0000 (-0.00)	-0.0041 (-0.07)
Post \times Treated	0.2809*** (3.35)	0.2924*** (3.15)	0.0460 (0.35)	0.0585 (0.48)
Controls	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes
Year FE	Yes	No	Yes	Yes
Year-Month FE	No	Yes	No	No
City FE	Yes	Yes	Yes	Yes
Job FE	Yes	Yes	Yes	Yes
N	26,583	26,583	26,439	26,439
adj.R ²	0.20	0.20	0.12	0.13

Wage Premium of H-1B Employees: STEM Jobs

$$\text{Wage Premium}_{i,k,l,s} = \alpha + \sum_{t=-8}^{10} \beta_t \times \text{Period}_{i,t} \times \text{Treated}_i + \sum_{t=-8}^{10} \gamma_t \times \text{Period}_{i,t} +$$

$$X' \times \gamma + \eta_i + \eta_k + \eta_l + \eta_s + \epsilon_{i,k,l,s}$$



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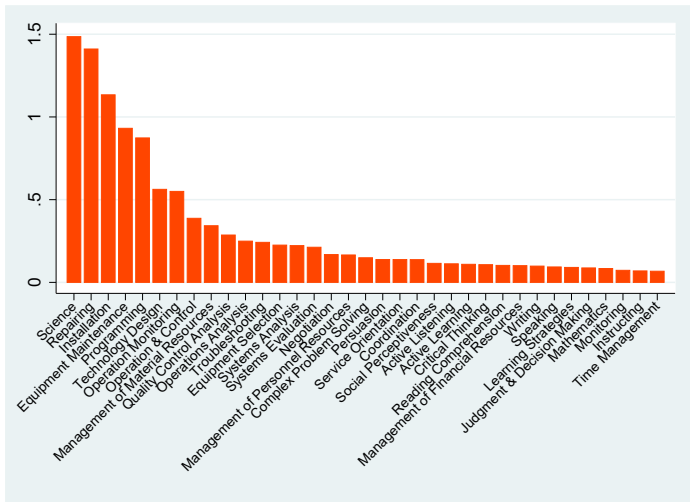
An Anatomy of STEM Jobs' Skill and Knowledge Sets

- Skill & Knowledge profiles of STEM vs. non-STEM
 - ▶ Sponsored under H-1B visa program
- O*NET Program
 - ▶ For each occupation, rates a skill & knowledge component
- Skill components
 - ▶ reading, problem solving

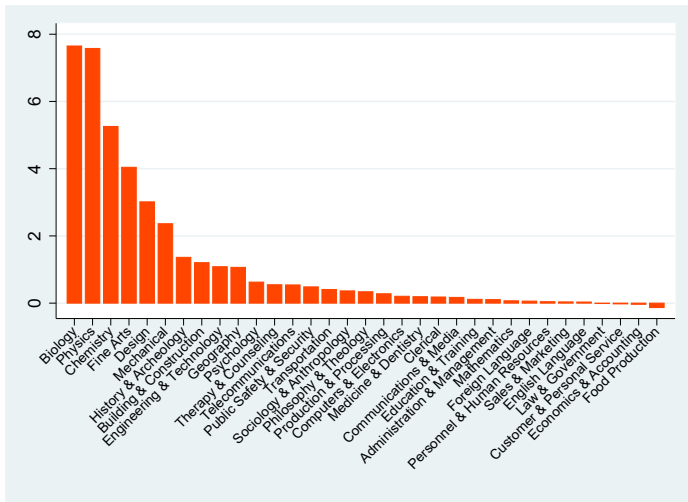
$$Difference_{h,i} = \frac{\frac{\sum_{k=1}^N \sum_1^n Rating_{h,k}}{\sum_N \sum_n 1}}{\frac{\sum_{k=1}^M \sum_m Rating_{h,k}}{\sum_M \sum_m 1}} - 1,$$

- ▶ $Rating_{h,k}$ is the rating on the level of a descriptor h to occupation k

Skill Difference: STEM vs. Non-STEM



Knowledge Difference: STEM vs. Non-STEM



Conclusion

- Restrictions in the ability of domestic companies to hire specialized foreign workers
 - ▶ Detrimental to traditional banks' ability to produce innovation and stay at the frontier of global banking
- Banks relying on foreign STEM workers reduce and worsen innovation activity following EAWA
- Open the black box of [bank innovation](#)