No. 20-17132

IN THE UNITED STATES COURT OF APPEALS
FOR THE NINTH CIRCUIT

NATIONAL ASSOCIATION OF MANUFACTURERS, *et al.*,
Plaintiffs-Appellees,

v.

UNITED STATES DEPARTMENT OF HOMELAND SECURITY, *et al.*,
Defendants-Appellants.

ON APPEAL FROM THE UNITED STATES DISTRICT COURT FOR THE NORTHERN DISTRICT OF CALIFORNIA
No. 4:20-cv-4887-JSW
The Hon. James S. White

DEFENDANTS-APPELLANTS' EXCERPTS OF RECORD

Volume 5 of 6
ER 685–957

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UNITED STATES DEPARTMENT OF STATE

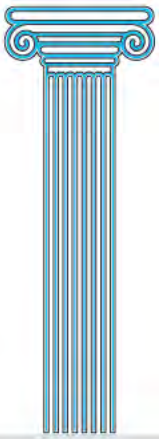
Bureau of Educational and Cultural Affairs

Moving people to move ideas

MISSION

To increase mutual understanding between the people of the United States and the people of other countries by means of educational and cultural exchange that assist in the development of peaceful relations for the advancement of American foreign policy.

FUNCTIONAL BUREAU STRATEGY

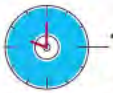


- *Advance American foreign policy objectives*
- *Increase Americans' global competitiveness*
- *Counter disinformation and radicalization*
- *Encourage strong civil society institutions*
- *Achieve greater efficiency in ECA operations*

FAST FACTS

$45 billion

The amount one million international students ***contributed to the U.S. economy*** in 2018–19.



125,000

Community service hours were performed by youth exchange participants in 2017.

450,000

U.S. jobs supported by international students in 2017.

$730 million

ECA's total budget in FY20 (projected).

55,000

People take part in ECA funded exchange programs every year.

97 percent

of ECA's budget goes to American organizations, businesses, and individuals.

1 in 3

Current world leaders are alumni of ECA exchange programs.

MORE THAN **640** ***personnel in ECA***, including over 80 FS positions.

97 ***Current or former members of Congress*** who have participated in ECA exchange programs.

MORE THAN

100 Countries

provide over $100 million in both direct and in kind contributions to the Fulbright program.

UNITED STATES DEPARTMENT *of* STATE
Bureau of Educational and Cultural Affairs

eca.state.gov | @ECAatState | ExchangeProgramsatState | ExchangeOurWorld

ECA'S PROGRAMS

Alumni Opportunities

These posts and offices work with Alumni Affairs to convene exchange alumni for Alumni Thematic International Exchange Seminars, focusing on key foreign policy themes and provide small grants funding opportunities that support alumni engagement on emerging priorities.

American Spaces

With over 700 Spaces in 169 countries worldwide, American Spaces provide welcoming environments where visitors can connect and learn about the United States. Hosted in embassies, schools, libraries, and other partner institutions worldwide, American Spaces are platforms for providing information about the policy, culture, and values of the United States.

Arts Envoy

The Arts Envoy program supports requests from U.S. embassies and consulates to bring American artists and arts professionals overseas for short term cultural exchanges. Arts envoys come from communities across the United States and represent a wide range of genres and fields.

English Language Specialists

Promoting the learning and teaching of American English around the world is an integral part of the U.S. Department of State's efforts to foster mutual understanding between the people of the United States and the people of other countries. The English Language Specialist Program sends U.S. academics and professionals in the fields of TESOL or TEFL to conduct two week to four month long programs overseas.

International Visitors Leadership Program (IVLP)

Through short term visits to the United States, current and emerging foreign leaders in a variety of fields experience this country firsthand and cultivate lasting relationships with their American counterparts. Professional meetings reflect the participants' professional interests and support the foreign policy goals of the United States.

Exchange Visitors Program

The primary goals of the Exchange Visitor Program are to allow participants the opportunity to engage broadly with Americans, share their culture, strengthen their English language abilities, and learn new skills or build skills that will help them in future careers. Exchange visitors on private sector programs may study, teach, do research, share their specialized skills, or receive on the job training for periods ranging from a few weeks to several years.

Fulbright Program

For over 70 years, the Fulbright Program has given hundreds of thousands of passionate and accomplished students, scholars, teachers, artists, and professionals of all backgrounds and fields the opportunity to study, teach and conduct research, exchange ideas, and contribute to finding solutions to complex global challenges.

Sports Envoy Program

Sports Envoys are current and former American professional athletes and coaches who go overseas to lead youth clinics and team building activities, as well as share lessons learned on and off the playing field about the importance of education, community engagement, and respect for diversity. ECA partners with professional sports leagues, the U.S. Olympic Committee, and national governing bodies of sport on programming in a variety of sports.

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THE UNITED STATES DEPARTMENT OF STATE

Exchange Visitor Program

More than 300,000 participants from almost every country in the world come to the United States on the Exchange Visitor Program each year. Eighty-five percent are 30 years of age or younger. Fifty-five percent are women or girls.

WHO COMES ON THE EXCHANGE VISITOR PROGRAM?

Participants are young leaders eager to hone their skills, strengthen their English language abilities, connect with Americans, and learn more about the United States. Most individuals choosing to come to the United States on the Exchange Visitor Program are funded privately. The program includes a cultural component that gives participants the opportunity to engage more broadly with Americans and share their own cultures with their U.S. host communities. They return home eager to stay connected, to expand their networks, and to explore future exchange opportunities as "citizen ambassadors."

Find out more about the Exchange Visitor Program at j1visa.state.gov, which also hosts the Route J-1 blog where participants share their experiences.

WHAT IS THE EXCHANGE VISITOR PROGRAM?

The primary goals of the Exchange Visitor Program are to allow participants the opportunity to engage broadly with Americans, share their culture, strengthen their English language abilities, and learn new skills or build skills that will help them in future careers. There are fifteen different categories of participants under the Exchange Visitor Program, of which, thirteen categories include privately-funded programs that are implemented under the auspices of the Office of Private Sector Exchange in the Department's Bureau of Educational and Cultural Affairs. The State Department designates more than 1,500 for-profit, non-profit, or federal, state, and local government entities to conduct such private sector programs. Exchange visitors on private sector programs may study, teach, do research, share their specialized skills, or receive on-the-job training for periods ranging from a few weeks to several years. In addition to the thirteen private sector exchange categories, the Exchange Visitor Program also includes two categories that are publicly funded: International Visitors and Government Visitors.

PROGRAM CATEGORIES

Professors/Research Scholars: These two categories promote the exchange of ideas, research, and linkages between research and academic institutions in the United States and foreign countries.

Short-term Scholars: Professors, scholars, and other accomplished individuals travel on a short-term visit to lecture, observe, consult, train, or demonstrate special skills at U.S. research and academic institutions, museums, and libraries.

Trainees: Professionals with a degree, professional certificate, or relevant work experience gain exposure to U.S. culture and receive training in U.S. business practices through a structured and guided work-based program.

Interns: College and university students or recent graduates gain exposure to U.S. culture as they experience U.S. business practices in their chosen occupational field.

College and University Students: Students study at a U.S. degreegranting post-secondary accredited academic institution, participating in a degree, non-degree, or student internship program.

Teachers: Educators teach fulltime at a U.S. accredited primary or secondary school or in an accredited pre-kindergarten program.

Secondary School Students: Secondary school students study at an accredited public or private high school and live with an American host family or at an accredited boarding school.

Specialists: Experts in a field of specialized knowledge observe U.S. institutions and methods of practice and share their knowledge with their U.S. colleagues.

Alien Physicians: Foreign medical graduates pursue graduate medical education or training at a U.S. accredited school of medicine or scientific institution, or pursue programs involving observation, consultation, teaching, or research.

Camp Counselors: Post-secondary students, youth workers, teachers or others with specialized skills interact with and supervise American youth at U.S. camps.

Au Pairs: A young adult lives with a host family for 12 months and experiences U.S. culture while providing child care and taking courses at an accredited U.S. post-secondary institution.

Summer Work Travel Program: College and university students at foreign universities gain first-hand experience as they work in seasonal or temporary jobs and travel in the United States during their summer.

Government Visitors: Distinguished international visitors develop and strengthen professional and personal relationships with their American counterparts in U.S. federal, state, or local government agencies.

International Visitors: Reserved for State Department-sponsored and funded exchange participants

Hughes Declaration
Exhibit 17

Table XVI(A)
Classes of Nonimmigrants Issued Visas
(Including Border Crossing Cards)
Fiscal Years 2015-2019

Class of Nonimmigrant		2015	2016	2017	2018	2019
Totals		**10,891,745**	**10,381,491**	**9,681,913**	**9,028,026**	**8,742,068**
A	Foreign Government Official	112,585	113,581	109,913	113,820	110,028
B-1	Temporary Visitor for Business	43,421	40,105	39,712	38,705	37,841
B-1/B-2	Temporary Visitor for Business and Pleasure	7,199,807	6,881,797	6,276,851	5,708,278	5,297,439
B1/B2/BCC	Combination B1/B2 and Border Crossing Card	1,203,876	1,106,723	1,073,915	1,032,467	1,106,852
B-2	Temporary Visitor for Pleasure	63,387	43,564	42,037	32,428	28,829
C	Transit	21,540	21,080	19,335	15,652	14,344
C-1/D	Combination Transit/Crew Member	280,664	295,140	293,285	288,957	285,477
CW	Commonwealth of Northern Mariana Islands Transitional Worker	3,737	8,972	6,846	3,550	3,787
D	Crew Member	6,339	6,322	7,202	6,689	8,133
E	Treaty Trader or Investor	59,221	64,329	62,974	60,438	63,178
F	Student	677,928	502,214	421,008	389,579	388,839
G	Representative/Staff of International Organization	44,616	44,814	45,316	46,169	47,489
H	Temporary Worker and Trainee	477,780	532,832	563,248	593,191	619,305
I	Representative of Foreign Information Media	14,447	14,536	14,126	11,874	11,312
J	Exchange Visitor	374,829	380,120	383,165	382,219	391,561
K	Fiance(e) of U.S. Citizen	35,559	44,252	40,208	28,662	41,087
L	Intracompany Transferee	164,604	165,178	163,432	153,099	157,708
M	Vocational Student	11,462	10,694	9,982	9,683	9,518
N	Certain Relatives of SK Special immigrants	18	21	9	22	24
NAFTA	NAFTA Professional	21,608	24,530	25,731	28,189	32,233
NATO	NATO Official	6,247	6,336	6,588	7,398	7,954
O	Person With Extraordinary Ability in the Sciences, Arts, Education, Business, or Athletics	23,680	28,171	30,038	30,259	31,831
P	Athlete, Artist or Entertainer	33,978	35,695	36,196	36,075	36,957
Q	International Cultural Exchange Program Participant	1,901	2,025	1,935	1,997	2,029
R	Person in a Religious Occupation	6,256	6,424	6,831	6,307	6,288
S	Informant Possessing Information on Criminal Activity or Terrorism	0	1	0	0	0
T	Victim of Severe Form of Trafficking in Persons	508	472	473	435	386
U	Victim of Criminal Activity	1,747	1,563	1,557	1,884	1,639

Hughes Declaration

Exhibit 18

RSS

CATO AT LIBERTY

MAY 14, 2020 12:08PM

Don't Ban H-1B Workers: They Are Worth Their Weight in Innovation

BY ALEX NOWRASTEH

The Trump Administration is reportedly working on an **executive order** to ban the issuance of new H-1B visas. His order is expected to be issued before the end of this month. His order would be quite a negative blow to the U.S. economy and hit American economic innovation the hardest. The H-1B visa system has problems: It's unreasonably costly to change firms, workers are restrained from starting their own firms, and the wait times to adjust their status to a green card are absurdly long. Complete H-1B worker portability between firms, allowing workers to sponsor themselves if they start a firm, and **reducing the backlog**, as well as other reforms, need to be implemented. But ending the H-1B visa is not the way forward and will hurt American innovation especially.

H-1B visas are for highly skilled workers in specialty occupations. They have to make a minimum of $60,000 a year. Annually, 85,000 are available to U.S. firms with an additional uncapped number available for non-profit research institutions, universities, and governments. Many workers who get an H-1B visa start as students in an American university, adjust to an H-1B visa, and eventually earn an employment-based green card – but often with **obscenely long waits**. **H-1B workers primarily labor in STEM and computer occupations**.

H-1B workers have an especially big impact on American innovation. New technology and knowledge allow for more efficient machines and production processes that increase nationwide productivity. Highly skilled migrants on H-1B visa, as well as those on other visas and green cards, directly increase the production of knowledge through patents, innovation, and entrepreneurship. These effects are localized and diffuse throughout the country.

Economist Charles I. Jones found that the increase in the share of scientists and engineers in the U.S. workforce can explain about half of U.S. growth in **total factor productivity** in recent decades. Jones didn't look specifically at the foreign-born contribution, but his general finding is applicable Across the economy, **economists Sari Pekkala Kerr, William Kerr, Çağlar Özden, and Christopher Parsons** find that highly-skilled immigrants directly boost innovation and productivity while displacing very few native-born innovators and highly skilled workers. Since the flow of innovation is largely constrained by the supply of talented scientists, engineers, and technicians, an increase in highly-skilled immigration would relax this constraint on innovation and allow for additional productivity growth. Chapter Six of the **National Academies of Sciences** report on immigration dug into this in more detail. That also means that a decline in the number of highly-skilled immigrants would subsequently reduce innovation and productivity growth.

These productivity enhancements show up in some unexpected places. Particularly important, since many of us are working at home during the COVID-19 pandemic, is that **Indian information technology (IT) workers on the H-1B visa increased the wages of American workers by $431 million in 2010**. Better IT at a lower price allows American firms to become more productive by, for example, allowing people to work from home. Imagine where the economy would be if IT services were more expensive and scarcer. H-1B visa workers inside of **accounting firms** also increased the wages of native-born American workers *with the same job title in those firms*, likely resulting from increased complementarity and division of labor that is possible from more H-1B workers.

Highly-skilled immigrants like H-1B workers primarily increase productivity through boosting innovation, the number of patents, and business startups. It is difficult to measure productivity-enhancing innovations directly, but **patenting rates** are a **decent proxy** as they are associated with higher productivity at the country and sectoral levels.

In the United States since 1976, **citizens of foreign countries** have filed 25 percent to 30 percent **of patents. Immigrants patent at double the rate of native-born Americans because they are more likely to hold science and engineering degrees.** Using a 1940-2000 state panel, **economists Jennifer Hunt and Marjolaine Gauthier-Loiselle** found that a 1 percentage point increase in the population share of immigrant college graduates boosted patents per capita by 9 to 18 percent. Immigrant college graduates were thus responsible for a nationwide per capita increase in patenting by 12 percent to 21 percent at a time when the total number of patents per capita rose by 63 percent. In other words, about a fifth of new patents during that 60-year period was due to the increase in the immigrant college graduate share of the population. That period of time overlaps with **Jones' work** on the role of skilled workers in boosting American productivity.

These findings are also mirrored on the local level since different areas of the United States attract different numbers of skilled immigrants. Economists **Ethan Lewis and Giovanni Peri** find that immigrants boost the productivity of native-born Americans on the local level when their skills differ from those of native-born Americans. Immigrants who work in science, technology, engineering, or mathematics (STEM) occupations are particularly productive in their fields, but they usually don't have the managerial or English-language skills to move up in firm hierarchies – at least initially. **Americans' comparative advantage may be management**. Skilled immigrants allow native-born STEM workers to move into more supervisory, managerial, and interactive occupations that require English-language communication and management skills. Beyond management in firms, the differences in H-1B and native-born American skills is also reflected in mathematical departments inside of American universities where they specialize in different **fields** of **research**, but with likely more displacement of native-born American mathematicians from academic jobs and publications in top journals due to the relatively fixed number of jobs and journal space in that particular academic field.

However, highly skilled immigrants might choose to settle in areas where there is already growing productivity. Thus, they may not be the drivers of local productivity growth and their movement to new areas may be another result of it rather than a cause. **Economists Giovanni Peri, Kevin Shih, and Chad Sparber** use an instrumental variable strategy to overcome this problem. They find that a "1 percentage point increase in the foreign STEM share of a city's total employment increased the wage growth of native college educated labor by about 7–8 percentage points and the wage growth of non-college-educated natives by 3–4 percentage points." Specifically, the inflow of H-1B workers to 219 American cities from 1990 to 2010 explains 30 percent to 50 percent of the aggregate nationwide productivity growth during that time as well as 4 percent to 8 percent of the skills-biased technological change. Again, their findings are not too different from what **Jones found**.

Economists William Kerr and William Lincoln find that firms that employ many H-1B workers file more patents. Specifically, a 10 percent increase in H-1B admissions is associated with 3 percent higher growth in patenting rates for H-1B dependent firms. Their results are driven by more Indian and Chinese workers on the H-1B visa who comprise about **three-fourths of all new initial H-1B visas issued in recent years**. The share of American patents awarded to U.S.-based inventors with Chinese and Indian names equaled 12 percent of the total in 2004, much in excess of their percentage of the population. **Across American states, increases in foreign science Ph.D. density are associated with greater increases in patent counts than the density of domestic science Ph.Ds**.The **quality of patents filed by highly-skilled immigrants is also higher**. The **untimely deaths of immigrant co-inventors** lowers the productivity of their still-living co-inventors by approximately 26 percent. Meanwhile, the death of a U.S.-born inventor lowers the productivity of his remaining co-inventor by about 10 percent.

A **paper** by economists Shair Berstein, Rebecca Diamond, Timothy McQuade, and Beatriz Pousada delved into this topic more thoroughly by linking actual patents with their actual inventors. Their research shows that, over the course of their careers, immigrants file more patents, have more patent citations, and their patents have a higher economic value than those filed by native-born Americans. For example, 16 percent of all U.S.-based inventors from 1976-2012 have been immigrants who came to the United States when they were at least 20 years old. They produced about 23 percent of all patents during that time, which is more than a 40 percent above their relative to their share of the U.S.-based inventor population. Furthermore, about 24 percent of immigrant patents were more frequently cited in future patents, **which is an indicator of their high market value**. **Finally, using stock market reactions to patents**, they found that immigrant inventors generated 25 percent of the aggregate economic value created by patents produced by publicly traded companies. That is an extraordinarily large contribution relative to their size of the population.

Highly-skilled immigrants disproportionately patent because they are more likely to choose STEM careers, they tend to be younger, they choose college majors related to technical and scientific skills, they are more likely to live in "innovation hubs" where there are higher rates of patenting overall, and they are more likely to incorporate foreign technologies into their patents. There might be other reasons as well, such as more drive or ambition, but we can't measure those as easily.**These patenting advantages only hold for immigrants who come to the United States as students, on employment-based green cards, and the H-1B visa**.

H-1B visa holders from China and India account for a significant share of growth in American science and technology employment, but don't crowd out native-born employment in these occupations. Many of the skilled immigrants who contribute most to the U.S. economy do so as green card holders or American citizens, but they frequently got their start here as students and workers on the H-1B visa. Some of the research above combines them all into one mass of foreign skilled workers while some specifically separates H-1B workers. **The American employment-based green card system is designed to move workers there from the H-1B visa system**. Killing the H-1B visa system will, with some years delay, eventually shrink the green card system for skilled workers while decreasing the number of skilled workers in the United States overall or at least diminishing its growth. Thus, halting the H-1B visa system will do enormous harm to the portion of our immigration system most like the merit-based system supported by President Trump in healthier times. For the sake of American innovation, don't close the H-1B visa.

Topics: Immigration

RELATED CONTENT

	(1)	(2)	(3)
Pct. Foreign Born	0.012		
	(0.013)		
Pct. Noncitizen		0.020	
		(0.026)	
Pct. Naturalized			0.022
			(0.023)
Constant	0.051	0.091	0.069
	(0.248)	(0.249)	(0.206)
Observations	15	15	15
R^2	0.106	0.058	0.133

Immigrants Don't Litter More than Native-Born Americans: Evidence from American Cities

Americans Don't Want to #Defund Police, Instead They Agree on Reform

More Evidence That "Ban the Box" Laws Don't Work

The Facts About H-4 Visas for Spouses of H-1B Workers

Hughes Declaration

Exhibit 19

EUREX FACTS

Au Pair Program

2020 Executive Summary Report

July 16, 2020

CIRQ ISO 20252 CERTIFIED RESEARCH STANDARDS

Smart Research Solutions

Contents

Prepared in compliance with ISO 20252 International Quality Standard for Market, Public Opinion and Social Research

Executive Summary of Findings

The Au Pair Program, a category within the U.S. Department of State's Exchange Visitor Program (EVP), has been promoting daily cultural exchange in American homes for more than 30 years. Through the Au Pair program, participants and host families take part in a mutually rewarding, intercultural opportunity. Participants can continue their education at U.S. universities and colleges while experiencing everyday life with an American family. Hosts receive reliable and responsible childcare support from individuals who become part of the family. Each year, au pairs care for over 50,000 children across 50 states and the District of Columbia.

The Alliance for International Exchange commissioned EurekaFacts, an independent firm, to conduct a thorough evaluation of the Au Pair Exchange Visitor Program. EurekaFacts surveyed 10,881 au pair participant alumni and 6,452 host families to determine the impact of the program.

The findings presented in this summary are based on:

- A document review and environmental scan of the U.S. State Department's Exchange Visitor Program (EVP) J-1 Visa Au Pair Program to conduct a multi-method study of au pair alumni and host family participants, addressing themes identified under direction of the Alliance for International Exchange.
- Analysis of surveys, in-depth interviews, and expenditure data on program impact, characteristics of international cultural exchange, relationship building, personal and career development, impact on children or family life, and economic growth.
- Web-based surveys of N=10,881 au pair alumni and N=6,452 host family representatives conducted simultaneously, April 15, 2020 – May 15, 2020. The surveys include host families living in the United States and au pair alumni recruited worldwide who participated in the J-1 Visa Au Pair Program within the last five years, representing a broad demographic cross-section of the host and au pair populations.

The full report on the Au Pair program will be released in August 2020.

The Alliance for International Exchange fact sheet can be found here: https://www.alliance-exchange.org/wp-content/uploads/2020/07/EF_AuPairReport_FactSheet_2020-1.pdf

Au Pair Alumni Experience, Motivations, and Benefits

The vast majority of au pair alumni express satisfaction with their overall experience in the au pair program and would recommend the program to their friends and other potential participants.

- More than eight-in-ten (84%) au pairs say they are satisfied with their overall experience in the program, including 48% who are “extremely satisfied”. Likewise, overwhelming majorities of au pairs say that specific aspects of the program are “good” or “very good”, including; the applications process (95%), program orientation and training (84%), and the ability to build close personal connections to their host families (83%).
- Nine-in-ten au pairs rate their overall experience in the U.S. as “excellent” (60%) or “good” (30%).
- The majority of au pair alumni report positive social experiences with their host families (83%), sponsor organizations (70%), and local program coordinators (68%).
- 87% of au pairs say that they would recommend the program to a friend, including 60% who are “very likely” to endorse the program to others.

Most au pairs have a positive experience in the host family home.

- The majority of au pairs characterize the home setting as “welcoming” (63%), and “comfortable” (55%) and half (51%) say that they are made to feel like one of the family.
- Speaking to the strengths of the au pair recruitment process, and the orientation and training they receive, just one-in-four au pairs (23%) say that they need an “adjustment period” living with a host family.

Au pairs are highly motivated to participate in the J-1 visa program, recognizing "very important" opportunities for cultural exchange, and personal and professional growth.

- Two-thirds or more of au pairs see the program as "very important" opportunities for them to "gain new or improved personal skills" (77%), to experience daily life in a different culture" (73%), to improve their English skills (69%), or to learn and interact with people from a different culture than their own (63%). Majorities see it as "very important" to gain new or improve professional skills (58%) and to learn about American values (52%).

Au pairs make great strides in acquiring English language skills while participating in the program.

- Overall, eight-in-ten (79%) of au pairs say that their understanding of the English language and speaking ability (80%) in the English language improved "a lot" from before entering the program.
- Au pairs at all language skills levels say improved "a lot", and especially among those arriving with basic skills level: 87% improved a lot in understanding, 80% in speaking, 60% in reading, and 48% in writing.

The overwhelming majority of au pairs gain experiences in the program to support their personal career and educational goals. Moreover, nearly all are able to put those skills to work in one or more professional sectors.

- More than eight-in-ten (84%) au pairs say that the program supports their career and educational goals and growth. Similarly, 80% say that the program provided practical work experience, including 38% who benefited a "great deal".
- Almost all (96%) au pairs say that they are applying the skills and experience they acquired through the program to their chosen professions: 68% to the education sector, 50% to childcare, 42% to business, and another 20% to careers in cultural exchange.

The au pair program imparts a wide spectrum of life skills and opportunities for personal development to participants.

- Topping the list of skills, about eight-in-ten au pairs say that they developed greater confidence in communicating with others (83%) and learned to multi-task (79%). About half say that they learned to prioritize objectives or manage their finances (53% each) and half (50%) acquired leadership skills.

Au pairs view the US and Americans very favorably. These affinities grow during their time in the program.

- When entering the program au pairs have widely favorable views of the US (88%) and of Americans (83%). Those views change for the positive when it comes to the American people (66% “more” or “much more” positive), American culture (65%), and the US in general (63%).
- In contrast, a sizeable minority say that their view of the American political system grew more negative (42%) compared with their initial impression.

The majority of au pairs build lasting relationships with host families, fellow au pairs, and American friends

- Au pairs build and maintain connections to a wide variety of people during their program. Most build relationships and maintain them with fellow au pairs (89% establish the relationship and 98% keep them), with host families (85% and 86%), and with American friends (67% and 93%).
- Nearly all au pairs (94%) say that they are likely to return to the US, including 79% who say they are “very likely” to do so.

Au pairs are introduced to a spectrum of American cultural activities and share many cultural activities from their native country with their host family and friends.

- Most au pairs (54%) participate in seven or more cultural activities while participating in the program, including American holidays (91%) and outdoor recreational activities (85%).
- Au pairs see great novelty in the activities shared with them. Many activities are different from their native country, including community celebrations (82%), holidays (72%), travel destinations (71%), and volunteer activities (58%).
- The cultural exchange between au pair and host family is reciprocal. Most Au pairs share food (89%), stories (80%) and cultural gifts (74%) with their host families and their friends.

Host Family Program Experience, Motivations, and Benefits

The vast majority of host families express great satisfaction with their experience hosting in the au pair program.

- More than eight-in-ten (85%) host families say that they are satisfied with their overall experience with the au pair program, including a majority (57%) who are “extremely satisfied”.
- Likewise, 86% of host families say that they are very or somewhat likely to recommend the program to friends or family, including 65% who are “very likely” to do so.
- Specifically, host families are highly satisfied with the au pairs themselves. Nine-in-ten host families report a “good” or “very good” experience establishing personal connections with their au pair and a “good” or ‘very good” experience with the childcare that their au pair provides (91% each).
- Overwhelmingly, the experience of integrating au pairs into the family setting (85%), communicating with au pairs (84%) and changes to their finances for operating the household (68%) are excellent or good according to host families.

Host family participation in the au pair program is most motivated by the opportunity for live-in childcare, the ability to develop a deeper level of trust with their childcare provider and for their family to engage in cultural exchange.

- Two-thirds of host families see the program as a “very important” opportunity for them to have live-in childcare (68%) and to build deeper trust with a childcare provider (67%). Most (78%) say the program is an important opportunity for their family to engage in cultural exchange, including 42% who say this is “very important”.

The vast majority of host families see great benefits of the additional help with childcare as part of the program, while also highly valuing the au pair – family relationship, fostering a life-time friendship and mentoring their au pairs

- Nine-in-ten (90%) of host families feel that they benefit from the additional help in caring for their children.
- Three-quarters or more see benefit in establishing a relationship with the au pair (82%) and in building a life-long relationship with the au pair.

The cultural exchange of the au pair program is seen as highly beneficial among host families

- Two-thirds recognize the benefit of interacting with individuals from other countries (67%), promoting inter-cultural engagement for their children (65%), developing an appreciation for other cultures (62%) and providing experiences for young people to carry home to their native country (71%).
- About nine-in-ten host families now say that they are able to interact with people from other countries (92%) and about as many say they have developed a better understanding of their au pair's culture (88%).

The au pair program is seen as critical to host families and very difficult to go without.

- If the program were not available, seven-in-ten host families (71%) say that they would be adversely affected, including 55% who say "a great deal".
- Most say it would be difficult to replace the flexibility the program grants their family (77%), the trust and bond build with the au pair as caretaker in their home (66%), and access to cultural exposure and other customs (52%).

Most host families say they would pay more for childcare and would have difficulty locating suitable childcare for their kids without the au pair program.

- Two-thirds say that they would likely not be able to find suitable care for the children (67%) and most would miss out on intercultural relationships (57%).
- 84% of host families say that without the au pair program they would likely spend more money for childcare, including 66% who say this is "extremely likely".

If the au pair program were not available, many host families would face challenges for their career and quality time with family.

- A sizeable minority (38%) of host families say that they may need to change or stop their careers if the au pair program were not available to them.
- Most (71%) would not be able to spend quality time alone with their spouse if the au pair program were not an option for them.

Economic Impact

During their time in the United States, au pairs spend approximately $257 million per year on items such as food, entertainment and travel.

- Individual participants spend approximately $5,336 per year in their local communities.

Earning money is the least important motivator when deciding to participate in the program in comparison to other motivating factors indicated.

- Gaining new or improved personal skills and experiencing daily life in a different culture are top drivers for participation among au pairs.
- 73% of au pairs say that experiencing daily life in a different culture was very important to them in their initial decision to participate in the au pair program.

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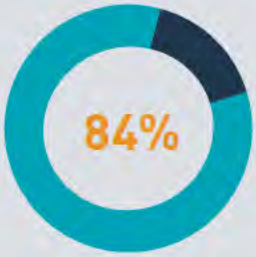
Exhibit 20

EurekaFacts Study: Impact of Camp Counselor Program

The Camp Counselor Program, a category within the U.S. Department of State's Exchange Visitor Program (EVP), offers international participants a way to interact directly with American youth campers by overseeing and leading group activities at camp during the U.S. summer season. The Alliance for International Exchange partnered with EurekaFacts, an independent research firm that specializes in social science and policy research, to conduct a thorough review and evaluation of the Camp Counselor Exchange Visitor Program. EurekaFacts surveyed 2,561 participant alumni and 376 host camps to determine the impact of the program. Highlights of the results are presented below.

Camp Counselor Programs Enhance Positive Opinions of the U.S.



of participant alumni report a more positive opinion about the United States and American culture after their experience at American camps

The total estimated contribution of Camp Counselor exchange visitor participants to the U.S. economy in 2018

Camp Counselor Programs Support U.S. National Security

Camp Counselor Programs are Excellent Public Diplomacy Tools in Fostering Positive Attitudes Towards the U.S.

98% of participants made connections with Americans

91% of participants still keep in touch with Americans after leaving the U.S.

76% of participants have more positive views of American people

71% of participants have more positive views of American culture

Building personal skills and experiencing a different culture are top drivers of participation for Camp Counselors

97% of participants feel that their program will help them in their futures

95% chose to participate to gain new or to improve their personal skills

94% of participants chose to participate to experience living in a different culture

87% of participants cited learning how to interact with people from other cultures as a top driver for participation in the program

** Earning money is the least important motivator when deciding to participate in comparison to other motivating factors indicated*

EurekaFacts Study: Impact of Camp Counselor Program

Camp Counselor Programs Support the U.S. Economy

- International camp counselors contributed over $59 million in total expenditures during their 30-day travel period in 2018
- On average, camp counselor participants spend $2,373 per month. Most money is spent on lodging such as hotels ($12.3 million) and entertainment such as dining out or going to the movies ($11.5 million)
- Camp counselors spend more than $4 million in NY, PA and ME. 12 of the remaining 47 states had camp counselors' expenditures between $1 million and $4 million.

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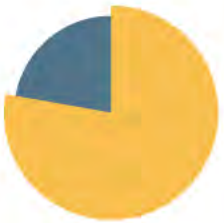
Camp Counselor programs are important for American businesses

99% of host camps offer equivalent chances regarding job opportunities for Americans in the U.S. Roughly the same amount of host camps offer equally available opportunities for training and development to Americans as for international counselors in the U.S.

96% of host camps said that exposing American campers and counselors to international culture is a top motivator for participating in the program

91% of host camps believe their organization would be negatively impacted if the Camp Counselor program ceased to exist

78% of host camps indicated that camp services or activities would be reduced in the absence of international camp counselors



50% of host camps report the absence of the Camp Counselor program would result in the inability to operate during the season and would decrease revenues.

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Exhibit 21

Alliance for International Exchange

EurekaFacts Study: Impact of Intern and Trainee Programs

The Intern and Trainee programs, part of the Department of State Exchange Visitor Program, offer international candidates the opportunity to temporarily live in the United States, participate in professional training with host organizations, and experience American culture and society. The Alliance for International Exchange commissioned an independent research firm, EurekaFacts, to conduct a thorough review of the Intern and Trainee programs.

The total contribution of Intern and Trainee exchange visitors to the U.S. economy in 2017

of participants report a more positive opinion about the American way of doing business and about American companies

Intern and Trainee Programs Support the U.S. Economy

- During their stay, Interns and Trainees contribute an estimated **$662.6 million** to the U.S. economy
- Intern and Trainee participants spend approximately **$2,000** per month in their local communities on items such as housing, food, entertainment, and travel

Intern and Trainee Programs **Support U.S. National Security**

Intern and Trainee Programs are Valuable Public Diplomacy Tools in Fostering Positive Attitudes Towards the U.S.

95%
of participants said they had a good or very good experience in the U.S.

75%
of participants developed a more positive opinion of American people after their experience

73%
of participants state they developed a more positive opinion of the U.S. in general after their program experience

70%
of participants developed a more positive opinion of American culture

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EurekaFacts Study: Impact of Intern and Trainee Programs

Building professional skills and learning about U.S. culture are top drivers of participation for Interns and Trainees

79% choose to participate in the program to learn about U.S. culture, and **85%** participate to gain job related experience. In contrast, earning money is the least important reason Interns and Trainees participate.

The benefits to future career aspirations outweigh any cost associated with participating in the program. **95%** feel their program provided them with practical skills and expertise, and **96%** agree that their program experience will help them in the future.

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Intern and Trainee programs add value to American businesses

85% of host organizations consider the programs important to their business

75% of host organizations stated that participants broaden perspectives of current staff through exposure to different cultures

71% of host organizations state that the program helps current staff develop intercultural communication skills

71% of host organizations offer equivalent intern or trainee program opportunities for Americans in the U.S. and reported that these positions are equally or more available to Americans than international participants

70% of host organizations participate to bring a unique cultural dimension to the workplace

60% of host organizations cite that Interns and Trainees bring a unique work ethic that positively contributes to the organization

60% of host organizations would experience a negative impact if the Intern and Trainee programs were no longer available

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Exhibit 22

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EurekaFacts Study: Impact of SWT Program

The Summer Work Travel (SWT) Program

is the largest U.S. Department of State regulated student exchange program. Every year, more than 94,983 university students from over 100 countries come to the United States to learn about American culture through temporary work and travel opportunities. Participants live, work, and travel in the U.S. (many in tourist areas) for a maximum of four months during their home university summer breaks. EurekaFacts surveyed 2,800 SWT alumni and 460 U.S. businesses participating in the program to determine the impact on local communities. Highlights of the results are presented below.

The total estimated contribution of SWT exchange visitor participants to the U.S economy in 2016 was about $509MM. That roughly equals $5300 per participant.

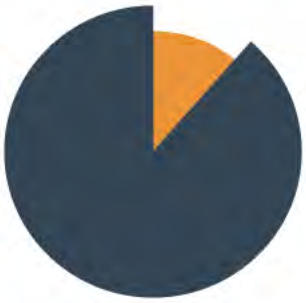
SWT Supports Future Partners for U.S. Businesses

of participants report higher regard for American companies.

of participants have higher opinion of the way Americans do business.

SWT Supports U.S. National Security

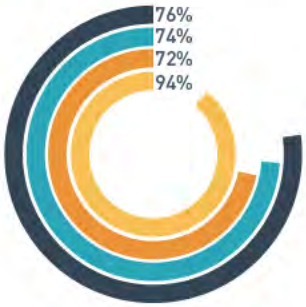
SWT Participants Specifically Choose to Learn About And Experience Life in The U.S.



91% of SWT participants report cultural exchange as their top reason for participating in the program. In contrast, very few participants said that learning specific work skills, gaining experience for a degree program, or earning money were their top reasons for participation.

It is in the United States' national security interests to facilitate opportunities for Americans to connect with people from all over the world, specifically with students from countries critical to U.S. foreign policy.

The SWT Program is an Excellent Public Diplomacy Tool — Fostering Positive Attitudes Toward the U.S.



76% of SWT participants have a higher overall regard for the U.S. after the program.

74% of participants said that their opinions of Americans became more positive.

72% have more positive views of American culture.

94% made friendships with Americans during their stay, and of those, 88% reported that they keep in touch with their new American friends.

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EurekaFacts Study: Impact of SWT Program

SWT Strengthens U.S. Economy

SWT Help U.S. Businesses Meet Seasonal Labor Shortages

- According to published reports, summer work participation among American students has been declining since 1990, a trend due to shifting priorities toward education and other summer activities.
- 96% of employers report seasonal labor shortages. In fact, 51% of employers surveyed said labor shortages were their most important reason for participating in the SWT program.
- SWT students do not displace local workers.
- Predictive models show that the number of SWT placements in a community is related to labor shortages. For instance, the number of SWT placements is higher in areas where there is greater workforce participation, a lower proportion of non-seasonal workforce involved in tourist-related industries, and fewer college students are available for seasonal jobs.

Without SWT, American Businesses Would Suffer Leading to Loss of American Jobs

97% of employers report having more seasonal jobs available than workers to fill them.

50% of employers state that the absence of SWT participants would have a negative impact on their revenues.

25% of employers report that it is likely or very likely that without SWT participation they would not be able to stay open during the summer season.

39% of employers say that it is likely or very likely that they would have to reduce hours of operation.

22% of employers report that it is likely or very likely that they would have to lay off permanent American staff members after the season.

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Exhibit 23

Supporting U.S. national security & foreign policy priorities

Exchange Visitor Program participants take home positive impressions of America -- 9 out of 10 report a more favorable view of the U.S. These university students and young professionals move into a broad range of professions in their home countries where they are likely to be influencers. Their exchange experiences create a foundation for positive relationships and trust with our country, equipping these future leaders with

favorable impressions of America, firsthand experience with American business practices and American families, and improved English skills.

FUTURE LEADERS FROM 200+ COUNTRIES

Participants are university students and young professionals from around the world. They are the future business, political, and civil society leaders of their countries.

9 OUT OF 10 HAVE A BETTER VIEW OF THE U.S.

More than 90% of all Exchange Visitor Program alumni report a more positive view of the U.S. following their programs.

6.5 MILLION+ WORLDWIDE ALUMNI

Since 2000, 6.5 million + students and young professionals from around the world have experienced American culture and values through the Exchange Visitor Program.

1 IN 3 WORLD LEADERS IS AN EXCHANGE PROGRAM ALUM

One in three current world leaders is an alumnus of a Department of State international exchange program.

Helping American small businesses and working families

Exchange Visitor Programs engage American businesses, summer camps, and families as hosts.

The Summer Work Travel Program helps local businesses—many of them small and family-operated, and all in tourist locations—to fulfill short-term, high-volume needs during peak seasons and the shoulder seasons (before Memorial Day and after Labor Day).

The Au Pair Program provides a valuable option for hardworking American families looking for quality, culturally enriching childcare.

The Camp Counselor Program places young people from around the world at American summer camps, providing a culturally enriching and memorable experience for young American campers.

The Intern and Trainee Programs allow American host businesses to train their American workforce to operate in the global economy, as well as to create new business connections in new countries.

$37 BILLION CONTRIBUTED TO THE U.S. ECONOMY

Exchange participants contribute to local American economies, spending their personal funds on living expenses, travel, shopping, and more. Summer Work Travel students contributed $509 million to the U.S. Economy in 2016. International students overall contributed $36.9 billion.

9 OUT OF 10 SAY EXCHANGES INCREASE BUSINESS

More than 90% of Summer Work Travel hosts said exchange participants enhance their businesses. 86% of Intern and Trainee hosts say that staff with more international expertise increases their business.

450,000 AMERICAN JOBS CREATED

Exchange participants supplement and sustain the existing American workforce in seasonal areas. They are placed in tourist destinations with high American employment rates. International students helped create more than 450,000 American jobs in 2016.

50% WOULD LOSE REVENUE

Half of Summer Work Travel hosts said they would lose critical seasonal revenue without international participants.

Facilitating a 360° cultural exchange

By living in the U.S. and interacting with Americans on a daily basis, international students and young professionals learn firsthand about American culture and American citizens Their programs also allow Americans to learn about the participants and their countries and cultures, fostering mutual respect and understanding. The fundamental purpose of all Exchange Visitor Programs is to encourage meaningful interactions between visiting participants and Americans.

Work is an integral part of the cultural experience. International students and professionals learn about American free market business practices and a transparent work culture, interact with American co-workers and customers, improve their English language skills, and in the process earn money to help defray the cost of their travels throughout the U.S. Outside of their work hours, participants further learn about American culture by getting involved in their communities, engaging in volunteer and leadership activities, and traveling and sightseeing. They gain a broader cultural understanding of the U.S., its customs, and its values.

96% SHARE THEIR CULTURE

96% of participants reported sharing their own culture with Americans.

95% MAKE FRIENDS WITH AMERICANS

95% of participants reported making friends with Americans, and 88% reported keeping in touch with American friends after returning home.

9 OUT OF 10 SEEK CULTURAL EXCHANGE

91% of participants reported cultural exchange as their top reason for participating in the Exchange Visitor Program.

Join Americans for Cultural Exchange and Show Your Support for Exchange Visitor Programs.

JOIN US AND SHOW YOUR SUPPORT (/JOIN-US)

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Exhibit 24

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An inquiry on the impact of highly-skilled STEM immigration on the U.S. economy☆

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ABSTRACT

This article estimates the potential economic benefits of STEM immigration and examines the impact of highly skilled STEM immigration on the wage structure in the United States. Considering that foreign-born share of STEM workers has been increasing rapidly in recent years, there are new interests in examining the extent to which labor market outcomes of natives – and immigrants alike – are affected by this supply inflow. The analysis yields a few main findings. First, U.S. and foreign-born STEM workers with similar skills have a high but finite elasticity of substitution (~18), implying that the adverse impact of STEM immigration would be more concentrated among immigrant STEM workers themselves. Second, 2000–2015 foreign STEM labor supply shock increases the average wage of preexisting U.S.-born STEM workers by 4.67%. This finding, however, masks a distributional consequence of the shock as native STEM workers with higher educational attainment experience lower wage gains. Finally, the economic benefit for native workers from 2000–2015 foreign STEM supply shock is approximately 103 billion USD or 1.03% of U.S. GDP in 1999. Almost all of this benefit comes from the productivity spillovers associated with high-skilled STEM immigration that increase the productivity and wages of U.S.-born workers.

1. Introduction

Over the past decades, the United States has experienced a large inflow of highly skilled STEM workers. Between 2000 and 2015, the foreign born share of STEM workers increased from approximately 16% to 24% (Fig. 1). In the face of this trend, there are new interests in exam ining the extent to which labor market outcomes of natives and immi grants alike are affected by this supply inflow. Despite a large number of studies on the effect of overall immigration (e.g., Borjas, 2003; Card, 1990; Ottaviano and Peri, 2012), very little is understood about how high skilled STEM immigration affects the U.S. labor market. In this pa per, I attempt to present new insights to several key issues regarding high skilled STEM immigration in the United States.

Recently, there is an intense debate in the U.S. on whether foreign STEM workers displace or complement U.S. born STEM workers. This is sue was raised by the emergence of cases claiming that U.S. firms were abusing high skilled H 1B visas to bring foreign STEM workers to do the work of native STEM workers for less money.[1] Although it might be hard to ascertain the intention of firms when they hire foreign born STEM workers, it is possible to shed light on this issue by examining the de gree of substitutability between similarly skilled U.S. and foreign born STEM workers. If these workers are imperfect substitutes, then the influx of foreign STEM workers would result in a higher competition among immigrants themselves, mitigating its adverse impact on the wage and employment outcomes of U.S. born STEM workers. I begin my analysis by outlining the theoretical framework to examine this issue. Using the framework, I found that similarly skilled U.S. and foreign born STEM workers are imperfect substitutes with an elasticity of substitution of ap proximately 18. This finding suggests that although displacement may occur, it is relatively hard for U.S. firms to fully replace its native STEM workers with their foreign born counterparts.

I continue the analysis by examining how much the returns to skills within the STEM fields are affected by STEM immigration. When foreign born STEM workers enter the U.S. labor market, they are hetero geneous in terms of their age/experience and educational attainment. Many studies (e.g., Kerr and Lincoln, 2010; Peri et al., 2015), however, have overlooked this heterogeneity in their analysis. To see why this is important, one can see that the changes of foreign STEM workers

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[1] A recent high profile case includes Disney lawsuit in which former workers claimed that the company used H-1B visas to displace American workers. Although this lawsuit was eventually dismissed, the case received national attention and spurred congressional hearing on the impact of high-skilled immigration on U.S. workers.

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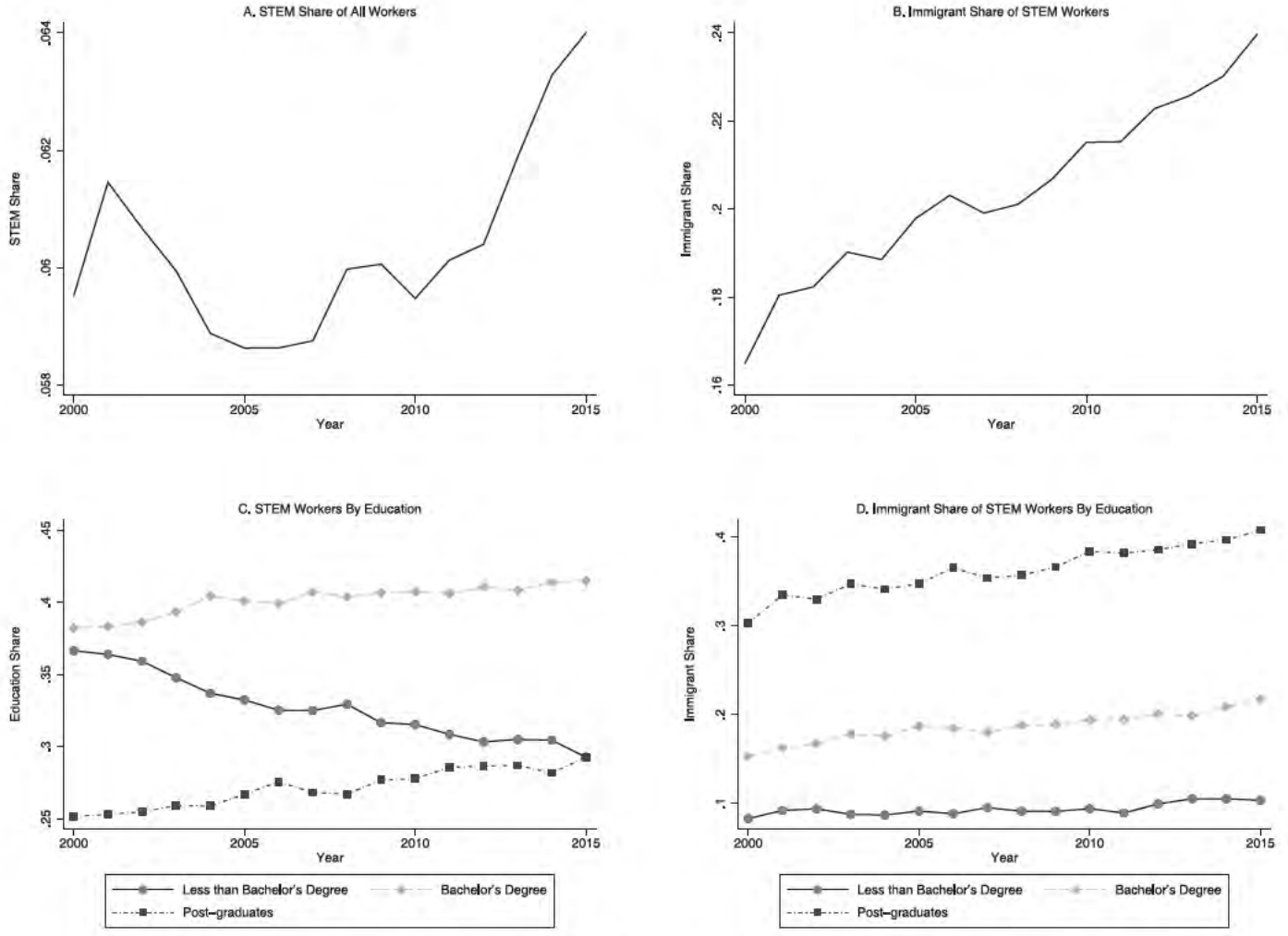

Fig. 1. STEM sector characteristics over time.

across skill groups between 2000 and 2015 had disproportionately increased the supply of relatively older STEM workers with bachelor and post graduate degrees (Table 1).[2] The differences in the magnitude of the supply shift across skill groups within STEM fields implies that if the preexisting workforce in 2000 experiences immigrants' supply shock that is as large as the changes observed from 2000 to 2015, the wage of older STEM workers with higher educational attainment would be more adversely affected relative to the wage of younger STEM workers with lower educational achievement. The results of the analysis suggest that although 2000 2015 foreign STEM labor supply shock increased the wage of preexisting U.S. born STEM workers by 4.67%, native STEM workers with higher educational attainment experienced lower wage gains. I do not find that the wage of older U.S. born STEM workers to be much more adversely affected compared to younger native STEM workers. This is because the degree of substitu tion between young and older workers in the STEM sector is relatively high.

Using the resulting wage effect estimates, it is possible to quantify the economic benefit of 2000 2015 foreign STEM labor supply shock that accrues to U.S. born workers. A simple back of the envelope cost benefit calculation suggests that the economic benefit for native workers is approximately 103 billion USD or 1.03% of U.S. GDP in 1999. It is worth noting that almost all of the benefit can be attributed to produc tivity spillovers generated by the influx of highly skilled STEM work ers. In the absence of this productivity spillovers, the economic benefit accrues for native workers is approximately only 1.64 billion USD or 0.02% of U.S. GDP in 1999. These results imply that the main benefit of STEM immigration comes largely from the generation of ideas asso ciated with high skilled STEM immigration which promotes the devel opment of new technologies that increase the productivity and wages of U.S. born workers. In the absence of these productivity spillovers, the economic impact of STEM immigration on the U.S. economy would likely be relatively small.

This paper contributes to the emerging literature that tries to ex amine the impact of high skilled immigration on U.S. workers. Tradi tionally, the economics literature has focused on immigration in the lower skilled groups (e.g., Borjas, 2017; Card, 1990; Peri and Yasenov, 2018). However, an increasingly larger share of foreign born in the to tal STEM workers pool spurs interests in examining the economic im pact of high skilled immigration. Recent research on the topic has fo cused on finding evidence of positive spillover effects of high skilled im migration (Borjas and Doran, 2012; Hunt and Gauthier Loiselle, 2010; Moser et al., 2014), while only a few studies tried to examine how the

[2] It should be noted that these changes in the supply across skill groups from 2000 to 2015 are caused by both net migration and the aging of immigrants who arrived at a younger age. Therefore, the wage effect estimates presented in this paper is a 'simulated' wage effect to see how much the wage of the pre-existing workforce in 2000 change if they experienced the supply shift in the magnitude observed in Table 1. This way of estimating the wage effect is consistent with previous works such as Borjas (2003), Ottaviano and Peri (2012), and Manacorda et al. (2012).

Table 1
Percentage change in supply across skill groups within STEM sector due to immigrants, 2000–2015.

Education	Age group	% Change in supply due to change in number of immigrants
Less than Bachelor's Degree	28–32	−2.57%
	33–37	−2.29%
	38–42	0.23%
	43–47	1.86%
	48–52	4.48%
	53–57	7.20%
	58–62	7.43%
Bachelor's Degree	28–32	6.78%
	33–37	9.43%
	38–42	12.03%
	43–47	14.79%
	48–52	14.53%
	53–57	20.45%
	58–62	25.31%
Post-graduates	28–32	23.59%
	33–37	20.60%
	38–42	24.99%
	43–47	28.66%
	48–52	25.66%
	53–57	26.28%
	58–62	26.81%

Source: IPUMS 5% 2000 Census and ACS 2001–2015. The table shows the percentage changes in supply across skill groups within STEM fields caused by changes in the number of foreign STEM workers from 2000 to 2015 in each skill groups. The analysis used both men and women of age 28 to 62. STEM occupations are defined using Census 2010 STEM classification.

wages of U.S. born STEM workers are affected by STEM immigration (Kerr and Lincoln, 2010; Peri et al., 2015).[3] A closely related study is the work by Turner (2017) who found that the wages of STEM workers fell by approximately 4 to 12% relative to non STEM because of immigration from 1990 to 2010. The work by Turner (2017), however, did not allow for the imperfect substitutability between similarly skilled U.S. and foreign born STEM workers. Furthermore, Turner (2017) did not take into account that the inflow of immigrant STEM workers has positive productivity effects. This paper complements the findings by Turner (2017) and other related studies in two important ways. First, this paper analyzes the degree of substitutability between similarly skilled U.S. and foreign born STEM workers, which have not been examined previously in the literature to my knowledge. The finding of imperfect substitutability between these two types of workers is important because it implies that the adverse effect of STEM immigration would be largely felt among immigrant STEM workers themselves. Additionally, it also implies that the finding in Kerr and Lincoln (2010) and Peri et al. (2015), who found that the wages and employment of U.S. born workers are not adversely affected by the inflow of H 1B STEM workers, can be partly explained by the imperfect substitutability between U.S. and foreign born STEM workers. Another important contribution of this paper is that it examines how much the relative wages within STEM are affected by STEM immigration. As noted by Kerr and Turner (2015), there is a need to understanding how much the wages within the STEM sector are affected by STEM immigration, especially since the flow of immigrant STEM workers are not uniform across skill groups.

The rest of the paper is constructed as follows. Section 2 describes the theoretical framework. Section 3 describes the data used in the analysis. Sections 4 and 5 present the estimation of the parameters used to simulate the wage effect of STEM immigration. Section 6 documents the results of the analysis. Section 7 concludes.

[3] Another related study is by Kerr et al. (2015) who found that an increase in the skilled H-1B immigrant workers in a firm is associated with a rising employment of skilled workers, especially for young natives.

2. Theoretical framework

In this section, I present a nested CES framework to estimate the impact of STEM immigration on the wage structure. The model is similar to Peri et al. (2015). However, I extend the model directly by considering that STEM workers may provide different inputs into aggregate production function depending on their skill (education age) and place of their birth (foreign or U.S. born).

Suppose that the aggregate output at time t is produced by the contribution of skilled and unskilled workers:[4]

$$Y_t = \left\{ A(S_t)\left[\beta(S_t)H_t^{\rho} + (1-\beta(S_t))L_t^{\rho}\right] \right\}^{\frac{1}{\rho}} \tag{1}$$

where H and L represent skilled and unskilled labor, respectively. $A(S_t)$ represents skill neutral technology parameter, and $\beta(S_t) \in [0, 1]$ is the relative productivity of high skilled labor. It follows that an increase in β represents a technological change that favors skilled workers. The total factor productivity (A) and the relative productivity of high skilled workers (β) are allowed to depend on the number of STEM workers, thereby capturing an important feature that STEM workers are the vital input in the development of new technologies that increase total factor productivity as well as the productivity of skilled workers. The elasticity of substitution between skilled and unskilled labor is represented by $\sigma_H = 1/(1-\rho)$. Following Ottaviano and Peri (2012) and Manacorda et al. (2012), I assume that (1) is a long run production function in which capital is in perfectly elastic supply and therefore can be solved out of the production function. The skilled labor input (H_t) is a combination of labor input of STEM workers of all levels of educational attainment and non STEM college educated workers:

$$H_t = [\gamma_t S_t^{\mu} + (1-\gamma_t)C_t^{\mu}]^{\frac{1}{\mu}} \tag{2}$$

where S and C represent STEM and non STEM college labor input, respectively. $\gamma_t \in [0, 1]$ represents the share of labor employed as STEM workers, while $\sigma_{sc} = 1/(1-\mu)$ represents the elasticity of substitution between the STEM and non STEM college workers. It is plausible for STEM and non STEM college educated workers to be perfect substitutes in this framework. However, STEM workers are different than non STEM college educated workers in their unique capability of generating innovations and ideas that increase workers' productivity.

So far, the framework is analogous to Peri et al. (2015). Extending their model, I considered that the STEM labor input is an aggregate of labor input of STEM workers with different level of educational attainments:

$$S_t = [\sum_e \theta_{set} S_{et}^{\pi}]^{\frac{1}{\pi}} \tag{3}$$

where e denotes education group and $\sigma_{se} = 1/(1-\pi)$ is the elasticity of substitution of STEM workers between different education levels. θ_{set} reflects the relative efficiency of STEM workers with education e, with $\sum_e \theta_{set} = 1$. Similarly as before, the supply of labor in each education group within STEM sector is an aggregate of contribution of STEM workers with different age:

$$S_{et} = [\sum_a \theta_{seat} S_{eat}^{\lambda}]^{\frac{1}{\lambda}} \tag{4}$$

where a denotes age group and $\sigma_{sa} = 1/(1-\lambda)$ is the elasticity of substitution of STEM workers between different age groups. θ_{seat} reflects relative efficiency of STEM workers with age a within education group e, with $\sum_a \theta_{seat} = 1$. I do not assume the relative efficiency term θ_{seat} to be constant over time (i.e., there is no age biased technological progress) because this assumption might be to restrictive, which I will discuss

[4] Unskilled workers are defined as those with at most high school diploma employed in non-STEM occupations.

in greater detail later. Finally, the labor supply of workers in each education age (skill) group within STEM fields is a combination of labor input of native born and immigrant workers:

$$S_{eat} = [\theta^{N}_{seat} N^{\eta}_{seat} + \theta^{I}_{seat} I^{\eta}_{seat}]^{\frac{1}{\eta}} \tag{5}$$

where N and I denote U.S. and foreign born STEM workers, respectively. $\sigma_{sn} = 1/(1-\eta)$ is one of the main parameters of interest as it describes the degree of substitutability between similarly skilled U.S. and foreign born STEM workers. Similarly as before, θ^{N}_{seat} and θ^{I}_{seat} are the relative efficiency of U.S. and foreign born STEM workers with education e and age a. Without loss of generality, I assume $\theta^{N}_{seat} + \theta^{I}_{seat} = 1$. Eq. (5) allows the relative efficiency of foreign born STEM workers to be different along education, age, and time. This can be caused by discrimination, selective migration, or changes in the quality of immigrant stock across cohorts.

In a competitive labor market, the wages for STEM workers with education e and age a are equal to their marginal product (for notational simplicity, I omit the dependence of A and β on the number of STEM workers S):

$$\begin{aligned}\ln W^{i}_{seat} = {} & \frac{1}{\sigma_H}\ln Y_t + \ln A_t + \ln \beta_t + \left(\frac{1}{\sigma_{sc}} - \frac{1}{\sigma_H}\right)\ln H_t + \ln \gamma_t \\ & + \left(\frac{1}{\sigma_{se}} - \frac{1}{\sigma_{sc}}\right)\ln S_t + \ln \theta_{set} + \left(\frac{1}{\sigma_{sa}} - \frac{1}{\sigma_{se}}\right)\ln S_{et} + \ln \theta_{seat} \\ & + \left(\frac{1}{\sigma_{sn}} - \frac{1}{\sigma_{sa}}\right)\ln S_{eat} + \ln \theta^{i}_{seat} - \frac{1}{\sigma_{sn}}\ln i_{seat}\end{aligned} \tag{6}$$

where $i = N, I$ denotes STEM workers' nativity (U.S. or foreign born). Similarly, the wages for non STEM college and low skilled workers are given by:

$$\ln W^{c}_{t} = \frac{1}{\sigma_H}\ln Y_t + \ln A_t + \ln \beta_t + \left(\frac{1}{\sigma_{sc}} - \frac{1}{\sigma_H}\right)\ln H_t + \ln \gamma_t - \frac{1}{\sigma_{sc}}\ln C_t \tag{7}$$

$$\ln W^{L}_{t} = \frac{1}{\sigma_H}\ln Y_t + \ln A_t + \ln(1-\beta_t) - \frac{1}{\sigma_H}\ln L_t \tag{8}$$

Ignoring the time subscript, if I denote changes in the numbers of foreign STEM workers in each education age cell as $d\ln I_{sea}$, then the impact of foreign STEM labor supply inflow on U.S. born STEM worker with education e and age a is given by:[5]

$$\begin{aligned} d\ln W^{N}_{sea} = {} & \frac{1}{\sigma_H} d\ln Y + \psi_A d\ln S + \psi_B d\ln S \\ & + \left(\frac{1}{\sigma_{sc}} - \frac{1}{\sigma_H}\right) d\ln H + \left(\frac{1}{\sigma_{se}} - \frac{1}{\sigma_{sc}}\right) d\ln S \\ & + \left(\frac{1}{\sigma_{sa}} - \frac{1}{\sigma_{se}}\right) d\ln S_e + \left(\frac{1}{\sigma_{sn}} - \frac{1}{\sigma_{sa}}\right) d\ln S_{ea}\end{aligned} \tag{9}$$

where $\psi_A = \frac{\partial \ln A}{\partial \ln S}$ and $\psi_B = \frac{\partial \ln \beta}{\partial \ln S}$ are the spillover (externalities) effects that is, the change in TFP and skill biased technological progress caused by new innovations and ideas that are generated by STEM workers. Similarly, the impact on immigrant STEM worker with education e and age a is

$$\begin{aligned} d\ln W^{I}_{sea} = {} & \frac{1}{\sigma_H} d\ln Y + \psi_A d\ln S + \psi_B d\ln S + \left(\frac{1}{\sigma_{sc}} - \frac{1}{\sigma_H}\right) d\ln H \\ & + \left(\frac{1}{\sigma_{se}} - \frac{1}{\sigma_{sc}}\right) d\ln S + \left(\frac{1}{\sigma_{sa}} - \frac{1}{\sigma_{se}}\right) d\ln S_e \\ & + \left(\frac{1}{\sigma_{sn}} - \frac{1}{\sigma_{sa}}\right) d\ln S_{ea} - \frac{1}{\sigma_{sn}} d\ln I_{sea}\end{aligned} \tag{10}$$

[5] The expressions to calculate each component from Eqs. (9) and (10) are given in the Appendix.

Eq. (9) shows that the direct partial wage effect (i.e., when Y, H, S, and S_e are held constant; this is obtainable by following the aggregate skill cell regression approach based on the work of Borjas (2003) by controlling for year specific effects along with characteristics by year specific effects in a regression framework) of STEM immigration on native STEM workers will depend on the size of σ_{sa} and σ_{sn} parameters.[6] If the complementarity between U.S. born workers and immigrants within closely defined skill groups in STEM fields is high enough to dominate the degree of complementarity between workers of different age ($\frac{1}{\sigma_{sn}} > \frac{1}{\sigma_{sa}}$), then the direct partial wage effect will be positive that is, an influx of STEM immigrants workers into a skill group would increase the wage of U.S. born STEM workers in that skill group.

As noted by Ottaviano and Peri (2012), however, the direct partial wage effect obtained through regression may be uninformative because it does not take into account the pattern of immigration across groups and omits all the cross group effects. If there is some complementarity between older and younger workers with similar education within the STEM sector, and immigration increases the relative supply of young STEM workers, then the wages of older STEM workers are expected to increase through some complementarity of older and young workers in the STEM sector. Furthermore, estimating direct partial wage effect in this case implies that the productivity spillover effects of STEM workers are ignored (i.e., when S is held constant, it follows that the externalities effects ψ_A and ψ_B are omitted).[7] Therefore, to fully capture the total impact of STEM immigration, I use Eqs. (9) and (10) to estimate the total wage effect of STEM immigration that takes into account the pattern of immigration across all groups within STEM fields, the degree of substitution within and across groups, and the potential spillover effects of STEM workers.

For non STEM college and low skilled workers, the effect of STEM immigration is:

$$d\ln W^{c} = \frac{1}{\sigma_H} d\ln Y + \psi_A d\ln S + \psi_B d\ln S + \left(\frac{1}{\sigma_{sc}} - \frac{1}{\sigma_H}\right) d\ln H \tag{11}$$

$$d\ln W^{L} = \frac{1}{\sigma_H} d\ln Y + \psi_A d\ln S - \frac{\beta}{1-\beta}\psi_B d\ln S \tag{12}$$

As shown in Eq. (12), it follows that although unskilled workers gain from an influx of foreign born STEM workers through an increase in TFP and some complementarity with highly skilled workers, STEM immigration may potentially reduce the wages of unskilled workers by inducing technological progress that favors skilled workers.

3. Data

The data used in the analysis were from IPUMS 5% 2000 Census and American Community Survey (ACS) 2001 to 2015 (Ruggles et al., 2015). Following the literature (e.g., Borjas et al., 2008; Katz and Murphy, 1992; Ottaviano and Peri, 2012), I constructed two slightly different samples to produce measures of labor supply and average wage by cell. The wage sample was designed to obtain an accurate price of labor and consisted of full time workers who are not self employed or currently in school.[8] As a measure of wages, I used real weekly earnings obtained by dividing the annual salary and income, INCWAGE, with weeks worked

[6] Since the seminal work by Borjas (2003), there are many studies (e.g. Bonin, 2005; Bratsberg and Raaum, 2012; Bratsberg et al., 2014; Steinhardt, 2011) estimating the direct partial wage effect obtained using aggregate skill cell regression approach.

[7] Alternatively, one can see from Eq. (6) that year fixed effect would capture the effect of foreign STEM inflow on TFP and skill-biased technological progress.

[8] Full-time workers were defined as those working at least 40 weeks in a year and at least 35 h in the usual workweek. IPUMS variable SCHOOL was used to determine if an individual is attending school.

in a year (WKSWORK) and then deflating it using the CPI.[9] Then, to obtain the average weekly wages in a cell, I took the weighted average of real weekly earnings where the weights are the hours worked by an individual times his or her person weight (PERWT).[10]

To construct the labor supply sample, I included all workers (including self employed, in school, or part time workers) because the supply in each cell should reflect the total labor supply provided by all foreign and U.S. born workers (Borjas et al., 2008). Although I also provide the result when labor hours are used, my preferred measure of labor supply is the number of employed workers. The reason for this is that because the measure of labor hours are usually obtained by multiplying usual hours worked per week with weeks worked in a year, measurement error in either usual hours or weeks worked may cause a non classical measurement error bias resulting from the error in the weighted average of real weekly earnings systematically correlated with the measure of labor hours.[11]

In regression analysis to obtain elasticity parameter estimates that were necessary to estimate the wage effect of STEM immigration, I mainly considered the sample of men of age 28 to 62 who are not living in a group quarter and worked at least one week in the previous year.[12] This is because women's labor supply is more likely to be endogenous to wages relative to men, and the inclusion of women in the sample may have a compositional effect that affects the within group trends in the wages of workers in a way that is hard to assess (Borjas et al., 2008). In simulating the wage effect of STEM immigration, however, I include both men and women in the analysis. Because highly skilled STEM immigration is mainly focused on workers with college degrees, my preferred specification divides STEM workers into three education groups: less than bachelor's degree, bachelor's degree, and post graduates.[13] Similar to Card and Lemieux (2001), I classified STEM workers in each education level into seven five year age groups (28 32, 33 37, 38 42, 43 47, 48 52, 53 57, 58 62). Following Borjas et al. (2012), all regressions in the analysis used mean log wages and appropriate regression weight (i.e., the inverse of the sampling variance of the dependent variable).

There are a few definitions of STEM occupations (e.g., Langdon et al., 2011; Peri et al., 2015). However, I used the broad STEM occupation classification outlined by National Science Foundation as a guideline to determine the STEM classification to be used in the analysis (National Science Board, 2016).[14] As such, my preferred STEM classification is the Census Bureau 2010 STEM occupations code list, which closely follows the NSF definition. As the Census' Standard Occupational Classification (SOC) expanded over time as a result of technological progress (Lin, 2011), I crosswalk the STEM occupation code list 2010 from the Census Bureau to the time consistent IPUMS 2010 occupational classification codes. I also used Peri et al. (2015) top 4% skill based STEM classification as a robustness check in the regression analyses to obtain elasticity parameters. It should be noted that the Census STEM definition is preferable because Peri et al. (2015) STEM classification is based on IPUMS 1990 occupational classification codes and therefore may exclude new occupation titles that became common after the beginning of the digital era.[15] Unless otherwise specified, the analysis used Census 2010 STEM occupations classification. The list of STEM occupations is provided in Table B.1 in the Appendix.

4. Estimation

To estimate the wage effect of STEM immigration as implied by Eqs. (9) (12), I need to find estimates of all the own and cross group elasticity of substitution parameters along with estimates of the externalities elasticity associated with highly skilled STEM workers. I use estimates obtained by Peri et al. (2015) for externalities elasticity, which are approximately 0.22 and 0.10 for ψ_A and ψ_B, respectively. The estimate of ψ_A is close to the Bound et al. (2017) estimate of the increase in TFP in the IT sector that is contributed to the number of computer scientists in the sector (0.233). As implied by nested CES framework above, I need an estimate of S_{eat} to estimate σ_{sa}. Moreover, to estimate CES weighted labor aggregate S_{eat}, I need estimates of θ^N_{seat} and θ^I_{seat} along with σ_{sn} as implied by Eq. (5). Similarly, to estimate σ_{se}, σ_{sc}, and σ_H, I need estimates of S_{et} and S_t along with H_t. It should be noted, however, that it is possible to bypass the calculation of the CES weighted labor aggregate S_{eat}, S_{et}, S_t, and H_t by using the actual number of workers in each group because they are highly correlated with each other and the distinction does not substantially affect the results (Borjas, 2003; Ottaviano and Peri, 2012). In the steps below, I proceed iteratively and present the results obtained using the actual number of workers and CES weighted labor aggregate.

4.1. Estimating σ_{sn}, θ^N_{seat}, and θ^I_{seat}

To estimate σ_{sn}, θ^N_{seat}, and θ^I_{seat}, I can derive the wage differential between U.S. born workers and immigrants in each skill group within STEM sector using Eq. (6):

$$\ln \frac{W^I_{seat}}{W^N_{seat}} = \ln \frac{\theta^I_{seat}}{\theta^N_{seat}} - \frac{1}{\sigma_{sn}} \ln \frac{I_{seat}}{N_{seat}} \tag{13}$$

Eq. (13) implies that the relative wages of U.S. born workers and immigrants in each skill group within the STEM sector are inversely related to their relative supply. If immigrants and native workers are perfect substitutes ($\frac{1}{\sigma_{sn}} = 0$), then changes in the relative employment of natives and immigrants will have no effect on their relative wages.

Similar to Borjas et al. (2012), I assume the relative efficiency term $\ln \frac{\theta^I_{seat}}{\theta^N_{seat}}$ can be captured by year, education, and age fixed effects along with their interactions:

$$\ln \frac{\theta^I_{seat}}{\theta^N_{seat}} = \delta_t + \delta_{ea} + \delta_{et} + \delta_{at} \tag{14}$$

It follows that I can obtain an estimate of σ_{sn} by estimating the following:

$$\ln \frac{W^I_{seat}}{W^N_{seat}} = \delta_t + \delta_{ea} + \delta_{et} + \delta_{at} - \frac{1}{\sigma_{sn}} \ln \frac{I_{seat}}{N_{seat}} \tag{15}$$

[9] Because weeks worked in a year are only available on a bracketed basis after 2007, I follow Ottaviano and Peri (2012) and Borjas et al. (2012) by imputing weeks worked using the mid-value of the range in a bracket. For example, on a 1–13 weeks bracket, I imputed 6.5 weeks. On a 14–26 weeks bracket, I imputed 20 weeks, and so on.

[10] The hours worked is obtained by multiplying usual hours worked per week (UHRSWORK) with weeks worked.

[11] This problem is similar to the "division bias" case outlined in Borjas (1980).

[12] The age range is chosen to allow the individual to complete his or her education, including post-graduate degree, and to abstract away from retirement age.

[13] Indeed, USCIS requires that highly skilled visa (H-1B) applicants to have at least bachelor's degrees or specialized training/experience that is equivalent to the completion of a U.S. bachelor's degree (USCIS, 2017). An exemption can be made if the applicant holds an unrestricted state license or certification that authorizes the applicant to fully practice the specialty occupation. In the fiscal years 2012 through 2015, approximately only 1% of new H-1B petition was approved for workers without a bachelor's or advanced degree in each year.

[14] NSF classifies "biological, agricultural, and environmental life scientists," "computer and mathematical scientists," "physical scientists," "social scientists," "engineers," "S&E managers," and "S&E technicians and technologists" as STEM occupations. It excludes "health-related" occupations.

[15] For example, the "computer and information systems managers" that are part of STEM in IPUMS 2010 occupation codes are classified as "managers and administrators, n.e.c." in IPUMS 1990 codes, which is not part of STEM occupations in Peri et al. (2015). Peri et al. (2015) also provide other possible ways to classify STEM occupation. However, they often include non-S&E and health-related occupations that are not part of STEM occupations according to NSF.

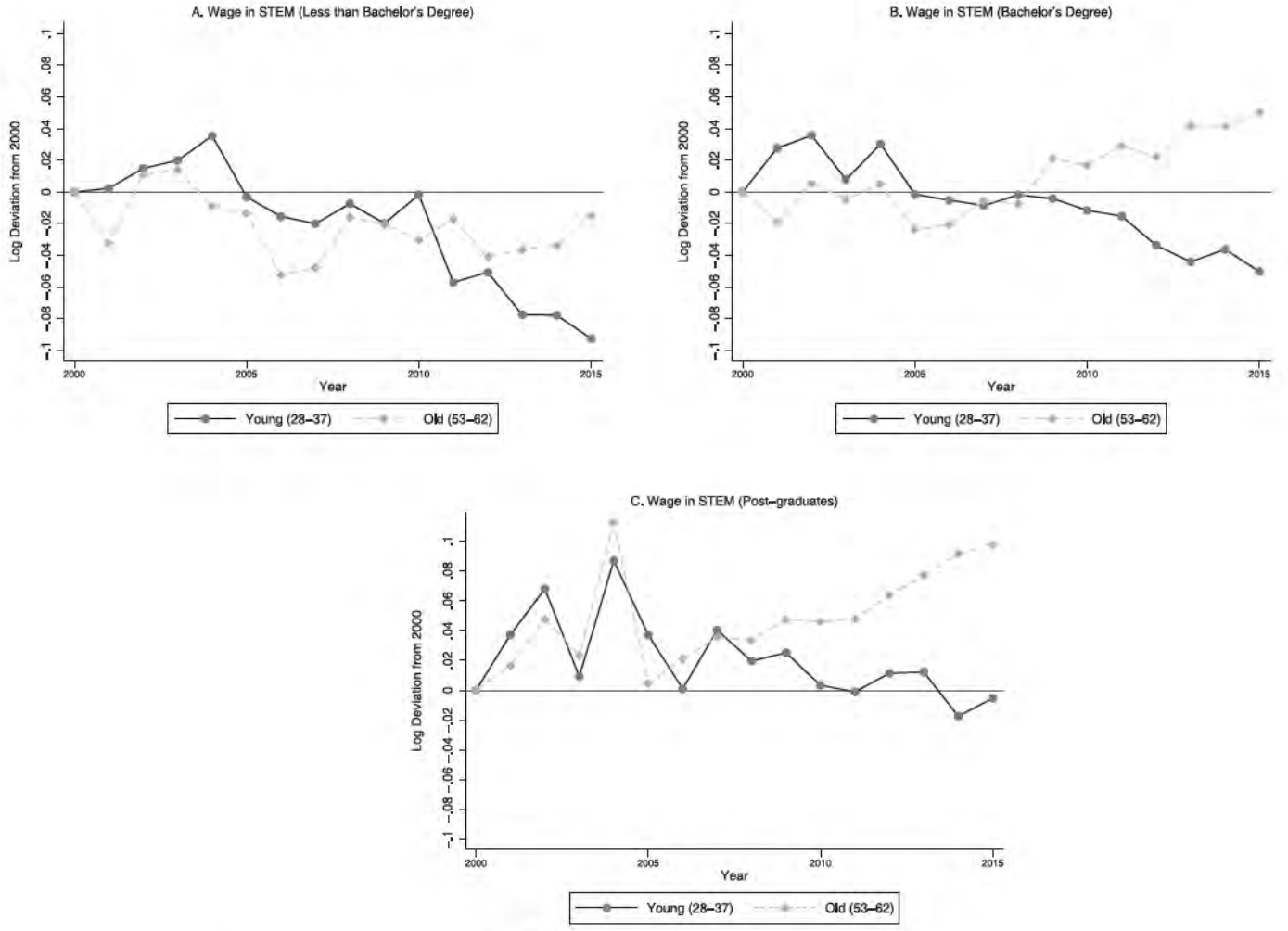

Fig. 2. Old and young wages in STEM.

where the estimates on the year, education, and age fixed effects along with their interactions provide estimates of θ^N_{seat} and θ^I_{seat}. I use these estimates along with an estimate of η to calculate S_{eat}.

4.2. Estimating σ_{sa} and θ_{seat}

Given the estimate of S_{eat}, I can then obtain the estimates of σ_{sa} and θ_{seat}. In a competitive labor market, the wages of STEM workers with education e and age a are given by

$$\ln W_{seat} = \underbrace{\frac{1}{\sigma_H}\ln Y_t + \ln A_t + \ln \beta_t + \left(\frac{1}{\sigma_{sc}} - \frac{1}{\sigma_H}\right)\ln H_t + \ln \gamma_t + \left(\frac{1}{\sigma_{se}} - \frac{1}{\sigma_{sc}}\right)\ln S_t}_{\delta_t} + \underbrace{\ln \theta_{set} + \left(\frac{1}{\sigma_{sa}} - \frac{1}{\sigma_{se}}\right)\ln S_{et}}_{\delta_{et}} + \ln \theta_{seat} - \frac{1}{\sigma_{sa}}\ln S_{eat} \quad (16)$$

Note that the first and second term of the right hand side can be captured by year fixed effects along with its interaction with education fixed effects. I assume that the relative efficiency term $\ln \theta_{seat}$ can be captured by the interaction of education age and year age fixed effects:

$$\ln \theta_{seat} = \delta_{ea} + \delta_{at} \quad (17)$$

It should be noted that studies that try to estimate the wage effect of overall immigration usually does not include year age fixed effects (δ_{at}) by assuming that there is no age biased technological change (e.g., Borjas, 2003; Manacorda et al., 2012; Ottaviano and Peri, 2012). However, a closer look at the data suggests that this assumption might be too restrictive, especially for highly educated STEM workers. Figure 2 show the evolution of wages between older and young STEM workers since 2000.[16] We can see that the trend in wages between the old and the young started to diverge around 2008 for bachelor's and post graduate degree holders. Because older and young workers might be imperfect substitute (e.g., Card and Lemieux, 2001), one may argue that this result may be driven by the decline of relative supply of older workers with a bachelor's or post graduate degree in STEM fields. This argument is partly true because the relative supply of older workers with a post graduate degree did decline around the same time as the divergence of the trend in wages between the old and the young (Fig. 3). However, the relative supply of older workers with a bachelor's degree in STEM fields did not decline, which implies that the relative productivity of older workers needs to increase to explain the divergence in the trend of wages between old and young STEM workers with bachelor's degree. These results imply that I need to take into account the changes over time in relative efficiency across age groups within an educational level in STEM fields, at least for the sample period considered in this study.[17]

[16] "Old" is defined as workers of 53 to 62 years old, while "young" consists of workers of 28 to 37 years old.

[17] This result mirrors the findings of Burtless (2013), who found older workers are more productive compared to younger workers in recent years from CPS data. One may want to include education-age-year fixed effects to fully capture the term $\ln \theta_{seat}$. However, this is not possible because there would be as many fixed effects as there are observations.

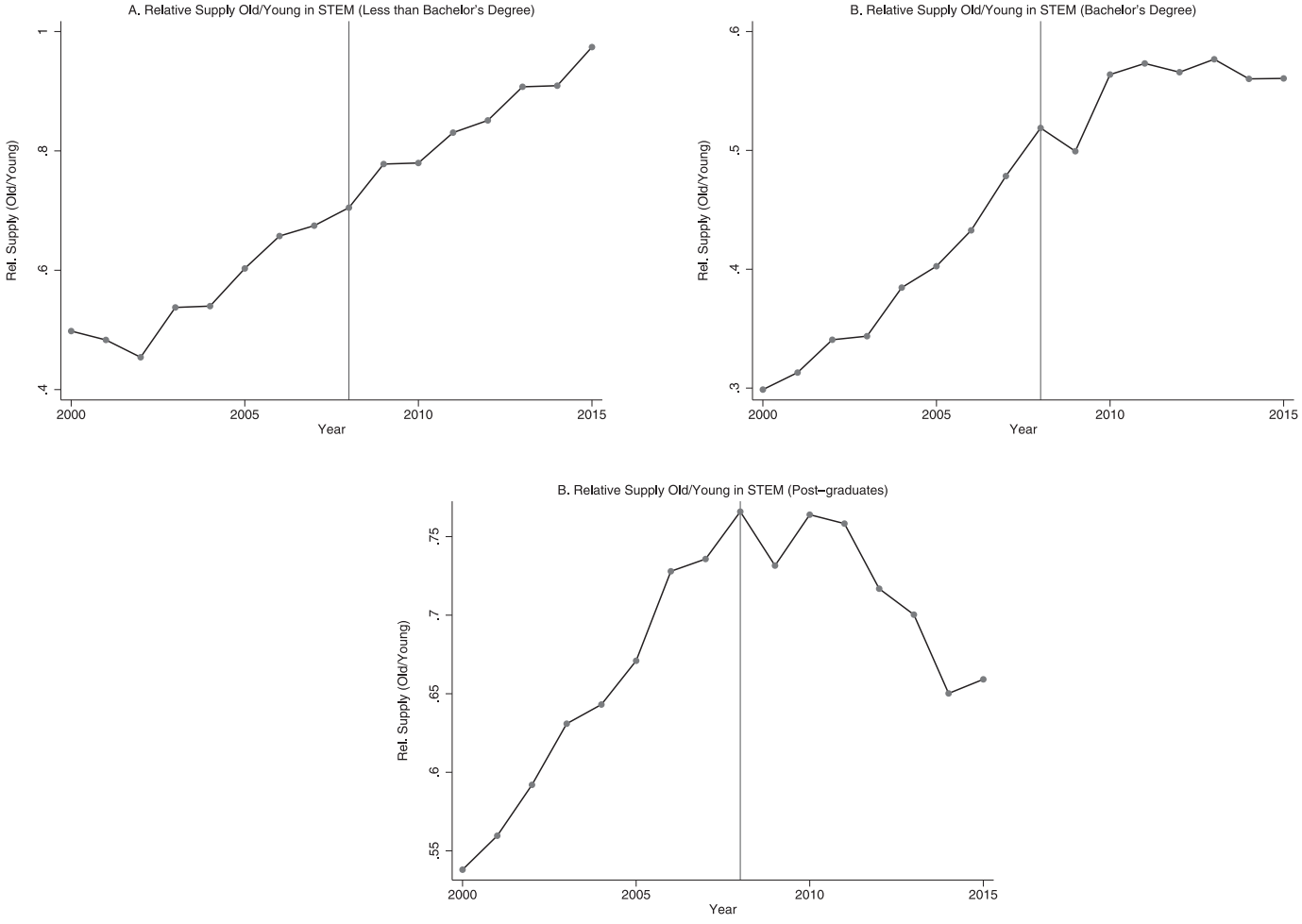

Fig. 3. Relative supply old/young in STEM.

Therefore, to obtain an estimate of σ_{sa}, I estimate the following:

$$\ln W_{seat} = \delta_t + \delta_{et} + \delta_{ea} + \delta_{at} - \frac{1}{\sigma_{sa}} \ln S_{eat} \tag{18}$$

where the coefficients on δ_{ea} and δ_{at} provide an estimate of θ_{seat} which can then be used to estimate S_{et}. As noted by Borjas (2003), however, the OLS regression of Eq. (18) may lead to a biased estimate of σ_{sa} because the supply of workers across different education groups is likely to be endogenous over the period of consideration in this study. Therefore, following previous literature (e.g., Borjas, 2003; Ottaviano and Peri, 2012), I use the number of immigrants in a skill group as an instrument for total labor supply in that particular group. This instrument would be valid under the assumption that the changes in immigrants' labor supply in each skill group is driven by supply shocks such as migration costs after controlling for fixed effects. This assumption, however, may not hold because income maximizing behavior by potential immigrants may generate larger inflows into skill cells that have relatively higher wages (Borjas, 2003). Therefore, it should be noted that the use of im migrants' labor supply as the instrument may still overstate the estimate of σ_{sa}.

4.3. Estimating σ_{se} and θ_{set}

Given the estimate of S_{et}, I can then obtain the estimates of σ_{se} and θ_{set}. In a competitive labor market, the wages of workers with education e in STEM sector are given by

$$\ln W_{set} = \underbrace{\frac{1}{\sigma_H} \ln Y_t + \ln A_t + \ln \beta_t + \left(\frac{1}{\sigma_{sc}} - \frac{1}{\sigma_H}\right) \ln H_t + \ln \gamma_t + \left(\frac{1}{\sigma_{se}} - \frac{1}{\sigma_{sc}}\right) \ln S_t}_{\delta_t} + \ln \theta_{set} - \frac{1}{\sigma_{se}} \ln S_{et} \tag{19}$$

Similarly as before, the first term of the right hand side can be captured by year fixed effects. Note that I cannot use year education fixed effects to capture the relative efficiency term $\ln \theta_{set}$ because I would not have an adequate degree of freedom to identify σ_{se}. Following Borjas (2003), I assume that $\ln \theta_{set}$ can be approximated by education fixed effects along with its interaction with linear time trend. Therefore, to obtain an esti mate of σ_{se}, I estimate the following:

$$\ln W_{set} = \delta_t + \delta_e + lineartrend \times \delta_e - \frac{1}{\sigma_{se}} \ln S_{et} \tag{20}$$

where the estimates on δ_e and its interaction with linear time trend pro vide an estimate of θ_{set}. Similarly as before, I use immigrants' labor sup ply as an instrument in the estimation. After obtaining all the estimates, I can then compute an estimate of S_t.

4.4. Estimating σ_{sc} and γ_t

To obtain an estimate of σ_{sc}, I can use wage differential between STEM and non STEM college workers:

$$\ln \frac{W_{st}}{W_{ct}} = \ln \frac{\gamma_t}{(1-\gamma_t)} - \frac{1}{\sigma_{sc}} \ln \frac{S_t}{C_t} \tag{21}$$

where I assume that the relative efficiency term $\ln \frac{\gamma_t}{(1-\gamma_t)}$ can be captured by linear time trend. It follows that I can obtain an estimate of σ_{sc} by estimating the following:

$$\ln \frac{W_{st}}{W_{ct}} = lineartrend - \frac{1}{\sigma_{sc}} \ln \frac{S_t}{C_t} \quad (22)$$

where the linear trend provides an estimate of γ_t. I can then calculate an estimate of H_t using estimates of γ_t and S_t along with the actual number of non STEM college workers at time t (C_t).

4.5. Estimating σ_H

Finally, I can obtain the last elasticity of substitution parameter (σ_H) by using the wage differential between skilled and unskilled workers:

$$\ln \frac{W_t^H}{W_t^L} = \ln \frac{\beta_t}{(1-\beta_t)} - \frac{1}{\sigma_H} \ln \frac{H_t}{L_t} \quad (23)$$

where following Katz and Murphy (1992), I assume the term $\ln \frac{\beta_t}{(1-\beta_t)}$ can be approximated by linear time trend.

5. Estimates of elasticity of substitution

5.1. Estimate of σ_{sn}

Table 2 provides an estimate of the elasticity of substitution between similarly skilled U.S. and foreign born STEM workers. The "Census" column use Census 2010 STEM classification while "Skill Based" use Peri et al. (2015) top 4% skill based STEM classification for the analysis. The baseline estimates show that similarly skilled U.S. and foreign born workers within the STEM sector are imperfect substitutes with an elasticity of substitution of approximately 13. Rows 2 to 5 of Table 2 use the alternative specifications to estimate $\frac{1}{\sigma_{sn}}$. In row 2, I use labor hours instead of employment as a measure of labor supply. In row 3, I include women in the sample. In row 4, I split the "less than bachelor's degree" group into "some college" and "at most high school graduates." In row 5, I further split the "at most high school graduates" group into "high school dropout" and "high school graduates." The results of imperfect substitution between similarly skilled U.S. and foreign born STEM workers hold under these alternative specifications, with a value of $\frac{1}{\sigma_{sn}}$ ranging from −0.056 to −0.086.[18] I took the most conservative value ($\sigma_{sn} = 18$) to estimate the wage effect of STEM immigration. This finding implies that the impact of STEM immigration would be concentrated among immigrant STEM workers themselves, while its effect on U.S. born STEM workers would be mitigated.

Table 2
Inverse of elasticity of substitution between U.S and foreign stem workers within skill group ($1/\sigma_{sn}$).

	STEM		
	Census	Skill-based	Observations
Baseline	−0.075	−0.072	336
	(0.035)	(0.038)	
	[13.40]	[13.98]	
Hours as Supply	−0.070	−0.066	336
	(0.033)	(0.035)	
	[14.21]	[15.14]	
Pooled (Men and Women)	−0.070	−0.068	336
	(0.027)	(0.029)	
	[14.32]	[14.67]	
Four Education Groups	−0.056	−0.080	448
	(0.029)	(0.026)	
	[17.94]	[12.58]	
Five Education Groups	−0.066	−0.086	560
	(0.027)	(0.024)	
	[15.21]	[11.67]	

Source: IPUMS 5% 2000 Census and ACS 2001–2015. Heteroskedastic- and cluster-robust standard errors at education-age groups in parentheses; Implied elasticity of substitution reported in square brackets. 'Census' column shows the result using Census 2010 STEM classification. 'Skill-Based' shows the result using Peri et al. (2015) top 4% skill-based STEM classification. All regressions are weighted by the inverse of the sampling variance of the dependent variable.

Table 3
Occupation segregation of U.S. and foreign-born workers in STEM sector in year 2000.

Age Group	*Less than Bachelor's Degree*	*Bachelor's Degree*	*Postgraduates*
28–32	0.12	0.20	0.29
33–37	0.10	0.15	0.27
38–42	0.12	0.12	0.25
42–47	0.13	0.16	0.24
48–52	0.14	0.16	0.27
52–57	0.13	0.19	0.26
58–62	0.17	0.20	0.29

Source: IPUMS 5% 2000 Census. The analysis used both men and women of age 28 to 62. STEM occupations are defined using Census 2010 STEM classification.

There are a few reasons why similarly skilled U.S. and foreign born STEM workers can be an imperfect substitute. For example, Chiswick (1978) found that the return to education and experience obtained abroad is lower compared to those obtained in the U.S., implying that U.S. employers may treat foreign education and experience as not equal to those acquired in the United States.[19] Peri and Sparber (2009) argued that immigrants might specialize in occupations that require less interactive and communication skills to maximize their wages. In a follow up study, Peri and Sparber (2011) found that immigrants with graduate degrees specialize in occupations that require more quantitative and analytical skills, while their U.S. born counterparts specialize in occupations requiring communication and interactive skills. Further suggesting specialization within STEM, a recent report by Ortega and Sparber (2016) found that among STEM graduates, immigrants are more likely to acquire a degree in engineering, computer science, mathematics or physics, while natives are more likely to pursue biological science and psychology.

To test whether specialization also occurs within the STEM sector, I calculate Duncan Dissimilarity Index to estimate occupation segregation between the U.S. and foreign born workers in STEM sector (Table 3).

[18] As an additional analysis, I check whether the estimates are robust to a stricter Census STEM classification that excludes STEM technician occupations which may not be closely related to innovation and technological progress usually associated with STEM workers. The results of the analysis are similar and reported on Appendix Table B.2. The excluded occupations are "Agricultural and Food Science Technicians", "Biological Technicians", "Chemical Technicians", "Geological and Petroleum Technicians, Nuclear Technicians", "Life, Physical, and Social Science Technicians, nec", "Engineering Technicians, Except Drafters", and "Surveying and Mapping Technicians". Considering that the typical H-1B immigrants are more likely to be young, I also check whether this result holds if I limit the sample only to those of age 28 to 32 years old. The result does hold and reported on Appendix Table B.3.

[19] Dustmann et al. (2013) argue that because immigrants may experience "downgrading" of skills upon arrival, pre-allocating immigrants based on their observable characteristics may not be appropriate because immigrants might be competing with U.S.-born workers at the other parts of skill distribution, which is different from the one assigned to them based on observable characteristics. They propose, therefore, to investigate the impact of immigration on a specific portion of native wage distribution because the estimate would not be affected by downgrading. However, as noted by Ottaviano and Peri (2012), their approach assumes the same wage effect of immigration in any other group on natives – that is, they consider only the wage effect of overall inflow of immigrants, even though the wage effect may also depend on the distribution of immigrants across skill groups as implied by nested CES framework. Furthermore, to obtain enough observations for their estimates, Dustmann et al. (2013) consider UK provinces as different labor markets, and therefore, they may not address the problems outlined by Borjas (2003, 2014).

The index does suggest that there is specialization, especially for workers with a post graduate degree, by which approximately 24 to 29% of U.S. or foreign born STEM workers would have to move to other STEM jobs to equalize occupational distribution in this education group. A more intuitive way to see if there is specialization between U.S and foreign born workers within STEM is by taking a look at the share of immigrants across occupations within STEM. Since immigrants constitute approximately 16% of the workforce within STEM, the share of immigrants across occupations within STEM should be around 16% if there is no task specialization between immigrant and U.S born in STEM. However, this is not the case (Appendix Table B.4). Immigrants are overrepresented in Physical Sciences occupations, while they are underrepresented in Psychology as well as Computer, Engineering and Natural Sciences Manager occupations. Within Engineering, foreign born workers are overrepresented in Computer Hardware Engineers occupations, while they are underrepresented in Sales Engineer occupations, which require higher communication and interactive skills.

To further examine the task specialization within the STEM sector, I obtain the required mathematics and speaking skill level for each occupation from the U.S. Department of Labor O*Net survey. Then, I crosswalk the O*Net 2010 SOC code with Census 2010 SOC code from IPUMS, which is used in ACS 2010 2015. After merging it with the individual level data in ACS 2010 2015, it follows that each individual in the sample have mathematics and speaking skill values associated with his/her occupation.[20] In Appendix Table B.5, I report the descriptive statistics for both immigrants and U.S. natives on the average mathematics and speaking skill level associated with their occupations. The results suggest that immigrants are more likely to be employed in occupations requiring higher mathematics skill in the STEM sector, in line with Peri and Sparber (2011) who found that immigrants with graduate degrees specialize in occupations that require more quantitative skills. Comparing the magnitude of the estimates of the differences between immigrants and natives in STEM with those in non STEM sector, it appears that task specialization is more intense in the non STEM sector. Nonetheless, the results still suggest that task specialization between immigrants and U.S. natives occurs within the STEM sector.

There are a few recent works that attempt to estimate the elasticity of substitution of similarly skilled U.S and foreign born without differentiating between STEM and non STEM workers. The seminal work by Ottaviano and Peri (2012) found the elasticity estimates of around 20, although this result has been disputed by Borjas et al. (2012). The work by Manacorda et al. (2012) found the elasticity estimates between 5 to 10 in Britain. My analysis shows that the estimates range from 12 to 18 within STEM, which suggests slightly more complementarity compared to Ottaviano and Peri (2012). A potential explanation for this is that the elasticity of substitution estimates are obtained based on the sample of recent immigrants who are likely to be different from natives, similar to Manacorda et al. (2012).

5.2. Other elasticity parameter estimates

Table 4 provides estimates of the elasticity of substitution between workers of different ages with similar educational levels in the STEM sector. The estimates range from 0.001 to −0.076, depending on the specification used. However, as noted above, the use of hours as labor supply measure may lead to non classical measurement error bias caused by the error in the weighted average of real weekly earnings systematically correlated with the measure of labor hours. Similarly, the use of a pooled (men and women) sample might not be preferable because women's labor supply is more likely to be endogenous to wages, and the inclusion of women in the sample may have a compositional effect that affects the within group trends in the wages of workers in a way that is difficult to assess (Borjas et al., 2008). Therefore, estimates obtained from rows 1 and 2 are preferable to estimates from rows 3 and 4.

As noted by Borjas et al. (2012), it may be necessary to use four or five education groups to examine the wage effect of *overall* immigration because immigration in the United States has mainly increased the size of some specific groups such as high school dropouts and workers with post graduate degrees. However, this paper is examining the impact of highly skilled STEM immigration, whereas the focus of recent policy debates, such as H1 B visas, is on increasing the number of immigrant workers with at least a bachelor's degree. Furthermore, the use of a larger number of education groups in a CES framework comes at a cost. For example, in a five education groups framework, the elasticity of substitution between high school dropouts and high school graduates is restricted to be the same as between high school dropouts and college graduates, even though it is quite likely that the degree of substitutability in the first case is higher than the second one. Therefore, the baseline model with three education groups (less than bachelor's degree, bachelor's degree, and post graduate degree) should be able to capture the impact of STEM immigration, while minimizing the cost associated with cross elasticities restriction. One way to test whether it is appropriate to combine "high school dropouts," "high school graduates," and "some college" into one group is by estimating the degree of substitutability of workers within the "less than bachelor's degree" group. The results of the analysis show that I cannot reject that these workers are perfect substitutes in any of the specifications used (Appendix Table B.6). I interpret the robustness of this result as suggesting that within the highly specialized/skilled STEM sector, "high school dropouts," "high school graduates," and "some college" groups can be reasonably combined into a single "less than bachelor's degree" group, and therefore, the estimates of $\frac{1}{\sigma_{sa}}$ obtained from rows 1 and 2 are preferable to those in rows 4 and 5. I use the value of 13 for σ_{sa}, which approximates the estimates obtained from the first two rows to estimate the wage effect of STEM immigration. My estimate of the elasticity of substitution between age groups within an education group in STEM sector

Table 4
Inverse of elasticity of substitution between age groups within STEM ($1/\sigma_{sa}$).

	STEM		
	Census	Skill-based	Observations
Baseline	−0.075	−0.076	336
	(0.046)	(0.043)	
	[13.40]	[13.12]	
Efficiency Units	−0.075	−0.077	336
	(0.046)	(0.043)	
	[13.30]	[12.94]	
Hours as Supply	−0.058	−0.049	336
	(0.041)	(0.039)	
	[17.19]	[20.35]	
Pooled (Men and Women)	−0.041	−0.059	336
	(0.029)	(0.030)	
	[24.14]	[17.09]	
Four Education Groups	−0.037	−0.017	448
	(0.032)	(0.032)	
	[27.39]	[60.22]	
Five Education Groups	−0.027	0.001	560
	(0.032)	(0.033)	
	[37.48]	[∞]	

Source: IPUMS 5% 2000 Census and ACS 2001–2015. Heteroskedastic- and cluster-robust standard errors at education-age groups in parentheses; Implied elasticity of substitution reported in square brackets. 'Census' column shows the result using Census 2010 STEM classification. 'Skill-Based' shows the result using Peri et al. (2015) top 4% skill-based STEM classification. The method of estimation is 2SLS using the labor supply of immigrant workers as an instrument for total labor supply. All regressions are weighted by the inverse of the sampling variance of the dependent variable.

[20] O*Net scales the skill level required for each occupation on a scale ranging from 0 to 7. Higher value implies higher proficiency of a particular skill required for the occupation.

Table 5
Inverse of elasticity of substitution between education groups within STEM ($1/\sigma_{se}$).

	STEM		
	Census	Skill-based	Observations
Baseline	−0.147	−0.179	48
	(0.072)	(0.047)	
	[6.82]	[5.60]	
Efficiency Units	−0.147	−0.166	48
	(0.069)	(0.042)	
	[6.80]	[6.03]	
Hours as Supply	−0.123	−0.162	48
	(0.064)	(0.041)	
	[8.15]	[6.18]	
Pooled (Men and Women)	−0.080	−0.128	48
	(0.085)	(0.083)	
	[12.47]	[7.79]	
Four Education Groups	−0.071	−0.127	64
	(0.107)	(0.062)	
	[14.03]	[7.86]	
Five Education Groups	−0.055	−0.092	80
	(0.081)	(0.071)	
	[18.23]	[10.89]	

Source: IPUMS 5% 2000 Census and ACS 2001–2015. Heteroskedastic- and cluster-robust standard errors at education groups in parentheses; Implied elasticity of substitution reported in square brackets. 'Census' column shows the result using Census 2010 STEM classification. 'Skill-Based' shows the result using Peri et al. (2015) top 4% skill-based STEM classification. The method of estimation is 2SLS using the number of immigrant workers as an instrument for total the labor supply of immigrant workers as an instrument for total labor supply. All regressions are weighted by the inverse of the sampling variance of the dependent variable.

(∼13) is relatively higher compared to Card and Lemieux (2001) and Ottaviano and Peri (2012), who did not differentiate between the STEM and non STEM workers (∼5). However, this estimate mirrors the finding of Kerr et al. (2015), who found that older workers in STEM occupations are more vulnerable to displacement by young skilled immigrants and estimated the elasticity of substitution across age groups of 14.6 for engineers, 7.4 for scientists, and 27.4 for computer related occupations.

Table 5 provides estimates of the elasticity of substitution between workers of different educational attainments in the STEM sector. Similarly as before, I use the value of 6 for σ_{se}, which approximates the estimates from the baseline model with three education groups, to estimate the total wage effect of STEM immigration. This elasticity of substitution between education groups in the STEM sector is larger compared to the estimates obtained without differentiating between the STEM and non STEM workers. For example, Borjas (2003) estimated that the inverse elasticity of substitution between workers across education groups to be −0.759 (with standard error equal to 0.582), using the elasticity of substitution value equal to 1.3 in estimating the wage effect of overall immigration. Similarly, Borjas and Katz (2007) estimated that the inverse elasticity of substitution between workers across education groups to be −0.412 (with standard error equal to 0.312), using the elasticity of substitution value equal to 2.4 in estimating the wage effect of Mexican immigration. Comparing my estimate of the elasticity of substitution between workers across education groups in STEM sector with the estimates of Borjas (2003) and Borjas and Katz (2007) who did not differentiate between STEM and non STEM workers, the result suggests that the degree of substitution between workers across education groups in the STEM sector is higher than between workers across education groups in the non STEM sector. This could be caused by the tasks performed across education groups within STEM are more similar compared to non STEM.

Table 6 provides estimates for σ_{sc}. Similar to Peri et al. (2015), I cannot reject that STEM and non STEM college workers are perfect substitutes in any of the specifications used. Therefore, I used $\sigma_{sc} = \infty$ to estimate the wage effect of STEM immigration. Finally, Table 7 provides estimates for σ_H. The literature provides some guidance on the value of σ_H.[21] In their influential study, Katz and Murphy (1992) found the estimate of σ_H to be 1.4. Ottaviano and Peri (2012) and Peri et al. (2015) provided estimates ranging from 1.5

Table 6
Inverse of elasticity of substitution between STEM and college non-STEM workers ($1/\sigma_{sc}$).

	Census	Skills based	Observations
Baseline	0.077	0.050	16
	(0.082)	(0.060)	
	[∞]	[∞]	
Efficiency Units	0.109	0.063	16
	(0.114)	(0.074)	
	[∞]	[∞]	
Hours as Supply	0.102	0.073	16
	(0.082)	(0.056)	
	[∞]	[∞]	
Pooled (Men & Women)	0.030	0.014	16
	(0.085)	(0.052)	
	[∞]	[∞]	
Pooled (Hours as Supply)	0.038	0.023	16
	(0.094)	(0.052)	
	[∞]	[∞]	

Source: IPUMS 5% 2000 Census and ACS 2001–2015. Newey-West heteroskedastic- and autocorrelation-consistent standard errors in parentheses; Implied elasticity of substitution reported in square brackets. 'Census' column shows the result using Census 2010 STEM classification. 'Skill-Based' shows the result using Peri et al. (2015) top 4% skill-based STEM classification. The method of estimation is 2SLS using the labor supply of immigrant workers as an instrument for total labor supply. All regressions are weighted by the inverse of the sampling variance of the dependent variable.

Table 7
Inverse of elasticity of substitution between high and low skilled ($1/\sigma_H$).

	Census	Skills based	Observations
Baseline	−0.726	−0.734	16
	(0.238)	(0.242)	
	[1.38]	[1.36]	
Efficiency Units	−0.724	−0.728	16
	(0.237)	(0.237)	
	[1.38]	[1.37]	
Hours as Supply	−0.459	−0.457	16
	(0.098)	(0.096)	
	[2.18]	[2.19]	
Pooled (Men & Women)	−0.680	−0.685	16
	(0.235)	(0.237)	
	[1.47]	[1.46]	
Pooled (Hours as Supply)	−0.381	−0.378	16
	(0.062)	(0.060)	
	[2.63]	[2.64]	

Source: IPUMS 5% 2000 Census and ACS 2001–2015. Newey-West heteroskedastic- and autocorrelation-consistent standard errors in parentheses; Implied elasticity of substitution reported in square brackets. 'Census' column shows the result using Census 2010 STEM classification. 'Skill-Based' shows the result using Peri et al. (2015) top 4% skill-based STEM classification. The method of estimation is 2SLS using the labor supply of immigrant workers as an instrument for total labor supply. All regressions are weighted by the inverse of the sampling variance of the dependent variable.

[21] It should be noted that the division of high- and low-skilled labor to estimate σ_H in this study departs slightly from the literature. I define high-skilled labor as STEM workers of all educational attainment and non-STEM college-educated workers, while the literature usually defines high-skilled labor as workers with a college education.

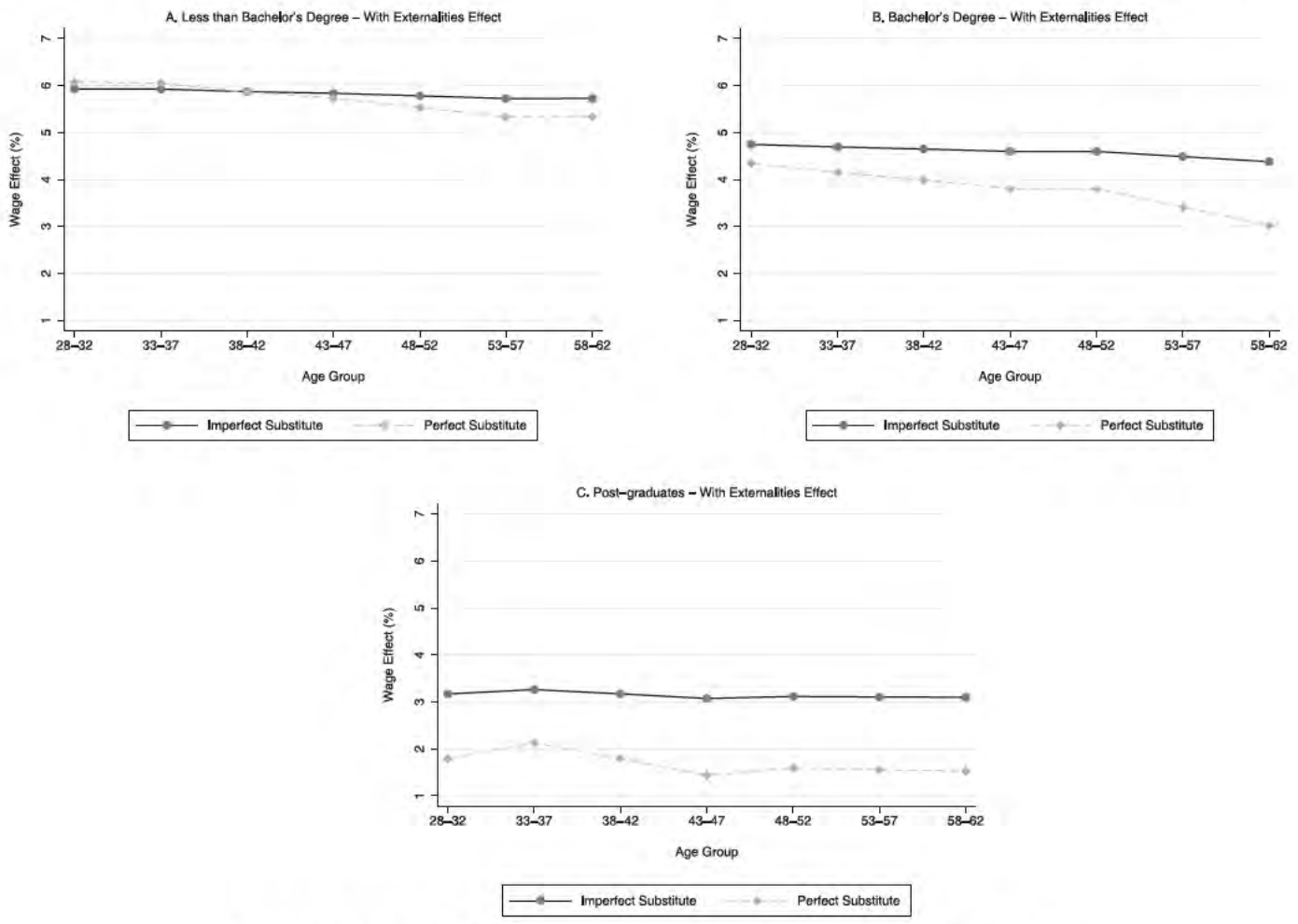

Fig. 4. 2000–2015 Foreign STEM supply shock and native STEM workers' wages with spillover effect.

to 3.1. I used the value of 2, which is the value that is also widely used in the literature.[22]

6. Wage effect

Now, I can use the elasticity parameter estimates obtained in the previous section to calculate the wage effect of 2000–2015 foreign STEM supply shock on the preexisting workforce. In estimating the wage effect, I used the actual changes in the supply of immigrants from 2000 to 2015 in each cell within STEM sector, holding the employment level of non STEM and U.S. born STEM workers constant at their 2000 level. Therefore, it should be noted that the wage effect estimate that is presented in this analysis is the wage effect on the preexisting workforce in 2000 in the case that they experience foreign STEM supply shock in the magnitude that is as large as the changes in supply caused by immigrants from 2000 to 2015 (as observed in Table 1). To see how much of the wage effect and economic benefit of STEM immigration can be attributed to the generation of ideas associated with high skilled STEM workers, I also report the result of the estimation assuming that STEM immigration does not have an effect on the total factor productivity and skill biased technological progress in 'without externalities' column (i.e., ψ_A and ψ_B are set to be equal to zero). Considering that the magnitude of positive externalities of high skilled STEM immigration is still widely debated in the literature (Borjas and Doran, 2012; Doran et al., 2016; Moser et al., 2014), the wage effect of foreign STEM labor supply shock in the absence of spillover effects can provide an approximation of the lower bound of the effect of STEM immigration.

Figs. 4 and 5 show the results of the wage effects across education age groups in STEM sector.[23] The wage gains of U.S. born STEM workers with less than a bachelor's degree is around 5 to 6%, and the gains are relatively similar for both young and older workers. The pattern of the wage gains being relatively similar between young and older workers is also found for workers with a bachelor's and post graduate degree. This finding reflects relatively high substitutability between young and older workers in the STEM sector. Table 8 shows the wage effect estimates across the educational level. As expected, workers with post graduate degree benefited the least (3.14%) because the influx of foreign born STEM workers during this period is more concentrated in this group. Comparing these estimates with the ones without the spillover effects, the results suggest that the positive effect of STEM immigration comes mainly through the generation of ideas that increase the overall productivity of U.S. born STEM workers. In the absence of spillover effects, the impact of 2000–2015 foreign STEM supply shift on the average wage of U.S. born STEM workers is approximately 0.58%, while this number increased by about 4.09% points when the positive externalities associated with an inflow of high skilled STEM workers are taken into account.

[22] It is worth noting that the estimates for σ_{sc} and σ_H are based on a small number of observations (16 obs.). Although it is a cause for concern, these estimates are comparable to those usually found in the literature, as noted in the main text.

[23] "Perfect Substitute" shows the result when similarly skilled U.S. and foreign-born STEM workers are assumed to be perfectly substitutable in production. In this case, the wage effects across skill groups depicted in Figs. 4 and 5 are the same for both U.S. and foreign-born STEM workers.

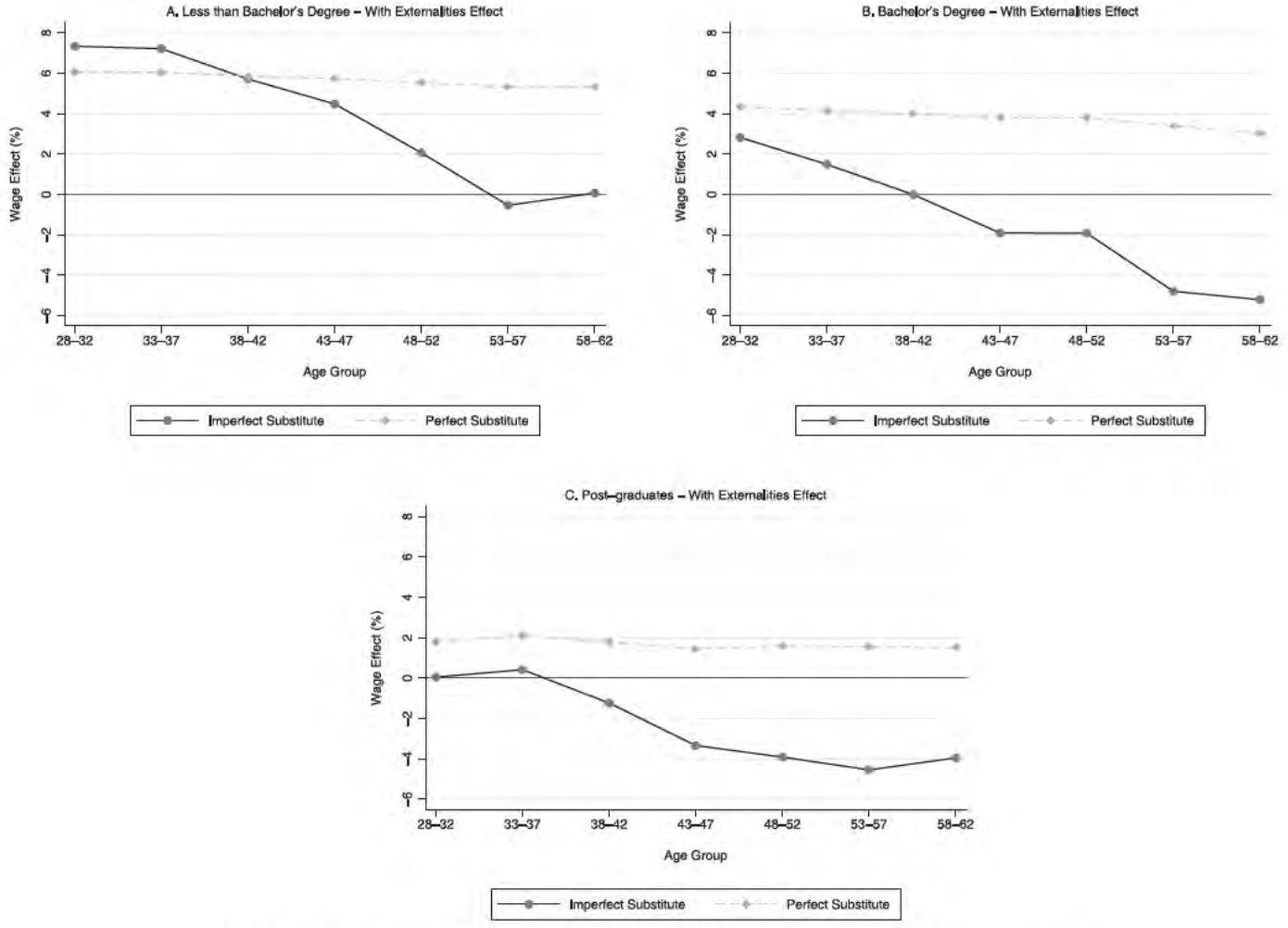

Fig. 5. 2000–2015 Foreign STEM supply shock and immigrant STEM workers' wages with spillover effects.

Table 8
2000–2015 Foreign STEM supply shocks and stem workers' wages.

	U.S.-born		Foreign-born	
	Without Externalities	*With Externalities*	*Without Externalities*	*With Externalities*
Less than Bachelor's Degree	1.75%	5.84%	0.71%	4.80%
Bachelor's Degree	0.54%	4.64%	−3.96%	0.13%
Post-graduates	−0.95%	3.14%	−5.66%	−1.56%
STEM Average	**0.58%**	**4.67%**	**−4.16%**	**−0.07%**

The wage effect is estimated using $\sigma_H = 2$, $\sigma_{sc} = \infty$, $\sigma_{se} = 6$, $\sigma_{sa} = 13$, $\sigma_{sN} = 18$, and actual wage shares in 2000 with pooled (men and women) sample. The wage effect is calculated using the actual change in STEM immigrant supply in each cell from 2000 and 2015 holding the level of employment of non-STEM and U.S.-born STEM workers constant at their 2000 level. 'Without Externalities' column assumes that STEM workers do not have an impact on TFP and Skill-biased tech. progress (i.e., ψ_A and ψ_B are set to be equal to zero).

In the case of earlier immigrant STEM workers, the wage effect of 2000 2015 foreign STEM supply shocks varies widely across age groups (Fig. 5). Older workers were more adversely affected relative to the young, reflecting the increase in the supply that is relatively larger among older workers and the imperfect substitutability between sim ilarly skilled U.S. and foreign STEM workers so that the impact of STEM immigration resulted in more competition among immigrants in that particular skill group. On average, the wage of earlier STEM immi grants declines by −0.07% (Table 8). The average, however, masks a higher adverse impact among foreign born STEM workers with a post graduate degree (−1.56%). If the productivity spillovers associated with high skilled STEM immigration are not taken into account, the loss of earlier STEM immigrants is even larger. On average, the wage of foreign born STEM workers declines by 4.16% if the positive externalities asso ciated with an inflow of high skilled STEM workers are not taken into account.

Although the data rejects the model in which similarly skilled U.S. and foreign born STEM workers are perfect substitutes, it might be inter esting to see how much the results change if they are assumed to be per fectly substitutable in production. In this case, the effect of 2000 2015 foreign STEM labor supply shock increases the average wage of all STEM workers (foreign and U.S born) by approximately 3.85% (Table 9). Sim ilar to before, the positive effect mainly comes from the positive exter nalities associated with an influx of high skilled STEM workers. In the absence of these externalities, the average wage of all STEM workers declines by a relatively small amount (0.24%).

Comparing the wage effects estimates when similarly skilled U.S. and foreign born STEM workers are assumed to be perfect substitutes

Table 9
2000–2015 Foreign STEM supply shocks and STEM workers wages - assuming $\sigma_{sn} = \infty$.

	All STEM workers	
	Without Externalities	*With Externalities*
Less than Bachelor's Degree	1.67%	5.76%
Bachelor's Degree	−0.14%	3.95%
Post-graduates	−2.37%	1.72%
STEM Average	**−0.24%**	**3.85%**

The wage effect is estimated using $\sigma_H = 2$, $\sigma_{sc} = \infty$, $\sigma_{se} = 6$, $\sigma_{sa} = 13$, $\sigma_{sn} = \infty$, and actual wage shares in 2000 with pooled (men and women) sample. The wage effect is calculated using the actual change in STEM immigrant supply in each cell from 2000 and 2015 holding the level of employment of non-STEM and U.S.-born STEM workers constant at their 2000 level. 'Without Externalities' column assumes that STEM workers do not have an impact on TFP and Skill-biased tech. progress (i.e., ψ_A and ψ_B are set to be equal to zero).

Table 10
2000–2015 Foreign STEM supply shock and college non-STEM/low-skilled wages.

	Without Externalities	With Externalities
Low-skilled	0.60%	1.41%
College Non-STEM	−0.24%	3.85%

The wage effect is estimated using $\sigma_H = 2$, $\sigma_{sc} = \infty$, and actual wage shares in 2000 with pooled (men and women) sample. The wage effect is calculated using the actual change in STEM immigrant supply in each cell from 2000 and 2015 holding the level of employment of non-STEM and U.S.-born STEM workers constant at their 2000 level. 'Without Externalities' column assumes that STEM workers do not have an impact on TFP and Skill-biased tech. progress (i.e., ψ_A and ψ_B are set to be equal to zero).

with the main estimates yields a few interesting findings. First, imperfect substitutability between similarly skilled U.S. and foreign born STEM workers does not have a substantial impact on the wage effect estimates for workers with less than a Bachelor's degree (5.84% vs. 5.76%), while it has a considerable influence on the wage effect estimates for workers with post graduate degree (3.14% vs. 1.72%). This result mainly reflects that recent STEM immigration in the United States mostly increased the supply of STEM workers with high educational attainment. Additionally, imperfect substitutability between similarly skilled and U.S. and foreign born STEM workers transfers most of the wage gains that accrue to foreign born STEM workers to U.S. born STEM workers (−0.07% vs. 3.85%).

It may also be interesting to see how much the results change when different values of σ_{sn} and σ_{sa} are used. Since most of σ_{sn} and σ_{sa} estimates lie between 12 18 and 13 40 respectively, I check how the wage effects change when these values are used. The results are reported in Appendix Table B.7. On average, the wage effects of 2000 2015 foreign STEM supply shocks on U.S. born STEM workers are between 4.67% and 5.02%, while for foreign born STEM workers, the wage effects range from −0.07% to −1.71%. If productivity spillovers are not taken into account, the impact of the supply shock on U.S. born STEM workers is between 0.58% and 0.93% on average, while for immigrant STEM workers it is between −4.16% and −5.80%.

For low skilled workers, the wage effect is approximately 1.41% (Table 10). This wage gain reflects the positive effect of high skilled STEM immigration through the increase in TFP that outweighs its adverse effect which comes from inducing technological progress that favors skilled workers. For college non STEM workers, the wage gain is bigger at 3.85%.

Given the wage effect estimates across skill groups, I can now make a simple back of the envelope cost benefit calculation of the economic benefit of foreign STEM labor supply shocks from 2000 to 2015 for U.S. born workers. To estimate the benefit/loss from STEM immigration, I used the annual earnings of workers between age 28 to 62 who worked at least a week and reported positive income. The benefit/loss in each skill group is calculated by multiplying the average earnings in a group with its estimated wage effect and the number of workers in the group. Then, the benefit/loss in each skill group can be summed up to get the overall benefit/loss. The result of this simple cost benefit calculation is reported in Table 11.

Table 11
Net benefit/loss of 2000–2015 Foreign STEM supply shock for U.S.-born workers (in billion USD).

	Without Externalities		With Externalities	
	$\sigma_{sn} = 18$	$\sigma_{sn} = \infty$	$\sigma_{sn} = 18$	$\sigma_{sn} = \infty$
STEM Workers				
Less than Bachelor's Degree	1.70	1.61	5.66	5.58
Bachelor's Degree	0.66	−0.18	5.64	4.79
Post-graduates	−0.67	−1.70	2.23	1.20
Benefit/Loss for Native STEM	*1.69*	*−0.27*	*13.53*	*11.58*
College Non-STEM and Low Skilled				
Natives College Non-STEM	−4.97	−4.97	78.04	78.04
Low-skilled Natives	4.93	4.93	11.62	11.62
Net Benefit/Loss	**1.64**	**−0.31**	**103.19**	**101.24**
As % of GDP in 1999	**0.02%**	**0.00%**	**1.03%**	**1.01%**

The net benefit is estimated by using the annual earnings of all workers (men and women) who reported positive earnings and worked at least a week. The benefit/losses in each skill group is calculated by multiplying the average earnings in a group with its estimated wage effect and the number of workers in the group. The benefit/loss in each skill group can then be summed up to get the overall benefit/loss by education level. 'Without Externalities' column assumes that STEM workers do not have an impact on TFP and Skill-biased tech. progress (i.e., ψ_A and ψ_B are set to be equal to zero).

The results suggest that 2000 2015 foreign STEM labor supply shock increases U.S. born workers' income by approximately 103 billion USD or 1.03% of U.S. GDP in 1999. Almost all of this benefit accrues to the productivity spillovers associated with an influx of highly skilled STEM workers. In the absence of this productivity spillover, the impact of STEM immigration on the U.S. economy can be expected to be relatively small.

To summarize, I estimated that although 2000 2015 foreign STEM supply shock increases U.S. born STEM workers' average wage by 4.67%, native STEM workers with higher educational attainment experience lower wage gain. The economic benefit for U.S. born workers is estimated to be approximately 1.03% of U.S. GDP in 1999, and almost all of this benefit can be attributed to the productivity spillovers associated with the influx of highly skilled STEM workers.

7. Conclusion

The foreign born share of STEM workers in the U.S. has been increasing rapidly in recent years. As such, there are concerns that immigrants are displacing U.S. workers and exacting downward pressure on wages within the STEM sector. In this paper, I attempt to present new insights to several key issues regarding high skilled STEM immigration in the United States.

There are a few main findings in this paper. First, similarly skilled U.S. and foreign born STEM workers have a high but finite elasticity of substitution of approximately 18. This finding implies that the adverse impact of STEM immigration would be concentrated among immigrant STEM workers themselves, while its effect on U.S. born STEM workers would be mitigated. Second, the 2000 2015 foreign STEM labor supply shock increases the average wage of preexisting U.S. born STEM workers by 4.67%. This result, however, masks a distributional consequence of the shock as native STEM workers with higher educational attainment experience lower wage gains. Finally, the economic benefit for native workers is approximately 103 billion USD or 1.03% of U.S. GDP in 1999, in which almost all of the benefit can be attributed to the generation of ideas associated with high skilled STEM immigration which promotes the development of new technologies that increase the productivity and wage of U.S. born workers.

Appendix A

The components of Eq. (9) to (12) can be calculated in the following way:

$$d\ln S_{ea} = \frac{\theta^I_{sea} I^{\eta}_{sea}}{\theta^I_{sea} I^{\eta}_{sea} + \theta^N_{sea} N^{\eta}_{sea}} d\ln I_{sea} = \alpha^I_{sea} d\ln I_{sea}$$

where α^I_{sea} is the share of labor income of foreign born STEM workers in education age cell. Similarly for $d\ln S_e$:

$$d\ln S_e = \sum_a \frac{\theta_{sea} S^{\lambda}_{ea}}{\sum_a \theta_{sea} S^{\lambda}_{ea}} d\ln S_{ea} = \sum_a \alpha_{sea} d\ln S_{ea}$$

where α_{sea} is the share of labor income of STEM workers of age group a within education group e. Now, I can calculate $d\ln S$:

$$d\ln S = \sum_e \frac{\theta_{se} S^{\pi}_e}{\sum_e \theta_{se} S^{\pi}_e} d\ln S_e = \sum_e \alpha_{se} d\ln S_e$$

where α_{se} is the share of labor income of STEM workers with education e. Then, I have

$$d\ln H = \frac{\gamma S^{\mu}}{\gamma S^{\mu} + (1-\gamma) C^{\mu}} d\ln S = \alpha_s d\ln S$$

where α_s is the share of labor income of STEM workers in the high skilled group. Finally, I have

$$d\ln Y = \frac{\beta H^{\rho}}{\beta H^{\rho} + (1-\beta) L^{\rho}} d\ln H = \alpha_H d\ln H$$

where α_H is the share of labor income of high skilled workers. For spillover effects, note that I can approximate ψ_A as follows:

$$\psi_A = \frac{\Delta A}{\Delta S}\frac{S}{A} = \phi_A \frac{S}{E}$$

where $\phi_A = \frac{\Delta A}{\Delta S}\frac{E}{A}$. Similarly for ψ_B:

$$\psi_B = \frac{\Delta \beta}{\Delta S}\frac{S}{\beta} = \phi_B \frac{S}{E}$$

where $\phi_B = \frac{\Delta \beta}{\Delta S}\frac{E}{\beta}$. I obtained estimates of ϕ_A and ϕ_B from Peri et al. (2015), which are 3.61 and 1.64 respectively. As STEM employment share in 2000 based on Census' STEM classification is approximately 6%, I used the value of 0.22 and 0.10 for ψ_A and ψ_B respectively. The estimate of ψ_A is close to the Bound et al. (2017) esti mate of increase in TFP in the IT sector that is contributed to the number of computer scientists in the sector (0.233). To get percentage change in average wages by groups, I follow Ottaviano and Peri (2012) by weighting the percentage changes by wage bill shares.

Appendix B

Table B.1
STEM classifications.

Census 2010 STEM List	Peri et al. (2015) Top 4% Skill-Based STEM List
Actuaries	Actuaries
Aerospace Engineers	Aerospace Engineer
Agricultural and Food Science Technicians	Agricultural and Food Scientists
Agricultural and Food Scientists	Biological Scientists
Architectural and Engineering Managers	Chemical Engineers
Astronomers and Physicists	Chemists
Atmospheric and Space Scientists	Civil Engineers
Biological Scientists	Computer Software Developers
Biological Technicians	Computers Systems Analysts and Computer Scientists
Chemical Engineers	Economist, Market Researchers, and Survey Researchers
Chemical Technicians	Electrical Engineer
Chemists and Materials Scientists	Engineering Technician, n.e.c.
Civil Engineers	Geologists
Computer and Information Systems Managers	Industrial Engineers
Computer Hardware Engineers	Mathematicians and Mathematical Scientists
Computer Programmers	Mechanical Engineers
Computer Scientists and Systems Analysts/Network systems Analysts/Web Developers	Medical Scientists
Computer Support Specialists	Metallurgical and Materials Engineers, variously phrased
Conservation Scientists and Foresters	Not-elsewhere-classified Engineers
Database Administrators	Operations and Systems Researchers and Analysts
Drafters	Optometrists
Economists and market researchers	Petroleum, Mining, and Geological Engineers
Electrical and Electronics Engineers	Physical Scientists, n.e.c.
Engineering Technicians, Except Drafters	Physicists and Astronomers
Engineers, nec	Podiatrists
Environmental Engineers	Programmers of numerically controlled machine tools
Environmental Scientists and Geoscientists	Sales Engineers
Geological and Petroleum Technicians, and Nuclear Technicians	Surveyors, Cartographers, Mapping Scientists and Technicians
Industrial Engineers, including Health and Safety	
Life, Physical, and Social Science Technicians, nec	
Marine Engineers and Naval Architects	
Materials Engineers	
Mathematical science occupations, nec	
Mechanical Engineers	
Medical Scientists, and Life Scientists, All Other	
Natural Science Managers	
Network and Computer Systems Administrators	
Operations Research Analysts	
Petroleum, mining and geological engineers, including mining safety engineers	
Physical Scientists, nec	
Psychologists	
Sales Engineers	
Social Scientists, nec	
Software Developers, Applications and Systems Software	
Surveying and Mapping Technicians	
Surveyors, Cartographers, and Photogrammetrists	
Urban and Regional Planners	

Table B.2
Additional robustness checks stricter census STEM classification (Excluding STEM technician occupations).

	$1/\sigma_{sn}$	$1/\sigma_{sa}$	$1/\sigma_{se}$
Baseline	−0.087	−0.062	−0.202
	(0.037)	(0.049)	(0.074)
	[11.52]	[16.08]	[4.96]
Hours as Supply	−0.076	−0.037	−0.164
	(0.036)	(0.041)	(0.065)
	[13.20]	[26.98]	[6.09]
Pooled (Men and Women)	−0.076	−0.024	−0.114
	(0.029)	(0.034)	(0.074)
	[13.10]	[41.79]	[8.78]
Four Education Groups	−0.059	−0.039	−0.126
	(0.033)	(0.040)	(0.081)
	[16.83]	[25.43]	[7.95]
Five Education Groups	−0.083	−0.009	−0.101
	(0.032)	(0.034)	(0.064)
	[12.07]	[108.65]	[9.88]

Source: IPUMS 5% 2000 Census and ACS 2001–2015. Heteroskedastic- and cluster-robust standard errors at education groups in parentheses; Implied elasticity of substitution reported in square brackets. All regressions are weighted by the inverse of the sampling variance of the dependent variable.

Table B.3
Inverse of elasticity of substitution between U.S. and foreign STEM workers within skill group ($1/\sigma_{sn}$) - youngest age group only.

	STEM		
	Census	Skill-Based	Observations
28–32 Years Age Group Only	−0.156	−0.154	48
	(0.042)	(0.029)	
	[6.42]	[6.50]	

Source: IPUMS 5% 2000 Census and ACS 2001–2015. Heteroskedastic- and cluster-robust standard errors at education groups in parentheses; Implied elasticity of substitution reported in square brackets. 'Census' column shows the result using Census 2010 STEM classification. 'Skill-Based' shows the result using Peri et al. (2015) top 4% skill-based STEM classification. All regressions are weighted by the inverse of the sampling variance of the dependent variable.

Table B.4
Share of immigrants across STEM occupations.

Share of Immigrants in STEM Occupations	0.161
Share of Immigrants in:	
Engineering	0.157
Biological, Agricultural, and Environmental Sciences	0.190
Psychology	0.108
Physical Sciences	0.256
Computer Sciences	0.175
Computer, Engineering, and Natural Sciences Manager	0.118
Other STEM occupations	0.106
Share of Immigrants within Engineering:	
Aerospace Engineers	0.149
Chemical Engineers	0.159
Civil Engineers	0.167
Computer Hardware Engineers	0.266
Electrical and Electronics Engineers	0.186
Environmental Engineers	0.122
Industrial Engineers, including Health and Safety	0.110
Marine Engineers and Naval Architects	0.104
Materials Engineers	0.143
Mechanical Engineers	0.152
Petroleum, mining and geological engineers, including mining safety engineers	0.112
Engineers, nec	0.192
Engineering Technicians, Except Drafters	0.124
Sales Engineers	0.086

Notes: The estimates are obtained from IPUMS 5% 2000 Census.

Table B.5
Occupation skills descriptive statistics.

	Mathematics Skill				*Speaking Skill*			
	Immigrants	*Natives*	*Immigrants-Natives*	*Diff. p-value*	*Immigrants*	*Natives*	*Immigrants-Natives*	*Diff. p-value*
Panel A: STEM								
All	3.570	3.498	0.072	0.000	3.797	3.813	−0.016	0.000
Young (28–37 Yrs. Old)	3.550	3.489	0.061	0.000	3.785	3.811	−0.026	0.000
Old (53–62 Yrs. Old)	3.657	3.537	0.120	0.000	3.818	3.825	−0.007	0.016
Panel B: Non-STEM								
All	2.249	2.511	−0.262	0.000	3.130	3.410	−0.280	0.000
Young (28–37 Yrs. Old)	2.250	2.480	−0.231	0.000	3.108	3.391	−0.283	0.000
Old (53–62 Yrs. Old)	2.248	2.522	−0.274	0.000	3.151	3.416	−0.265	0.000

Notes: Estimates based on ACS 2010–2015 and U.S. Department of Labor O*Net data. The analysis used both men and women of age 28 to 62. STEM occupations are defined using Census 2010 STEM classification.

Table B.6
Estimates of $(1/\sigma_{se})$ for lower education group in STEM.

	STEM		
	Census	Skill-Based	Observations
Baseline	0.074	0.041	48
	(0.050)	(0.059)	
	[∞]	[∞]	
Hours as Supply	0.067	0.023	48
	(0.056)	(0.073)	
	[∞]	[∞]	
Pooled (Men and Women)	0.041	−0.019	48
	(0.059)	(0.054)	
	[∞]	[52.36]	
Pooled (Hours as Supply)	0.050	−0.019	48
	(0.053)	(0.054)	
	[∞]	[53.46]	

Source: IPUMS 5% 2000 Census and ACS 2001–2015. Heteroskedastic- and cluster-robust standard errors at education groups in parentheses; Implied elasticity of substitution reported in square brackets. 'Census' column shows the result using Census 2010 STEM classification. 'Skill-Based' shows the result using Peri et al. (2015) top 4% skill-based STEM classification. The method of estimation is 2SLS using the labor supply of immigrant workers as an instrument for total labor supply. All regressions are weighted by the inverse of the variance of the dependent variable.

Table B.7
Immigrant STEM supply shock and STEM workers wage (2000–2015) - different values of σ_{sa} and σ_{sn}.

	U.S.-born		Foreign-born	
	Without Externalities	*With Externalities*	*Without Externalities*	*With Externalities*
Panel A: $(\sigma_{sa}=13$ ***and*** $\sigma_{sn}=12)$				
Less than Bachelor's Degree	1.79%	5.89%	0.21%	4.30%
Bachelor's Degree	0.89%	4.98%	−5.89%	−1.80%
Post-graduates	−0.22%	3.87%	−7.32%	−3.23%
STEM Average	**0.92%**	**5.01%**	**−5.77%**	**−1.67%**
Panel B: $(\sigma_{sa}=13$ ***and*** $\sigma_{sn}=18)$				
Less than Bachelor's Degree	1.75%	5.84%	0.71%	4.80%
Bachelor's Degree	0.54%	4.64%	−3.96%	0.13%
Post-graduates	−0.95%	3.14%	−5.66%	−1.56%
STEM Average	**0.58%**	**4.67%**	**−4.16%**	**−0.07%**
Panel C: $(\sigma_{sa}=40$ ***and*** $\sigma_{sn}=12)$				
Less than Bachelor's Degree	1.80%	5.89%	0.19%	4.28%
Bachelor's Degree	0.90%	4.99%	−5.93%	−1.84%
Post-graduates	−0.21%	3.88%	−7.36%	−3.26%
STEM Average	**0.93%**	**5.02%**	**−5.80%**	**−1.71%**
Panel C: $(\sigma_{sa}=40$ ***and*** $\sigma_{sn}=18)$				
Less than Bachelor's Degree	1.75%	5.84%	0.68%	4.78%
Bachelor's Degree	0.55%	4.64%	−3.99%	0.10%
Post-graduates	−0.93%	3.16%	−5.69%	−1.60%
STEM Average	**0.59%**	**4.68%**	**−4.20%**	**−0.11%**

The wage effect is estimated using $\sigma_H = 2$, $\sigma_{sc} = \infty$, $\sigma_{se} = 6$, and actual wage shares in 2000 with pooled (men and women) sample. The wage effect is calculated using the actual change in STEM immigrant supply in each cell from 2000 and 2015 holding the level of employment of non-STEM and U.S.-born STEM workers constant at their 2000 level. 'Without Externalities' column assumes that STEM workers do not have an impact on TFP and Skill-biased tech. progress (i.e., ψ_A and ψ_B are set to be equal to zero).

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Hughes Declaration

Exhibit 25

Deloitte. Insights

MANUFACTURING Institute

2018 Deloitte and The Manufacturing Institute skills gap and future of work study

A DELOITTE AND THE MANUFACTURING INSTITUTE SERIES ON THE SKILLS GAP AND FUTURE OF WORK IN MANUFACTURING

ER 0740

The United States is experiencing near-historic low unemployment amid an extended period of economic expansion. The skills shortage that Deloitte and The Manufacturing Institute have been tracking for the past 17 years continues to swell, threatening to impede the current growth in the US manufacturing industry. This fourth skills gap study explores the depths of today's talent shortage in manufacturing, how jobs are changing due to technology and automation, and what measures manufacturers could take to solve today's shortage while preparing their future work-force for success.

Contents

Introduction

THE US ECONOMY is humming along in a period of remarkable expansion, marked by notable contributions from the manufacturing industry. The sector has been consistently contributing to over 10 percent of the national gross domestic product (GDP) and represented more than 8 percent of all US employed population in 2017.[1] The contributions of the manufacturing sector seem to become more apparent when we consider its multiplier effect on the economy and jobs. Every dollar in output from the manufacturing industry generates another US$1.89 of additional value and every direct job creates 2.5 additional jobs in the US economy.[2] It's no surprise then that most manufacturers express strong optimism for the economy and jobs generation in the months to come.[3]

However, while most manufacturers may expect jobs to grow, they must contend with one of the tightest labor markets in recent history, including a situation where the number of open jobs exceeds the number of people looking for work.[4] For manufacturers, filling open jobs has been an ongoing challenge in recent years, but the current conditions are reaching serious levels.

Deloitte and The Manufacturing Institute entered their fourth skills gap study with an interest in reevaluating their prior projections and moving the conversation forward to today's hiring environment and the future of manufacturing work. The results appear to highlight a widening gap between the jobs that need to be filled and the skilled talent pool capable of filling them. Beyond the numbers, the study probes the depths of today's talent shortage in manufacturing. It explores how jobs are changing due to technology and automation, and what measures manufacturers could take to solve today's shortage while preparing their future workforce for success.

METHODOLOGY

Deloitte and The Manufacturing Institute have been tracking the skills shortage for the past 17 years and have come up with their fourth skills gap study. Its primary focus is to engage manufacturing executives, industry leaders, public office, and educational training resources in an active dialogue to understand the expanse of the skills shortages in manufacturing, identify future skills needed, and develop concrete solutions toward filling the gap. The study includes an online survey of more than 400 US manufacturers, interviews with executives from manufacturing organizations, extensive analysis of secondary data, and economic projections from Deloitte's economic team based on our analyses.

Measuring the depths of the current skills shortage

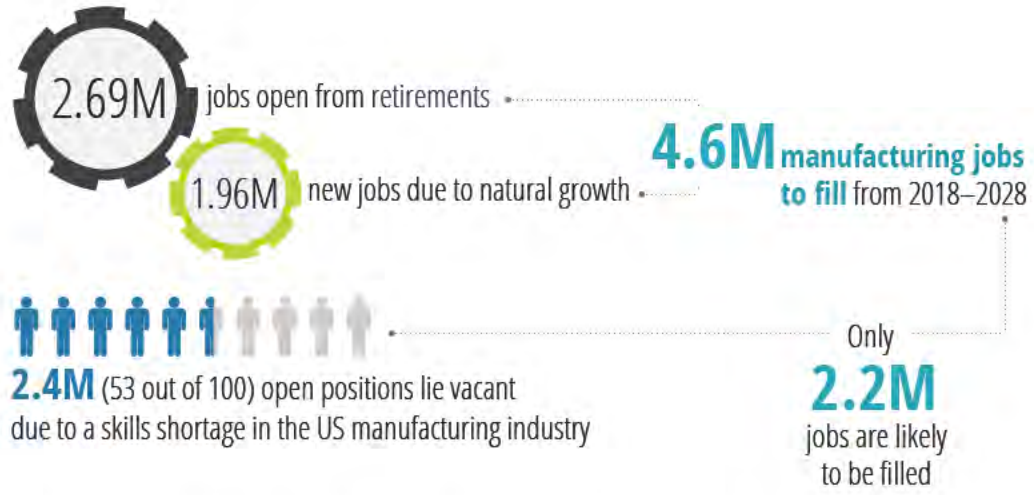
AS RECENTLY AS August 2018, there were 508,000 open jobs in US manufacturing, part of the best annual job sector gain in more than 20 years.[5] While the job gains are positive indications that the industry continues to recover from the Great Recession and reflect strong production levels, it also means that finding talent with the right skills to fill the open jobs could reach crisis proportions. As one manufacturing executive noted, "With the positive turn in the economy, we don't have enough job candidates with the right skills and work ethic to fill our openings, and this is making it difficult for us to accept the orders our vendors are asking us to complete."[6] This talent crunch is hitting most manufacturers where it matters most—the top line. Fifty-one percent of executives cited "maintaining or increasing production levels to satisfy growing customer demand" as the biggest challenge arising from not filling open jobs in the next three years.[7]

The gap continues to widen

Job shortages are not new to manufacturing, especially in recent years. Deloitte and The Manufacturing Institute have captured the widening gap since the United States emerged from the Great Recession, and the current projections indicate

FIGURE 1

The skills gap may leave an estimated 2.4 million positions unfilled between 2018 and 2028



*Calculated on the basis of 52.7% of the skilled manufacturing positions that are unfilled (per the 2018 survey)
**Retirement age of 66

Source: BLS Data, OEM (Oxford Economics Model), Deloitte and Manufacturing Institute skills research initiative.

an increase in the total unfilled jobs in the next 10 years from 2.0 million to 2.4 million (see figure 1). What *is* new to the talent shortage discussion is many manufacturers' expectation that the situation is about to get much worse.

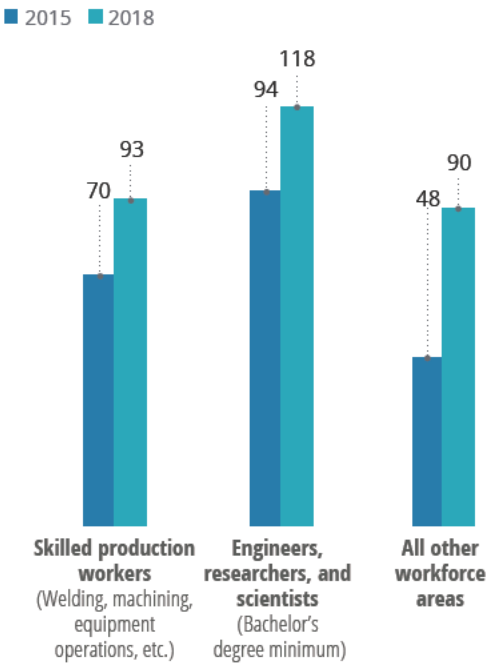
Skilled jobs are becoming more difficult to fill

The study shows many companies expect job categories where they have rated the current shortage "very high"—digital talent, skilled production, operational managers—to triple in difficulty in terms of filling positions in the next three years.[8] In fact, many manufacturers surveyed expect the extent of the skills shortage to increase across all workforce areas in the coming three years. Even at present, many of these jobs are taking longer to fill, stretching out to months of time where a company is missing key workforce to deliver open orders, expand production, or respond to customer needs (see figure 2).

FIGURE 2

The average time to fill an open job position is on the rise

Number of days to fill a job position, by categories, 2015 and 2018



Source: 2018 Deloitte and Manufacturing Institute skills gap study.

Measuring the impact of the skills shortage on future manufacturing economic output

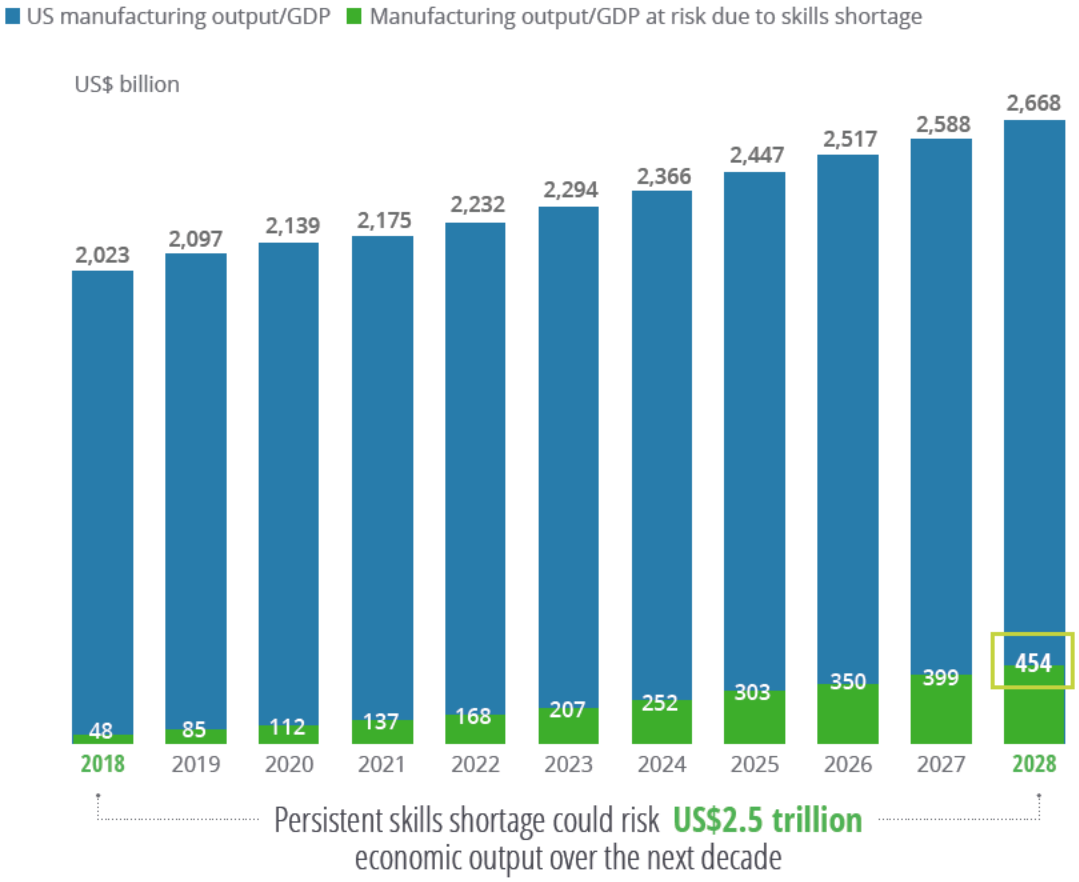
Based on our analysis, Deloitte's economic team created a baseline projection that assumes that by 2028, US manufacturing employment will grow at an average rate of 1.5 percent per year. This implies that as a baseline, the industry would need to employ approximately 1.96 million additional workers between 2017 and 2028 to produce the goods the growing economy could demand. However, the lack of skills identified by manufacturing industry executives and impending retirements suggest the industry could experience employment bottlenecks, leading to a potential 2.4 million jobs going unfilled, with the risk of limiting production below these projections. By 2028, in the base case, additional manufacturing value added of US$454 billion could be at risk if qualified workers cannot be found to fill the open jobs, which could account for about 17 percent of the total US forecasted manufacturing GDP of US$2.67 trillion (see figure 3).

Linking job shortages to shifting skills needed in manufacturing

A notable shift seems to have occurred since the 2015 study in what manufacturers see contributing to the current talent shortage. Then, the retirement of baby boomers topped the list, followed by strength of the economy.[9] The current study reveals that most manufacturers believe that the No. 1 cause of the skills shortage is "shifting skill set due to the introduction of new advanced technology and

FIGURE 3

Skills shortage could put US$454 billion of manufacturing GDP at risk in 2028 alone



Note: 2017 base year.
Source: Data from BLS and Oxford Economics Model, Deloitte and Manufacturing Institute skills research initiative.

automation," followed by "negative perception of students/their parents toward the manufacturing industry." Baby boomer retirements complete the top three causes of today's skills shortages, according to manufacturing executives.[10]

It may come as no surprise that shifting skills would top the list, as manufacturers find themselves in the midst of the Fourth Industrial Revolution, one that is defined by its use of advanced technology to transform work throughout an organization.[11]

Half of the manufacturers in the study expressed that they have already adopted technologies such as robots, cobots, machine learning, and artificial intelligence (AI). In the presence of increased human–machine teaming and access to insights surfaced via the Internet of Things (IoT), the types of skills that employees need to possess are rapidly evolving, and it seems increasingly difficult for the workforce to keep pace.

DELOITTE'S US MANUFACTURING EMPLOYMENT PROJECTIONS TO SUPPORT PRODUCTIVITY

These projections are based on 10-year extensions of *Deloitte's 2018 Q2 US Economic Forecast*.[12] The forecasts are calculated using the Oxford Global Economic Model, a standard model used for a variety of forecasting and policy analysis purposes. The model projects quarterly real quantities for major components of GDP:

- Consumer spending
- Fixed private investment
- Inventory investment
- Exports
- Federal investment in defense
- Federal investment, nondefense
- State and local investment*

These final demand categories are the basis for measuring GDP by expenditure. To obtain GDP by industry, the model includes an equation for each one-digit industry code, which translates expenditure components into the industry supply required to produce those components. For example, a dollar of additional exports generates a larger demand for manufacturing output than a dollar of consumption demand. The shares are based on the US Bureau of Economic Analysis's input–output matrix, which measures the supply and demand of goods and services by industry and final demand.[13] This determines the real value added (GDP) for each industry.

*Source: Deloitte analysis; Oxford Global Economic Model.

Digital impact: How are skills shifting?

The year is 2025. Digital transformation has helped a major industrial manufacturer realize the promise of the Fourth Industrial Revolution, including its product design approach, where digital twin engineers spend their time creating virtual models of the products the company makes. These twins help the company predict and respond to customer problems using real-time data analysis and advanced technologies.[14] The skills these next-generation engineers need include the ability to collaborate across manufacturing disciplines and to interact with customers and partners in ways that today's engineers often do not.

This example, and the additional personas that will be described in Deloitte's future of jobs in manufacturing series, highlight the seismic shift that could occur over the next decade as the Fourth Industrial Revolution completes its transformation of manufacturing. Today, the early stages of digital transformation seem to already be creating a mismatch between the available workers and the skills necessary to fill open jobs. For production workers, it is not the need for STEM degrees (science, technology, engineering, math) but rather the ability to program machines on the plant floor. Increasingly, employers are looking for extended computer skills that enable core production workers to program a CNC (computer numeric control) machine for a new job, or interact with CAD/CAM (computer-aided design/computer-aided manufacturing) and other engineering or manufacturing software. In fact, manufacturing executives stated the top five skill sets that could increase significantly in the coming three years due to the influx of automation and

advanced technologies are: technology/computer skills, digital skills, programming skills for robots/automation, working with tools and technology, and critical thinking skills (see figure 4).[15]

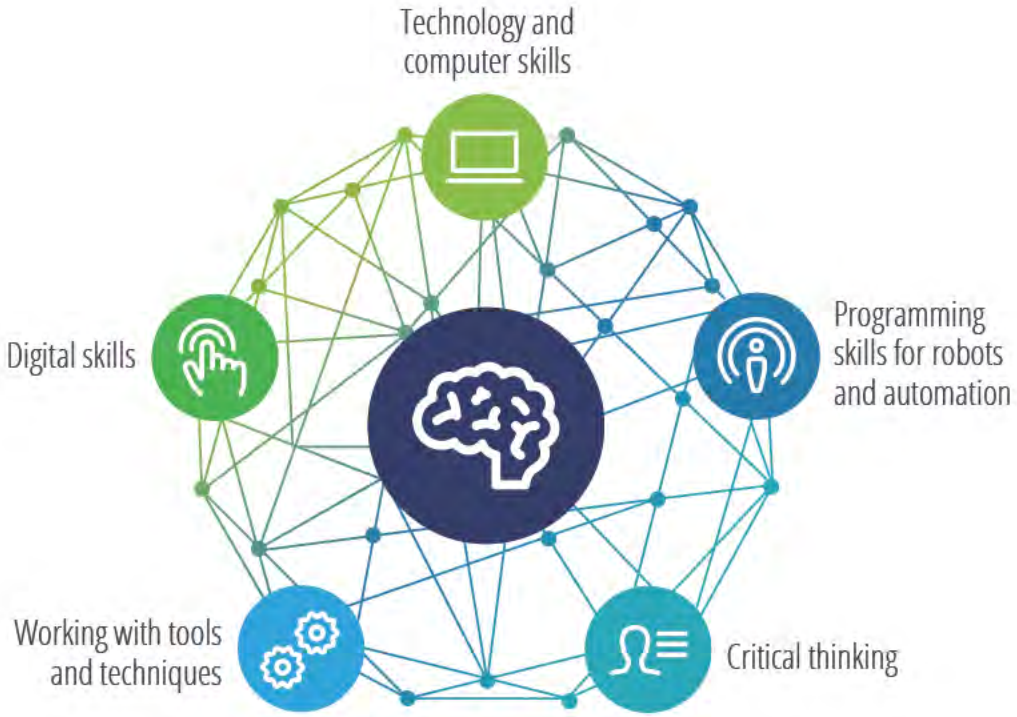
Expanding "soft" skills in a digital workplace

One of the top five skills—critical thinking—stands out, as it portends a return to "human" skills in the face of technology transformation. As technology could replace many of the manual or repetitive tasks today's jobs entail, it would free up space for skills that are uniquely human, often called "soft" skills. A recent World Economic Forum study found human skills such as critical thinking, creativity and originality, attention to detail, problem-solving, and people management are expected to see an outsized increase in demand relative to their current prominence.[16] Companies need workers that can demonstrate these skills as well as the digital skills necessary to work alongside automation.

In manufacturing, this generally translates to solving problems in production, such as having the

FIGURE 4

Five key skills are expected to be needed to succeed in the Fourth Industrial Revolution



Source: Deloitte analysis.

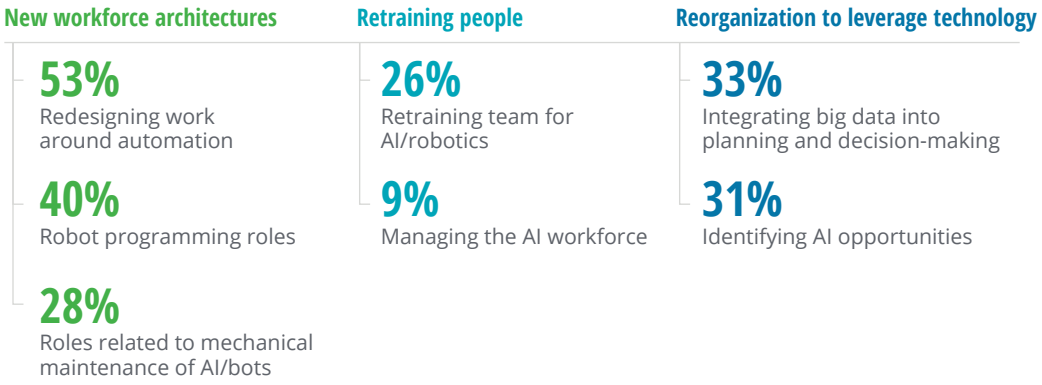
ability to identify quality failures with parts coming off an automated production line and, more importantly, to take actions that remediate the problem in real time. These skills are expected to become increasingly important as automation is added to production lines in the form of robots and cobots. As Deloitte's *2018 Global Human Capital Trends* report explains, many organizations are working hard to put humans in the loop—rethinking work architecture, retraining people, and rearranging the organization to leverage technology to transform business (see figure 5).[17] The broader aim is not just to eliminate routine tasks and cut costs, but to create value for customers and meaningful work for people. The human–machine pairing becomes a means of delivering value.

Supporting soft skills with the digital toolbox in manufacturing

While the value of soft skills tends to grow in lockstep with the move toward automation, robotics, and artificial intelligence, manufacturing workers can turn to a digital toolbox to support productivity and effectively complete tasks (see figure 6). Deloitte has identified some of the digital tools that could amplify the human skills that are increasingly necessary to support the future work in manufacturing. The *2018 Global Human Capital Trends* study shows that tools such as collaboration platforms, work-based social media, and instant messaging can increasingly support the communication necessary for higher productivity.[18]

FIGURE 5

A growing number of US manufacturers are finding new ways to facilitate the human-machine integration



Source: Deloitte, *2018 Global Human Capital Trends*, March 28, 2018.

FIGURE 6

About 67 percent of US manufacturers surveyed expect a positive impact of connected work tools on personal productivity

Percentage of manufacturers who expect the usage of below tools to increase in the next 3 to 5 years

Source: Deloitte, *2018 Global Human Capital Trends*, March 28, 2018.

TOOLBOX

The toolbox supports the worker as a whole—in achieving external outcomes such as productivity as well as internally focused ones such as decision-making and learning.

Productivity

Venus This artificial intelligence (AI)-powered, voice-enabled digital assistant provides a conversational interface for all productivity-related tasks, from scheduling to finding answers to questions and checking the status of products and projects.

WeAR It is an augmented reality (AR) wearable device that connects digital twin engineers to IoT devices, and receives work instructions and training. These smart glasses, paired with Bluetooth-enabled scanners and voice guidance, respond to commands and open a pop-up on monocular display, which help boost productivity.

InstaCap It captures data automatically using digital technologies such as radio frequency identification (RFID) and speech recognition. It helps collect information from machines, images, or even sounds without manual data entry.

Symphony This software suite runs simulations and connects digital twin engineers with other resources—people, machines, and systems, for data-driven digital manufacturing. Using advanced real-time analytics, it helps digital twin engineers create models and optimize manufacturing production performance.

Decision-making

Smart Dash It is a visual display that presents data, live information, and analysis from multiple sources to facilitate informed decision-making.

Envision This tool uses machine learning to identify potential problems as well as opportunities to devise solutions that make a positive business impact.

RealConnect This application enables an engineer to seamlessly interact with suppliers, partners, customers, and the broader ecosystem.

Sixth Sense It is a tool that incorporates machine learning, cognitive computing, and artificial intelligence to detect macro trends in the broader environment.

Learning

SkillsPro This smart learning assistant helps digital twin engineers refresh existing skills as well as learn new and emerging skills. Its conversation mode shares tips and tricks about the tools/techniques that an engineer has learned recently. When synced with an engineer's project planner, it shares a list of skills to be learned for implementation in upcoming projects.

SmartLab It facilitates classroom learning using virtual reality headsets and simulation. It tests trainees on a defined skill framework and measures subjective aspects based on their response style. Each trainee receives customized learning objectives.

Note: Toolbox represents some of the tools that the workers of the future could need to perform their daily work. For the full description of the above tools and to explore additional tools, please read *The future of work in manufacturing: What will jobs look like in the digital era?*.

Approaches to patch the gap in the short term

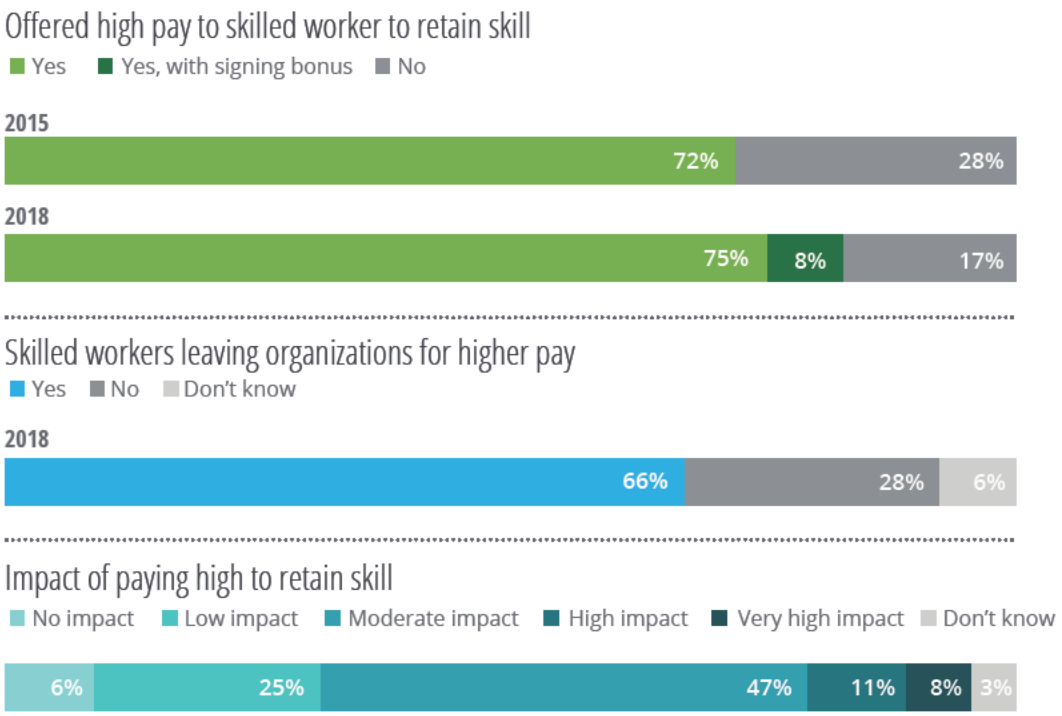
The age-old lure of paying higher wages

Given the immediacy of job openings and skilled worker shortages that most manufacturers face today, the industry is turning to several short-term, stop-gap measures to fill open jobs. One method is to offer pay increases and signing bonuses to skilled workers. Comparing the percentage of executives willing to take this measure in 2015 and in 2018, there is a noticeable increase (see figure 7). Additionally, there is a cohort of executives offering signing bonuses for certain positions. And, 68 percent of these companies report they are seeing a "moderate," "high," or "very high" impact on the time it takes to fill skilled jobs by offering higher wages or signing bonuses. But, on the flip side, while this might get skilled workers in the door, it does not guarantee they will stay. In fact, the study shows that 66 percent of executives see skilled

FIGURE 7

Offering higher pay to attract talent is a double-edged sword

Though manufacturing companies are ready to pay more to attract and retain talent, they also find skilled workers leaving their organization for higher pay elsewhere



Source: 2018 Deloitte and Manufacturing Institute skills gap study.

workers leave to accept outside positions that offer higher pay. As one executive noted, "We are setting up a position where skilled workers are jumping to the next offer of higher pay, which doesn't solve our skills shortage long term."[19]

Outsourcing: A catch-22 situation

As many as 42 percent of manufacturers in the survey indicated a strong affinity toward outsourcing to contract manufacturers as a solution to the current skilled worker shortage. Though outsourcing can help manufacturers increase productivity and save investments in the short term, it poses several risks. The most obvious ones are product quality and intellectual property (IP) protection. However, the more important risk is that manufacturers could be losing out on opportunities to develop high-potential employees and create a steady supply of talent within their factory's walls. With the manufacturing industry gathering steam and continuing to add jobs, a more holistic approach could be needed to solve long-term talent issues.

Increasing flexibility in the hiring process

The limited availability of active candidates in the job market could make it harder for manufacturers to find the talent that ticks every box. Manufacturers in the 2018 survey indicated they are rethinking whether strict adherence to certain hiring requirements is truly preferable to greater flexibility in the hiring process. In fact, it's now clear to many manufacturers that this flexibility—in other words, prioritizing competencies and potential in job candidates over strict adherence to sometimes arbitrary factors such as years of experience—could actually become increasingly necessary to find and bring onboard the very talent necessary for businesses to thrive. This flexibility, combined with improved employee onboarding and on-the-job training, could help manufacturers identify new employees with good attitudes who can adapt to and fit the needs of the job.

Forging a path forward to fill the gap for skills and jobs in the future manufacturing workplace

TO SOLVE THE ongoing skills shortages in manufacturing, efforts will likely need to move beyond short-term solutions such as signing bonuses and outsourcing. Deloitte and The Manufacturing Institute identified a number of strategic approaches that manufacturers could take to influence a more positive employment future.

Engaging the open talent ecosystem

Deloitte's *2018 Global Human Capital Trends* report notes that the traditional employer–employee relationship is being replaced by the emergence of a diverse workforce ecosystem—a varied portfolio of employees, talent networks, gig workers, and service providers that offers employers flexibility, capabilities, and the potential for exploring different economic models in sourcing talent.[20] In the United States, more than 40 percent of workers are now employed in "alternative work arrangements," such as contingent, part-time, or gig work. This percentage is steadily rising—increasing by 36 percent in just the past five years—and now includes workers of all ages and skill levels.[21] Taking advantage of the emerging workforce ecosystem's benefits brings a variety of new challenges, and Deloitte's research shows that most companies are not fully ready. For manufacturers to take full advantage of this emerging workforce to help close the skills gap, it would take a concentrated effort to change the way they structure their work demands, execute talent acquisition, and engage talent within the four walls of the factory. Clearly, the potential is there to incorporate the open talent ecosystem into longer-term strategies for employment in the industry.

The rise of automation: A salve for job shortages?

The influx of automation in manufacturing continues to disrupt all aspects of operations. It can be found in the form of robotic arms on production lines, cobots that assist humans in manual tasks, and robotic process automation (RPA) to automate routine business processes such as warranty claims processing. In its future of jobs report, the World Economic Forum highlighted that by 2022, machines and algorithms will contribute 42 percent of total task hours, compared to 29 percent in 2018.[22] Initially thought to present a danger to human jobs by replacing them, many manufacturers today are turning toward automation to supplement the low-skilled jobs they cannot fill and instead focus their existing workers on jobs that are either higher-skilled or require uniquely human skills. Nearly half of the executives surveyed in the skills gap study have implemented automation technologies in the form of robots, cobots, machine learning, or AI in the past three years.[23] And one in three of these manufacturers is supplementing their current workforce with automation, often for repetitive

tasks. Further, 64 percent of these executives found that automation helped them overcome some of the challenges they are facing in filling open jobs with qualified talent.

Tapping the resources of the retiring, experienced workforce

One of the core assets that most manufacturing companies today still possess are workforces that have extremely seasoned workers, many of whom hold intrinsic knowledge of best practices and the nuances of their workplace. Even though these workers are staying longer—most recent data shows the retirement age rising to an average of 66 years[24]—the volume of retirements in the coming decade could be detrimental to the industry. Manufacturers should think carefully about the potential impact a wave of retirements could have on their organization and seize any opportunities to hold on to their proven, committed, and experienced workforce and leverage them as a competitive advantage. The *2018 Global Human Capital Trends* study found that manufacturing companies in the United States are unprepared to leverage the aging workforce, with only 9.2 percent of manufacturing companies creating targeted roles for older workers.[25] However, some manufacturers are moving in the right direction and have launched specific programs to retain the value of their oldest employees.

Michelin North America, through a dedicated retiree program, successfully leverages the knowledge and experience of its retired workforce. The company conducts an off-boarding interview at the time of retirement exits and enquires if the professional would be interested to work in some capacity after their retirement. The names of interested professionals are shared with the various business units within the company, enabling the units to contact the retired employees for short-term project work. Through this unique strategy, Michelin has added approximately 250 people to its overall headcount of 19,000 in the United States.[26]

Developing in-house training that leverages digital technology

Executives in the current survey highlighted in-house training and learning courses, along with on-the-job training, as the preferred training methods, a finding consistent with the 2015 study. Despite manufacturers' focus on internal training programs, the pace of change still exceeds the extent and capacity of the training programs. Manufacturers should consider increasing investment in training programs and integrating digital technologies to add relevance, helping employees move ahead on the digital curve.

A German industrial goods company employs advanced digital technology to enhance the skills and productivity of its employees. Through an AI headset, Microsoft HoloLens, the company provides on-the-job training to its 24,000 service engineers. The technology helps engineers with visual cues on assembling and disassembling the latest company products in a 3D space, and with viewing equipment schematics in the field while being connected with specialists via a Skype call. The technology improved service times by a factor of four. Several other industrial manufacturers also employ similar AR technologies to upskill and provide live assistance to their workers.

The value of public–private partnerships

One area perhaps ripe for further exploration by US manufacturers is how to partner with public

agencies to attract, train, and hire skilled workers. Only two in 10 manufacturers indicated that they partner with government and just over three in 10 indicated that they partner with private education/training institutes to train their workforce. Manufacturers often possess the necessary means and the knowledge to train but their access to new workers is limited, while public education is in the opposite situation. The path forward includes manufacturing organizations forging long-term partnerships with public education, industry associations, and agencies to develop programs that build a strong connection with the industry, creating a skilled talent pool for tomorrow's manufacturing environment.

Fluor Corporation, a multinational engineering and construction firm, partners with high schools and the Texas Workforce Commission (a state agency) to provide pre-employment training in skilled workforce areas. The 12-week training courses are based on NCCER (The National Center for Construction Education and Research) curriculum and also include 40 hours of employability skills development. Fluor, through this public–private partnership, aims to make a long-term investment and build a pipeline of skilled talent for the future of manufacturing. The trained graduates are in a better position to be productive for their employers.[27]

Training the future: Apprenticeship programs

Another approach to building the future talent pool harkens back to a primary form of skills transfer prior to the Industrial Revolution: apprenticeship. Exposure to a skilled trade through an apprenticeship has shown to be a promising pathway for filling many of the skilled jobs that lie open in the manufacturing industry. The government and manufacturers together can fund such education and apprenticeship programs to develop a job-ready stream of qualified workers.

The Apprenticeship Carolina program in South Carolina is a comprehensive partnership model to build a multi-industry talent pipeline. The program partners with businesses, educators, students, and their parents to build a workforce pipeline of the future. It works by combining high school curriculum and technology training with the essential on-the-job trainings required by the businesses. The program has thus far produced over 28,000 apprentices since 2007, with 965 registered programs (with Department of Labor) and 211 youth apprenticeship programs. As of 2017, 158 companies had a youth apprenticeship program with corporations such as Schaeffler Group USA and Greenfield Industries. The program helps companies gain access to more productive employees and fill key jobs involving new technologies.[28]

Final thoughts

AS THE JOBS and economic situation in US manufacturing continue to unfold in the coming months, manufacturers should continue to address their present needs for finding qualified talent to ensure sustained workforce engagement. In addition, moving down the future path toward broader, industrywide approaches to closing the skills gap are fundamental to offset the expected shortfalls in skilled workers the coming decade may bring. Along with the approaches suggested above, industry leaders should explore ways to provide exposure to robotics, automation, and computer programming to primary school students. While companies often focus on middle and high school, engaging primary school students can be important to building the foundational skills and abilities needed to succeed in programs in the secondary grades.

Additionally, manufacturers should also work on changing workforce perceptions in manufacturing. Deloitte and The Manufacturing Institute's most recent *US Public Opinion of Manufacturing* study

reveals a gap between American people's support of manufacturing and their interest in pursuing long-term manufacturing careers.[29] To overcome this, the industry should continue building awareness and promoting manufacturing as an industry that has safe working conditions and can provide long-term career progression with competitive pay. Working through these approaches while strengthening the internal human capital strategy can position manufacturers for successful outcomes in the future of work in manufacturing.

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About The Manufacturing Institute

The Manufacturing Institute is the social impact arm of the National Association of Manufacturers. The Manufacturing Institute drives programs and research to promote modern manufacturing and jump-start new approaches to growing manufacturing talent.

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High-Skill Immigration, Innovation, and Creative Destruction
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ABSTRACT

Economists have identified product entry and exit as a primary channel through which innovation impacts economic growth. In this paper, we document how high-skill immigration affects product reallocation (entry and exit) at the firm level. Using data on H-1B Labor Condition Applications (LCAs) matched to retail scanner data on products and Compustat data on firm characteristics, we find that H-1B certification is associated with higher product reallocation and revenue growth. A ten percent increase in the share of H-1B workers is associated with a two percent increase in product reallocation rates – our measure of innovation. These results shed light on the economic consequences of innovation by high-skill immigrant to the United States.

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1 Introduction

Recent political and academic discussions have shone a spotlight on issues related to high-skill immigration. This discourse could have far reaching implications for US policy, the profitability of firms, the welfare of workers, and the potential for innovation in the economy as a whole. Yet, the effects of high-skill immigration on receiving countries are theoretically ambiguous. On the one hand, skilled migrants may increase the profitability and innovative capacity of the firm (Kerr and Lincoln, 2010) and raise wages of native workers who are complements in production (Peri and Sparber, 2009). On the other hand, migrants may crowd out domestic workers (Doran, Gelber and Isen, 2017) and lower the wages of close substitutes (Bound, Braga, Golden and Khanna, 2015).

What has been missing so far from this discourse is a discussion about how migrants may affect the product-mix produced by a firm and the innovation involved in creative destruction. The entry and exit of products have long been seen as an important determinant of firm-level innovation and Schumpeterian growth (Aghion, Akcigit and Howitt, 2014). Hiring high-skill workers from abroad may have a meaningful impact on such innovation, and this has implications not only for firm profits but also for consumer welfare. For instance, hiring more engineers and programmers from abroad, at perhaps a lower cost, allow firms to implement incremental innovations that may lead to newer products on the market. In this paper we fill this gap by studying the impact of H-1B worker applications, on firm-level product reallocation, defined broadly as the entry of new products and the exit of outdated products.

We create a new data set by combining data on H-1B worker applications and

firm production. Our H-1B data consists of publicly-available Labor Condition Applications (LCAs).[1] Our product level data from the Nielsen Retail Scanner Data is combined with firm characteristics from the Compustat database. Together, a combination of these datasets at the firm-by-year level between 2006 and 2015 allows us to comprehensively examine the impact of wishing to hire foreign workers on firm production and innovation.

Our analysis consists of a few different methods. We first describe the entry and exit of products over the business cycle and across a firm's baseline propensity to hire H-1B workers.[2] We find that product reallocation falls precipitously in times of recession and rises in periods of economic recovery. Moreover, product reallocation is strongly associated with the baseline propensity to hire H-1B workers: firms that applied for H-1B workers in the first year of our LCA data are more likely to consistently have high product reallocation rates over the business cycle. Indeed, this association is invariant to a firm's R&D expenditure, size, or revenue share. R&D expenditures and revenues are no longer strong determinants of product entry and exit after accounting for baseline propensities to hire H-1B workers.

We then use panel regressions, where we account for firm level characteristics that are stable over time and for shocks that affect the economy widely with the help of fixed effects. Our preferred specifications look at outcomes in the following period as they are less likely to be affected by contemporaneous shocks, and we would expect that firm dynamics change with a lag. We show that an increase in product

[1] LCAs are filed with the Department of Labor when a firm wishes to hire H-1B workers, and a single LCA may list many workers.

[2] Our baseline propensity is whether or not a firm applied to hire H-1B workers in the first year of our LCA data (2000-1).

reallocation is strongly associated with higher firm revenue growth.

We find that the number of LCAs, the number of certified workers, and number of workers as a fraction of the total firm employment base, is strongly associated with reallocation rates.[3] A one percentage point increase in the share of workers from certified LCAs is associated with a five percentage point increase in the reallocation rate. This association is stronger for software workers than other occupation groups. In a distributed lead and lag set up, we also see that even as future H-1B certification does not affect current reallocation rates, current H-1B certification does affect future reallocation rates.

Our results speak to the innovative capacity of the firm by focusing on product reallocation, which is found to be highly correlated with firm growth and productivity (Argente, Lee and Moreira, 2018b). Previous work on high-skill immigrants and innovation focus on patenting activity (Kerr and Lincoln, 2010; Hunt and Gauthier-Loiselle, 2010; Moser, Voena and Waldinger, 2014). The propensity to patent may be affected by rulings of the Federal Court of Appeals, the firm's industry and products, and changes in state polices and taxes (Lerner and Seru, 2018). Indeed, many important innovations are never patented (Fontana, Nuvolari, Shimizu and Vezzulli, 2013). While patents may be a good measure of newer production processes and inputs into production, our measure of innovation captures the final products produced by firms. The major advantage of a product reallocation measure is that it captures incremental innovations that are not usually patented. Previous work using patent data might have underestimated the benefits of having additional high-skilled

[3]A firm can file one LCA for many workers, and this LCA may either be denied, withdrawn or certified. We define "certified workers" as the number of workers on certified LCAs.

immigrant workers by not being able to capture these incremental innovations.

Such changes affect not just firms, but also consumers. Changes in a firm's production portfolio are strongly linked to a firm's revenue generation ability and profitability. In concurrent work, we examine how changes in consumer goods products affect the welfare of US consumers (Khanna and Lee, 2018). Together these results have striking implications for the overall consequences of H-1B migration on the US economy.

Our paper is organized into five sections. In Section 2 we provide a background on the H-1B program and how that may relate to innovation and product reallocation. In Section 3 we describe the data that we use and how we combine our datasets. Our primary analysis is in Section 4 where we first describe trends over the business cycle, the association between reallocation rates and revenue growth, and then between H-1Bs and product reallocation. Section 5 concludes.

2 Background

2.1 The H-1B Program

The Immigration Act of 1990 established the H-1B visa program for temporary workers in "specialty occupations" with a college degree.[4] In order to hire a foreigner on an H-1B visa, a firm must first file a Labor Condition Application (LCA) to the Department of Labor (DOL), and pay them the greater of the actual compensation

[4]Specialty occupations are defined as requiring *theoretical and practical application of a body of highly specialized knowledge in a field of human endeavor including, but not limited to, architecture, engineering, mathematics, physical sciences, social sciences, medicine and health, education, law, accounting, business specialties, theology, and the arts.*

paid to other employees in the same job or the prevailing compensation for that occupation.

After which, the H-1B prospective must demonstrate to the US Citizenship and Immigration Services Bureau (USCIS) in the Department of Homeland Security (DHS) that they have the requisite amount of education and work experience for the posted positions.[5] USCIS then may approve the petitions, up to the annual cap. Approved H-1Bs are for a period up to three years, which can be extended up to six years. Once the H-1B expires, employers can sponsor a green card and each country is eligible for only a specific number of those. The U.S. General Accounting Office 2011 survey estimates the legal and administrative costs associated with each H-1B hire to range from 2.3 to 7.5 thousand dollars. It therefore seems reasonable to assume that employers must expect some cost or productivity advantage when hiring high-skill immigrants.

In the early years, the H-1B cap of 65,000 new visas was never reached, but by the time the IT boom was starting in the mid-1990s, the cap started binding and the allocation was filled on a first come, first served basis. The cap was raised to 115,000 in 1999 and to 195,000 for 2000-2003, and then reverted back to 65,000 thereafter. The 2000 legislation that raised the cap also excluded universities and non-profit research facilities from it, and a 2004 change added an extra 20,000 visas for foreigners who received a masters degree in the US. Renewals of visas up to the six-year limit are not subject to the cap, and neither are employment at an institution

[5]Workers may be educated in the US. The National Survey of College Graduates (NSCG) shows that 55% of foreigners working in CS fields in 2003 arrived in the US on a temporary working (H-1B) or a student type visa (F-1, J-1).

of higher education or a non-profit or governmental research organization.

When the cap is reached, USCIS conducts a lottery to determine who receives an H-1B visa. For instance, in the the 2014 fiscal year, USCIS received approximately 124 thousand petitions in the first five days of open applications for 85 thousand visas. A computer generated lottery first determines the visas for petitions of applicants who received a masters degree in the US (a quota of 20 thousand visas), and then the remaining 65 thousand visas are granted. Those not selected in the lottery may file again the next year. Those who are selected will eventually also receive an I-129 form from USCIS.

According to the USINS (2000), the number of H-1B visas awarded to computer-related occupations in 1999 was about two-thirds of the visas, and U.S. Department of Commerce (2000) estimated that during the late 1990s, 28% of programmer jobs in the US went to H-1B visa holders. H-1B visas, therefore, became an important source of labor for the technology sector. Yet, many non-IT firms also hire H-1B visas. Such workers may be in-house programmers, but also scientists, mathematicians and engineers.

2.2 The Impact of High Skill Immigrants on the US

Work by economists on the impacts of the H-1B program are mostly focused on the wages and employment of native born workers. Some argue that employers find hiring foreign high-skilled labor an attractive alternative and that such hiring either "crowds out" natives from jobs or puts downward pressure on their wages (Doran, Gelber and Isen, 2017). Given the excess supply of highly qualified foreigners willing

to work, and given the difficulty in portability of the H-1B visa, immigrant workers may not be in a position to search for higher wages, allowing firms to undercut and replace US workers (Matloff, 2003; Kirkegaard, 2005). On the other hand, negative wage effects may be muted as native workers switch into complementary tasks (Peri and Sparber, 2009).

Importantly, immigrants may affect the innovative capacity of the firm. Kerr and Lincoln (2010) and Hunt and Gauthier-Loiselle (2010) provide evidence on the link between variation in immigrant flows and innovation measured by patenting, suggesting that the net impact of immigration is positive rather than simply substituting for native employment. Kerr and Lincoln (2010) also show that variation in immigrant flows at the local level related to changes in H-1B flows do not appear to adversely impact native employment and have a small, statistically insignificant effect on their wages. Indeed, in other research it is evident that changes in the size of the STEM workforce at the city-level may raise wages for US born workers (Peri, Shih and Sparber, 2015).

Even though much of the theoretical analysis underlying studies of immigration are about firms, a large fraction of the literature focuses on variation across states or metro areas.[6] Yet, for high-skilled migrants sponsored by firms in specialty occupations we may expect that effects on receiving firms will be rather different from the impacts on the larger labor market. Kerr and Lincoln (2010) and Kerr, Kerr and Lincoln (2015) are among the first to focus on the firm, and more recently working papers using publicly traded firms (Mayda, Ortega, Peri, Shih and Sparber,

[6]As Kerr, Kerr and Lincoln (2015) point out, the word "firm" does not appear in the 51 pages of the seminal Borjas (1994) review of the immigration literature.

2018) or administrative tax data (Doran, Gelber and Isen, 2017) look at employment outcomes for native workers and the patenting propensity of the firm.

Yet, focusing on either the labor market or innovative capacity may miss overall productivity changes in the US economy. Bound, Khanna and Morales (2016) and Khanna and Morales (2018) take a different approach and set up a general equilibrium model of the US economy. Doing so allows them to conduct a comprehensive welfare analysis and study the distributional implications of the H-1B program. Importantly, by modeling the firms' decisions, including the spillovers from technological innovation, they find that even though US computer scientists are hurt by immigration, complements in production, consumers and firm entrepreneurs benefit substantially.

2.3 Innovation and Product Reallocation

Work on high-skill immigrants and innovation often focuses on patenting activity (Kerr and Lincoln, 2010; Hunt and Gauthier-Loiselle, 2010; Moser, Voena and Waldinger, 2014). Such pioneering work highlighted the importance of immigrants in innovation. While patents are a rich measure, they capture a specific type of innovation. While patents may capture larger significant innovations, product reallocation often captures incremental innovation that are rarely patented.

Certain features of patent data make it important to study alternative measures of innovation as well. First, immigration status is not directly observed in the patenting data and often ethnicity needs to be inferred by the name, and one needs to compare traditionally Indian or Chinese names to more Anglo-Saxon or European names. Second, changes to patenting over time may be a result of changes in intel-

lectual property laws (like the Computer Software Protection Act of 1980 and the Semiconductor Chip Protection Act of 1984), and rulings of the Court of Appeals for the Federal Circuit, rather than actual innovation. Furthermore, there are gaps when a patent is filed and when it is granted, and any contemporary analysis like ours, would need to limit ourselves to filing information and ignore granting-status or citations to avoid issues with truncation.

The propensity to patent and cite innovations also vary widely across types of products and industries. Some patents are heavily cited due to their industry rather than "fundamental innovativeness" (Lerner and Seru, 2018). Indeed, a relatively low number of important innovations may ever be patented.[7] Lastly, patenting propensities may differ across regions due to changes in state intellectual property policies and taxes, or differences in industrial composition across regions, and analyses that use cross state and city variation need to account for such changes.

To complement the literature using patenting data, we investigate an alternative measure of innovation. For decades, economists have identified product entry and exit as one of the key mechanisms through which product innovation translates into economic growth (Aghion and Howitt, 1992; Grossman and Helpman, 1991). In the consumer goods sector, recent developments in point-of-sale systems allow us to investigate barcode-level transactions, and therefore product entry and exit. We calculate firm-level product creation and destruction by identifying manufacturers of each barcode-level product and aggregating transactions from about 35,000 stores in

[7] Fontana, Nuvolari, Shimizu and Vezzulli (2013) find that 91% of R&D award winning inventions between 1977 and 2004 were never patented. Some inventions, like penicillin, may be never be patented as inventors may never wish to patent them.

the United States. Following the idea of creative destruction where new and better varieties replace obsolete ones, we define firm-level product reallocation as the sum of firm-level product creation and destruction. Most product reallocation is driven by surviving incumbent firms that add or drop products in their portfolios. The speed of product reallocation is strongly related to the innovation efforts of firms and several innovation outputs such as revenue growth, improvements in product quality, and productivity growth (Argente, Lee and Moreira, 2018b). The major advantage of product reallocation as a measure of innovation outcomes is that it captures incremental innovation that are not usually patented. Under the presence of incremental innovations, previous work only with patent data might have underestimated the benefits of having additional high-skilled immigrant workers.

3 Data

We combine data at the firm-by-year level from multiple sources. We first obtain publicly available H-1B data on Labor Condition Applications (LCAs) between 2000 and 2016. We merge this H-1B data to firm-level data from the Nielsen Retail Scanner Data (2006 to 2015) that provides us with information on products produced at the firm level, and also Compustat firm level characteristics for a subset of large publicly listed firms.

3.1 Data on High-skill Immigration

Data on H-1B visas come from the publicly available list of 2000-16 Labor Condition Applications (LCAs) which firms file with the US Department of Labor (DOL) when they wish to hire a foreign high-skill worker. Attached to each LCA is an employer name, address (including city, zip code and state), work start date and end date, occupation and job title, and number of workers requested. The LCA database also documents whether the application was denied, withdrawn or certified. For our analysis we only use certified applications, and count the "certified workers" as the number of workers on certified LCAs. We aggregate this LCA-level data to the firm-by-year level, counting not just the number of LCAs and workers, but also the types of workers for broad occupational categories. These categories, in descending order of prevalence are: (1) software workers (including computer programmers, software engineers and software developers), (2) Scientists / Mathematicians / Statisticians and Engineers (including electrical and mechanical engineers), (3) managers (and administrators), (4) those working in finance or marketing. Together, these categories account for more than 90% of all LCAs in each year of our data.

Due to the H-1B caps, not all certified LCAs lead to actual H-1B hires. However, since they are necessary for approved H-1Bs, these LCAs measure the firms' desire to hire H-1Bs and therefore are likely to be highly correlated with actual H-1Bs. Since our analysis is only for for-profit firms that produce consumer goods, none of the H-1B LCAs we eventually match to our products dataset are cap exempt. Importantly, our data set should not be thought of as being representative of H-1B firms. Instead, it is only representative of consumer goods producing firms. Since about 2011 there

has been an increase in outsourcing firms grabbing the majority of H-1B visas, and filing a lot of LCAs – yet such firms are not a part of our sample, and not the focus of our analysis.

With the help of these data we compute a few important variables: (1) we count the number of LCAs filed by a firm each year, (2) the number of workers under certified LCAs, (3) the number of workers in each of the four broad occupational categories mentioned above, and (4) the number of workers normalized by the total employment in the firm (from Compustat).

3.2 Data on Products

For data on products, we use the Nielsen Retail Scanner Data provided by the Kilts Center for Marketing at the University of Chicago. Each individual store reports weekly prices and quantities of every UPC (Universal Product Code) that had any sales during that week. The data is generated by point-of-sale systems and contains approximately 35,000 distinct stores from 90 retail chains across 371 MSAs and 2,500 counties between January 2006 and December 2015. The data is organized into 1,070 detailed product modules, aggregated into 114 product groups that are then grouped into 10 major departments.[8] Table 1 summarizes basic facts on the data.

Our data set combines all sales of products at the national and annual level. As in Broda and Weinstein (2010); Argente and Lee (2016), we use UPC (Universal Product Code) as the level of analysis. A critical part of our analysis is the identi-

[8]The ten major departments are: Health and Beauty aids, Dry Grocery (e.g., baby food, canned vegetables), Frozen Foods, Dairy, Deli, Packaged Meat, Fresh Produce, Non-Food Grocery, Alcohol, and General Merchandise.

fication of entries and exits, for which we mostly follow Argente, Lee and Moreira (2018a,b). For each product, we identify the entry and exit periods. We define entry as the first year of sales of a product and exit as the year after we last observe a product being sold.

We link firms and products with information obtained from GS1 US, the single official source of UPCs. In order to obtain a UPC, firms must first obtain a GS1 company prefix. The prefix is a five- to ten-digit number that identifies firms and their products in over 100 countries where the GS1 is present. In Figure 1 we show a few examples of different company prefixes. Although the majority of firms own a single prefix, it is not rare to find that some own several. Small firms, for instance, often obtain a larger prefix first, which is usually cheaper, before expanding and requesting a shorter prefix. Larger firms, on the other hand, usually own several company prefixes due to past mergers and acquisitions. For instance, Procter & Gamble owns the prefixes of firms it acquired such as Old Spice, Folgers, and Gillette. For consistency, in what follows we perform the analysis at the parent company level.

Given that the GS1 US data contains all of the company prefixes generated in the US, we combine these prefixes with the UPC codes in the Nielsen Retail Scanner Data. Less than 5 percent of the UPCs belong to prefixes not generated in the US. We were not able to find a firm identifier for those products.

With this data set on products and firms, we can compute how firm-level product creation and destruction evolve over time.

Note that typical firms in the data produce multiple products in several different categories. Over the sample period, about 82.2 percent of revenue has been generated

by firms operating in more than one product department. Figure 2 shows that the share of firms in multi-departments has been between 78 and 84 percent from 2006 to 2015, declining a bit during the Great Recession.

3.3 Data on Other Firm Characteristics

We obtain other firm-level characteristics from Compustat. The Compustat is a database of financial and market information on global companies throughout the world. For the purpose of this research, we bring information on employment and R&D expenditure over the sample period from the fundamental annual database of North America. This limits the number of firms in analysis, but provides much more detailed information on firms. For instance, with information on the number of employees, we can calculate the share of high-skill immigrant worker applications, instead of just the number of high-skilled migrant applications. Additionally, data on R&D expenditures allow us to test the importance of H-1B workers on product reallocation relative to R&D investments.

3.4 Combining Datasets

We merge our data-sets at the firm-by-year level, using a string matching algorithm for firm names. When there is uncertainty in the name matching, we consult city and/or zipcodes. We do not expect matching-error to be correlated with our main variables of interest. For our analysis, we create two different merged samples: (i) the LCA-Nielsen sample, and (ii) the LCA-Nielsen-Compustat sample. Table 2 reports descriptive statistics for all three merged samples.

The first sample combines Labor Condition Applications (LCAs) and Nielsen Retail Scanner Data. As Table 2 shows, the LCA-Nielsen sample contains 36,218 distinct firms for 2006 to 2015. This covers both small and big firms, where the average annual number of certified workers from LCAs is 0.79 (many firms file no LCAs in some years) and the average annual revenue in the Nielsen data is 6.25 million USD.

The second sample adds Compustat to the LCA-Nielsen sample, in order to obtain other firm characteristics. As Table 2 shows, the LCA-Nielsen-Compustat sample has 482 distinct firms for 2006 to 2015. Due to the limited coverage of the Compustat database, this sample mostly covers large companies, where the average annual number of certified workers from LCAs is 20.7 and the average annual revenue in the Nielsen data is 154 million dollars. From the Compustat database, we additionally know that the average number of employees is 43 and the average R&D expenditure to sales ratio is 0.25.

3.5 Measurement of Creative Destruction

We start with a description of the measures that we use to identify the degree of creative destruction by firms in the product space.

To capture the importance of product entry and exit, we use information on the number of new products and exiting products, and the total number of products for each firm i over year t. We define firm-level entry and exit rates as follows:

$$n_{it} = \frac{N_{it}}{T_{it}} \tag{1}$$

$$x_{it} = \frac{X_{it}}{T_{it-1}} \tag{2}$$

where N_{it}, X_{it}, and T_{it} are the numbers of entering products, exiting products, and total products, respectively. The entry rate is defined as the number of new products for each firm i in year t as a share of the total number of products in period t. The exit rate is defined as the number of products for each firm i that exited in year t as a share of the total number of products in year $t-1$.

From the idea of creative destruction at the firm level, the overall change in the portfolio of products available to consumers can be captured by the sum of firm-level entry and exit rates. We refer to this concept as the product reallocation rate:

$$r_{it} = n_{it} + x_{it} \tag{3}$$

With this measure we can investigate the extent of changes in the status of a product in our data, either from the entry or the exit margin.

4 Empirical Analysis

4.1 Product Reallocation and Firm Outcomes

To understand the importance of product reallocation we first study the association between reallocation and firm revenue growth. This is simply a replication of the result found in Argente, Lee and Moreira (2018b), and theoretically similar to results in Aghion, Akcigit and Howitt (2014). We test for this association in our sample with the following regression specification:

$$\Delta Log(Revenue)_{i,t+1} = \alpha + \beta r_{i,t} + \mu_i + \tau_t + \epsilon_{i,t} \ , \tag{4}$$

where $\Delta Log(Revenue)_{i,t}$ is growth in the sum of revenue over all products in firm i's portfolio between years t and $t-1$. μ_i are firm fixed effects and τ_t are year fixed effects. With the help of fixed effects, our associations account for firm characteristics that are stable over time, and for annual shocks that affect the entire US economy. Our resulting variation is driven by changes over time within firms. Here and elsewhere, we cluster our standard errors at the firm level.

In Table 3 we study this association. Product reallocation has a strong positive association with firm revenue growth. When we look at product entry and exit separately, once again it is clear that both entry and exit of new products are strongly associated with firm revenue growth, however firm entry has a much stronger association than firm exit. While these associations are not causal, they are suggestive as to how product reallocation is important for firm revenue growth.

4.2 Reallocation and Immigration Over the Business Cycle

Our period of study, 2006 to 2016, encapsulates the Great Recession of 2008-10. This is an ideal setting to understand how the business cycle affects product reallocation, and how high-skill migration interacts with this relationship. In much of this subsection we divide firms by whether or not they have a propensity to apply for H-1B workers. Any firm that filed an LCA that was certified in the first year of our LCA data (2000-1) is categorized as a firm that has a propensity to hire H-1B workers. We use the earliest possible year (2000-1) rather than our sample period (2006-15) for our

classification, so as to ensure that contemporaneous changes in firm characteristics are not driving much of our analysis.[9] The aim is to capture baseline propensities of the firm that may not be related to differential trends over time in reallocation rates; perhaps, such as the ability of human resources (HR) departments within a firm to be able to file H-1B paperwork, or connections to employers in countries like India.

In Figures 3 we use the LCA-Nielsen sample to look at reallocation rates, product entry and product exit over this period. We split the sample by H-1B dependent firms (defined as any firm that wished to hire H-1B workers in 2000-1) and non dependent firms (no new H-1B LCAs certified in 2000-1). Panel (a) of Figure 3 highlights two important takeaways: (i) H-1B prone firms have higher product reallocation rates, and (ii) the business cycle is strongly correlated with product reallocation. Over the recession, product reallocation fell drastically, only to rise again over the recovery. Firms that wished to hire H-1B workers started out with a higher reallocation rate, were not as adversely affected as non-H-1B prone firms, and unlike non-H-1B prone firms, recovered to their previous reallocation rates by 2015.

In Panels (b) and (c) of Figure 3, we look at product entry and exit rates. As expected, over the recession, product entry falls and exit rises. H-1B firms have higher entry and exit rates at baseline, however, by the end of the period, non-H-1B prone firms have marginally higher exit rates. The fall in entry over the recession is not as strong for H-1B dependent firms, and the recovery is mildly stronger – by the end of the business cycle H-1B prone firms have much higher entry rates than

[9]The propensity to hire H-1B workers in 2000-1 is also strongly predictive of the propensity to hire H-1B workers between 2006-15. However, it is important to note that the propensity to hire may not be actual hiring given the caps.

non-H1B prone firms.

The stark differences between H-1B and non-H-1B firms in product reallocation may be driven by other factors correlated with H-1B visas. For instance, firms that spend more on R&D, or larger firms in general, may have more H-1B workers and also higher reallocation rates. Additionally, it is important to understand the interaction between H-1B dependency and R&D expenditures. Our analysis in Table 4 and Figure 4 investigates this interaction.

Table 4 is divided into two panels. In Panel A we use the LCA-Nielsen-Compustat sample and divide firms into four groups by H-1B propensity and R&D expenditures. Low H-1B firms are those that did not apply for a new H-1B worker in the first year of our H-1B data (2000-1), whereas high H-1B firms did. This division roughly splits the sample in half. We also split the firms by whether or not they are above the median level of R&D expenditures as a proportion of total sales (in 2000-1). By construction this division splits the sample in half.

In Panel A it is clear that high H-1B firms have higher reallocation rates than low H-1B firms. This is true whether or not the firms have a high R&D expenditure share. Regardless of R&D share, high H-1B firms have a reallocation rate that is about 17% higher than low H-1B firms. Interestingly, enough, within H-1B categories, R&D share is not as strong a determinant of reallocation rates since firms with low and high baseline R&D rates have similar reallocation rates.

In Panel B, we do a somewhat similar exercise, but instead of R&D shares we use baseline revenues from Nielsen. We use the larger LCA-Nielsen sample. Firms that did not apply for an H-1B worker in 2000-1 far outnumber the firms that did apply

for an H-1B worker. Once again comparing the means in reallocation rates suggest a meaningful difference between H-1B and non-H1B firms: high H-1B firms have, on average, between 35-38% higher reallocation rates than low H-1B firms. On the other hand, baseline firm revenues are not predictive of reallocation rates over the period as both large and small firms have similar reallocation rates.

Such differences are succinctly captured in Figure 4 which splits up the sample by H-1B propensity and R&D expenditure share. Consistent with the tables, it shows that there is a substantial difference in reallocation rates between high and low H-1B firms. This difference is unaffected by R&D expenditure share, which in and of itself, is less predictive of differences in reallocation rates.

Table 4 and Figure 4 suggest that whether or not a firm has a higher propensity to hire H-1B workers is strongly associated with product reallocation rates. This association is somewhat independent of whether or not the firm has high R&D expenditures or is a large firm with high revenues. Indeed, in comparison to the association between H-1B workers and reallocation rates, it seems like R&D expenditures and firm revenues are less strongly associated with high product reallocation.

4.3 The Association Between Immigration and Product Reallocation

We first study the association between high-skill immigration and product reallocation graphically in Figure 5. Here, we plot reallocation rates, entry rates and exit rates across the number of workers on certified LCA applications. Each point is a firm-year observation. There seems to be a mildly positive association between

reallocation rates and the number of certified workers. Yet, such analyses may be confounded by firm specific characteristics or annual shocks to the economy. To account for these we perform a fixed effects regression:

$$r_{i,t+1} = \alpha + \beta H1B_{i,t} + \mu_i + \tau_t + \epsilon_{i,t+1} \ , \tag{5}$$

where $r_{i,t}$ is the product reallocation rate for firm i in year t and $H1B_{i,t}$ is a measure of new H-1B worker certifications at firm i in year t. Even as we show results with both contemporaneous and next period's outcomes, our preferred specification looks at future reallocation. As proposed in other similar work (Argente, Lee and Moreira, 2018b), future product reallocation is less likely to be affected by contemporaneous shocks, and we expect that changes in firm dynamics occur with a lag. We include both firm μ_i and year τ_t fixed effects, and cluster errors at the firm level.

Our measures of $H1B_{i,t}$ worker certifications take on a few different forms. We look at the: (1) the number of LCAs filed by a firm each year, (2) the number of workers on certified LCAs each year (called "certified workers"), and (3) the number of workers from certified LCAs in each broad occupational group. We use the LCA-Nielsen sample for such regressions. Additionally, using the LCA-Nielsen-Compustat sample, we can (4) normalize the number of certified workers by total employment in the firm, using Compustat measures of employment.

Table 5 reports the coefficients of OLS regressions with the LCA-Nielsen merged sample. We find a strong positive association between the number of applications/ certifications and reallocation rates in both the current and the following year. When we divide certifications into four occupational categories, science / math and engi-

neering have the largest effect in magnitude but is imprecisely estimated. Software, is more precisely estimates and has a positive effect, which may be consistent with the type of innovations we capture with reallocation rates. Unlike patent data, we mostly capture incremental innovation, where it is possible that lower costs and a better quality of occupations that perform auxiliary functions may matter more.

Next we normalize our measures by the size of firms. The same number of high-skilled immigrants may affect firms differentially by firm size. We now calculate the share of applications/ certifications by normalizing them with the number of employees from Compustat. Table 6 reports the coefficients of OLS regressions with the LCA-Nielsen-Compustat merged sample. Once again we find a positive association between shares of applications/ certifications and reallocation rates. A one percentage point increase in the share of certifications is associated with a five percentage point increase in the reallocation rate.[10]

4.4 The Timing of Effects

To further investigate the timing of effects we use a distributed lead and lag model. Such a model allows us to check that future H-1B applications do not affect past reallocation rates, and to also study whether our outcomes of interest react contemporaneously or with a lag. While informative, however, these results should be interpreted carefully as we are not necessarily identifying a 'shock' in the number of

[10]The mean share of certifications is 0.047%, so a one percentage point increase in the share of certified workers corresponds to more than double the mean. The reallocation rate in Table 6 ranges from 0 to 200 with a mean of 25.85. A five percentage point increase in reallocation rates corresponds to a 20% increase at the mean. In other words, a 1% increase at the mean share of certified workers is associated with about a 0.2% increase at the mean of reallocation rates.

H-1B applications, which is instead a choice variable for the firm. In the following equation we describe the model:

$$r_{i,t} = \alpha + \beta_1 H1B_{i,t-1} + \beta_2 H1B_{i,t} + \beta_3 H1B_{i,t+1} + \mu_i + \tau_t + \epsilon_{i,t} \ , \tag{6}$$

while we would expect that past H-1B certifications $H1B_{i,t-1}$ affects re-allocation rates, we can also test to ensure that the number of future H-1B certifications $H1B_{i,t+1}$ is not correlated with current reallocation rates.[11]

In Figure 6 we can see that future H-1B applications do not affect lagged reallocation rates. Furthermore, the main impact on reallocation rates seem to show up with a one-period lag.

5 Conclusion

In this paper we highlight an important fact: H-1B applications are associated with higher rates of reallocation (entry and exit) of products at firms. Product reallocation is an integral part of Schumpeterian growth, driven by the discarding of older products and the generation of newer products. We complement the literature on patenting (capturing larger innovations) and highlight that smaller, incremental innovations are captured by measures of product reallocation.

At the firm-level we merge data on H-1B Labor Condition Applications with Nielsen scanner data on products and Compustat data on firm characteristics. We find that H-1B LCAs are strongly associated with product reallocation, which in

[11] As we have a limited number of years in our data it is statistically challenging to include more leads and lags.

turn is associated with firm revenue growth.

Our work is consistent with work showing that high-skill migrants are strongly associated with higher patenting activity (Kerr and Lincoln, 2010; Hunt and Gauthier-Loiselle, 2010). Measures of firm patenting and new product entry should be thought of as complementary, yet capturing different aspects of a firm's innovation ladder. While patenting may be more associated with newer methods of production and newer inputs into final goods, we study the entry and exit of final goods as and when they show up in the consumer market. Yet, other work that uses variation generated by the H-1B lottery, finds little effect on patenting activity (Doran, Gelber and Isen, 2017). We find it, therefore, important to study alternative measures of firm innovativeness to get a comprehensive picture of firm dynamics.

Importantly, as we look at consumer goods, we may expect that such activity affects consumer welfare as well. In Khanna and Lee (2018) we study how prices and the variety of products in the consumer goods market changes, as firms introduce newer products and produce older products more efficiently when they wish to hire H-1B workers.[12] Such changes affect the welfare of consumers and alter quantitative estimates of the overall impacts of high-skill immigration on the US economy.

[12]This work is closely related to the findings of Cortes (2008) that finds that low-skill immigration lowers the prices of non-tradable goods and services like housekeeping and gardening. In contrast, we estimate the effects of high-skill migration at the firm level on prices and varieties of tradable products.

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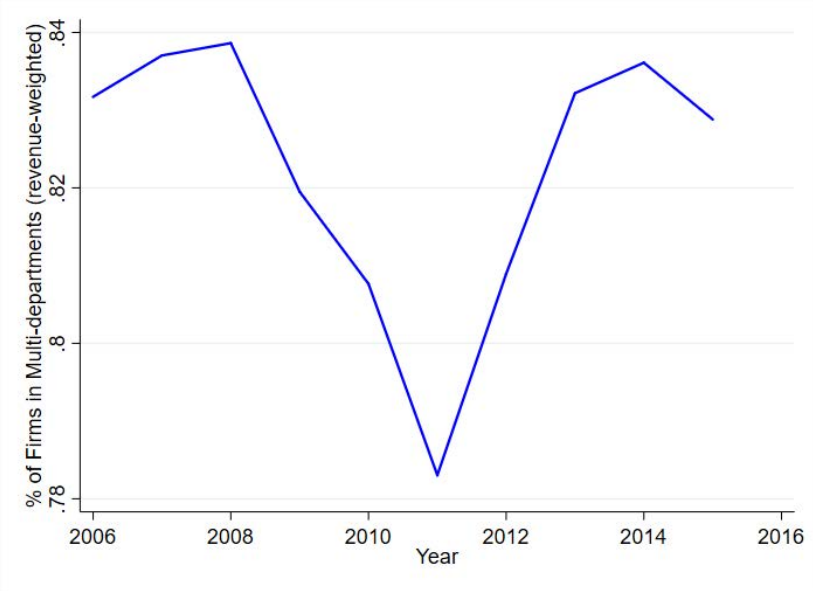
Figure 1: Example of a Company Prefix

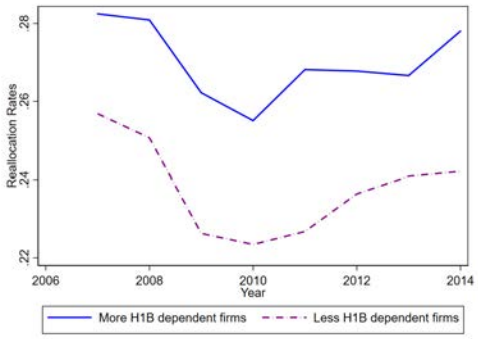
Note: This figure shows examples of a 6- and a 9-digit firm prefix. The source is the GS1-US website (http://www.gs1-us.info/company-prefix).

Figure 2: Share of Firms in Multi-Departments

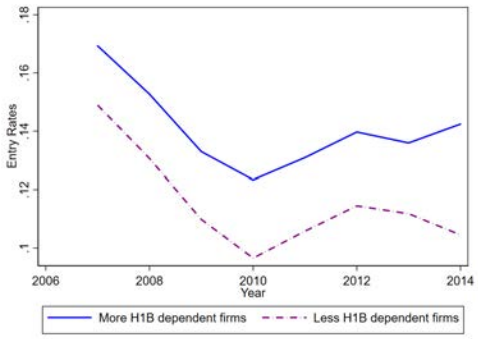


Note: This figure shows the share of firms operating in more than one product departments. The share is calculated with real revenue weights. The ten major departments are: Health and Beauty aids, Dry Grocery (e.g., baby food, canned vegetables), Frozen Foods, Dairy, Deli, Packaged Meat, Fresh Produce, Non-Food Grocery, Alcohol, and General Merchandise.

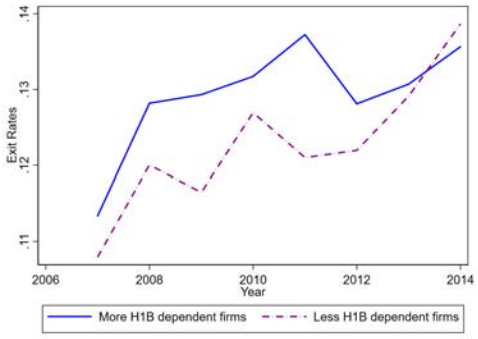
Figure 3: Product Entry, Exit and Reallocation Over the Business Cycle



(a) Reallocation Rates



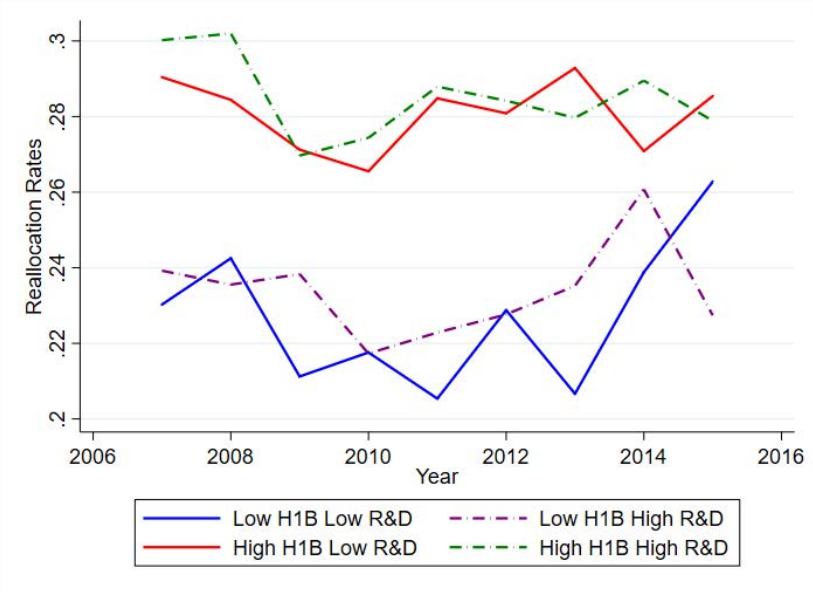
(b) Entry Rates



(c) Exit Rates

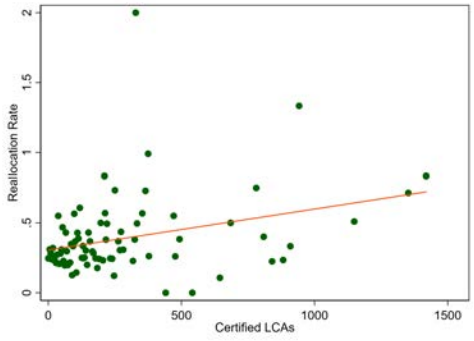
Note: This figure shows product reallocation rates, entry rates and exit rates by type of firm using the LCA-Nielsen sample. Reallocation rates range from 0 to 2, whereas entry and exit rates range between 0 and 1. More H-1B dependent firms have at least one H-1B worker application in the 2000-1 (the first year of our LCA data), whereas less H-1B dependent firms have no H-1B worker applications in 2000-1.

Figure 4: Product Reallocation by H-1B dependency and R&D propensity

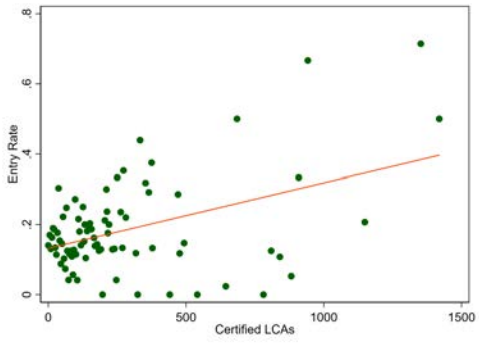


Note: This figure shows the reallocation rates by type of firm using the LCA-Nielsen-Compustat sample. Reallocation rates range between 0 and 2. More H-1B dependent firms have at least one H-1B worker application in 2000-1 (the first year of our H-1B data), whereas less H-1B dependent firms have no H-1B worker applications in 2000-1. Low R&D have below median R&D expenditures as a proportion of sales in 2000-1. High R&D have above median R&D expenditures as a proportion of sales.

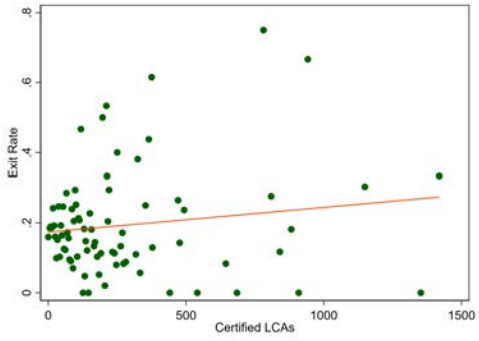
Figure 5: Product Entry, Exit and Reallocation v Number of Certified H-1B Workers



(a) Reallocation Rates



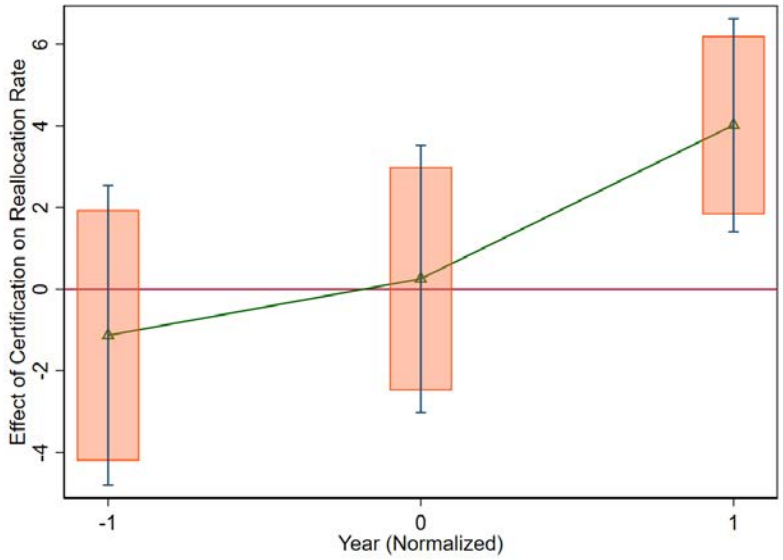
(b) Entry Rates



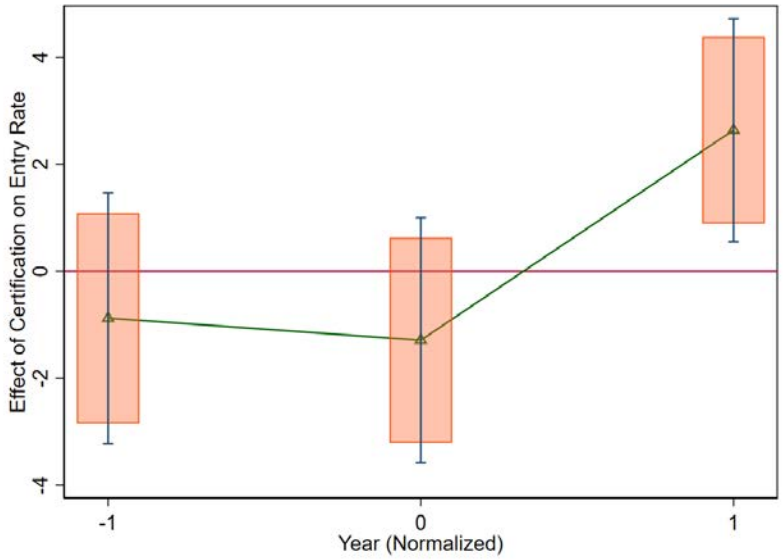
(c) Exit Rates

Note: This figure shows product reallocation rates, entry rates and exit rates by the number of certified workers in the LCA data. Reallocation rates range from 0 to 2, whereas entry and exit rates range between 0 and 1. LCAs that are certified (not withdrawn or denied) list the number of workers that a firm wishes to hire. This measure is the number of certified workers. The LCA-Nielsen sample pooled across firms and over 2006-15 is used. Values are binned at each unique point of the x-axis (number of certified LCA workers).

Figure 6: Distributed Lead and Lag Model



(a) Reallocation Rates



(b) Entry Rates

Note: This figure shows the impact of number of certified workers from H-1B LCAs on product reallocation rates and entry rates. Reallocation rates range between 0 and 200, whereas entry rates range between 0 and 100. LCAs that are certified (not withdrawn or denied) list the number of workers that a firm wishes to hire. This measure is the number of certified workers. We use a distributed lead and lag model to estimate the coefficients. The LCA-Nielsen-Compustat sample over 2006-15 is used. Standard errors are clustered at the firm level.

Table 1: Facts on Nielsen Retail Scanner Data

The table reports basic facts on the Nielsen Retail Scanner Data.

	Nielsen Retail Scanner Data
Time period	2006-2015
Coverage	1,071 modules, 114 groups
Observational units	Store
# of stores	35,510 stores
# of states	49
# of counties	2,550
# of products in 2006	724,211
Frequency	Weekly, average
Tag on temporary sales	none

Table 2: Descriptive Statistics for Two Merged Samples

The table reports descriptive statistics for two merged samples: (i) LCA-Nielsen and (ii) LCA-Nielsen-Compustat.

Merged Samples:	(1) LCA-Nielsen	(2) LCA-Nielsen-Compustat
Number of Firms	36,218	482
Years	2006-2015	2006-2015
Variables from LCA		
Average # of Certified Workers	0.79	20.72
Variables from Nielsen		
# of Observations	235,522	4,022
Average Firm Revenue (USD)	6.25 million	154 million
Average Reallocation Rates (0-2)	0.1944	0.2585
Variables from Compustat		
# of Observations	-	4,565
Average # of Employees	-	43,841
Average R&D to Sales	-	0.251

Table 3: Reallocation Activities and Revenue Growth

The table reports the coefficients of OLS regressions with the LCA-Nielsen merged sample. The dependent variable is the revenue growth rate in the next year: the change in revenues between year t and $t+1$. The product reallocation rate is defined as the product entry rate plus the product exit rate at the firm level, as defined in the main text. Reallocation rates range from 0 to 2, whereas entry and exit rates range between 0 and 1. Revenue growth rates are winsorized at the 1% level. Standard errors are clustered at the firm level and presented in parentheses. ***, **, and * represent statistical significance at 1%, 5%, and 10% levels, respectively.

Dep. var: $\Delta Log(Revenue)_{i,t+1}$	(1)	(2)	(3)
Product Reallocation Rate	0.432		
	(0.0235)***		
Product Entry Rate		1.240	
		(0.0210)***	
Product Exit Rate			0.355
			(0.0377)***
Observations	147,723	179,502	147,723
R-squared	0.013	0.063	0.009
Number of Firm	27,574	31,626	27,574
Fixed Effects	Year and Firm	Year and Firm	Year and Firm
Cluster	Firm	Firm	Firm

Table 4: Reallocation Rates by Firm H-1B Status and R&D or Revenue

Panel A compares reallocation rates across H-1B propensity and R&D expenditures (as a fraction of sales) using the LCA-Nielsen-Compustat sample. R&D expenditures as a fraction of sales are divided at the median. Panel B compares reallocation rates across H-1B propensity and firm revenue across all products in their portfolio using the LCA-Nielsen sample. Reallocation rates range from 0 to 2. Revenue is divided at the median. Low H-1B is defined as having no H-1B worker applications in 2000-1. High H-1B is defined as having at least one H-1B worker application in 2000-1.

Panel A: Reallocation Rates by H-1B and R&D propensity

	Low R&D	High R&D	Difference
High H-1B	0.289	0.286	-0.002
SE	(0.019)	(0.013)	(0.022)
N	48	62	
Low H-1B	0.247	0.242	-0.006
SE	(0.011)	(0.012)	(0.017)
N	78	63	
Difference	0.041	0.044	
SE	(0.021)	(0.018)	

Panel B: Reallocation Rates by H-1B and Revenue

	Low Revenue	High Revenue	Difference
High H-1B	0.266	0.260	-0.005
SE	(0.008)	(0.003)	(0.007)
N	305	555	
Low H-1B	0.197	0.189	-0.008
SE	(0.001)	(0.001)	(0.001)
N	10442	12170	
Difference	0.069	0.072	
SE	(0.007)	(0.003)	

Table 5: LCA Application/Certification and Reallocation Activities

The table reports the coefficients of OLS regressions with LCA-Nielsen merged sample. The dependent variable is the product reallocation rates this and next year. Reallocation rates range from 0 to 200. The product reallocation rate is defined as the product entry rate plus the product exit rate at the firm level as defined in the main text. The number of applications is the number of LCAs filed by a firm. The number of certifications is the number of workers on LCAs that were certified. The occupation composition is the number of workers in each occupation from LCAs that were certified. Standard errors are clustered at the firm level and presented in parentheses. ***, **, and * represent statistical significance at 1%, 5%, and 10% levels, respectively.

Dep. var:	Reallocation Rate in year t			Reallocation Rate in year $t+1$		
	(1)	(2)	(3)	(4)	(5)	(6)
Number of Applications	0.00217			0.00118		
	(0.000413)***			(0.000615)*		
Number of Certifications		0.00291			0.00140	
		(0.000466)***			(0.000767)*	
By Occupations:						
Software			0.00217			0.00166
			(0.000471)***			(0.000294)***
Science, Math and Engineer			0.0300			0.0206
			(0.0446)			(0.0274)
Manager			-0.00273			0.000558
			(0.00976)			(0.0260)
Finance, Analyst and Marketing			0.0359			-0.000832
			(0.0196)*			(0.0228)
Observations	183,554	183,554	183,554	181,451	181,451	181,451
R-squared	0.003	0.003	0.003	0.003	0.003	0.003
Number of firm	31,876	31,876	31,876	31,685	31,685	31,685
Fixed Effects	Year and Firm	Year and Firm	Year and Firm	Year and Firm	Year and Firm	Year and Firm
Cluster	Firm	Firm	Firm	Firm	Firm	Firm
Type	OLS	OLS	OLS	OLS	OLS	OLS

Table 6: Applying/Certified Immigrant Worker Shares and Reallocation Activities

The table reports the coefficients of OLS regressions with LCA-Nielsen-Compustat merged sample. The dependent variable is the product reallocation rates this and next year. Reallocation rates range from 0 to 2. The product reallocation rate is defined as the product entry rate plus the product exit rate at the firm level as defined in the main text. The share of applications is the number of LCAs filed by a firm divided by the total employment base in Compustat. The share of certifications is the number of workers on LCAs that were certified divided by the total employment base in Compustat. The occupation composition is the number of workers in each occupation from LCAs that were certified divided by the total employment base in Compustat. Standard errors are clustered at the firm level and presented in parentheses. ***, **, and * represent statistical significance at 1%, 5%, and 10% levels, respectively.

Dep. var:	Reallocation Rate in year t			Reallocation Rate in year $t+1$		
	(1)	(2)	(3)	(4)	(5)	(6)
Share of Applications	3.910			5.077		
	(2.693)			(2.040)**		
Share of Certifications		4.242			5.593	
		(2.789)			(2.034)***	
By Occupations:						
Software			4.839			9.344
			(1.238)***			(0.732)***
Science, Math and Engineer			-0.915			0.203
			(2.140)			(1.402)
Manager			8.953			5.854
			(5.095)*			(4.384)
Finance, Analyst and Marketing			0.771			1.098
			(2.016)			(2.221)
Observations	2,742	2,742	2,742	2,800	2,800	2,800
R-squared	0.015	0.016	0.022	0.022	0.022	0.029
Number of firm	416	416	416	429	429	429
Fixed Effects	Year and Firm	Year and Firm	Year and Firm	Year and Firm	Year and Firm	Year and Firm
Cluster	Firm	Firm	Firm	Firm	Firm	Firm
Type	OLS	OLS	OLS	OLS	OLS	OLS

Hughes Declaration

Exhibit 27

Policy Brief
July 2020
UC Davis Global Migration Center

Presidential Executive Actions Halting High Skilled Immigration Hurt the US Economy

By Giovanni Peri, University of California, Davis
Chad Sparber, Colgate University

On June 22, the Trump Administration issued a proclamation suspending the processing of new visas for high skilled foreign workers seeking US employment through the H-1B and related programs. The administration argued that "Under ordinary circumstances, properly administered temporary worker programs can provide benefits to the economy. But under the extraordinary circumstances of the economic contraction resulting from the COVID-19 outbreak, certain nonimmigrant visa programs authorizing such employment pose an unusual threat to the employment of American workers (White House 2020)." That view is myopic and inconsistent with what we know from economic research. Moreover, it represents just the latest of several recent decisions from the current administration designed to discourage many forms of legal entry for skilled foreign workers. In fact, economic evidence suggests that such restrictions will reduce long-term economic growth while also failing to increase the employment of Americans. In short, the suspension of H-1B visas will ultimately have a negative impact on the American economy.

The H-1B Program

The H-1B program allows high-skilled foreign-born workers in specialty occupations to temporarily work in the United States (US Dep. of Labor 2020). New H-1B issuances are capped at 65,000 per year, plus an additional 20,000 for workers who have obtained a master's degree or higher education from a US institution. Employees of universities and non-profit research institutions are exempt from this cap.

Limits on new H-1B issuances have not changed for 16 years despite evidence that those workers are in high demand from public and private US employers. The program is vastly oversubscribed in the sense that the number of cap-bound applications far exceeds the number of available H-1Bs. United States Citizen and Immigration Services (USCIS) has received around 200,000 applications during the first week of the application period in each of the last several years and has allocated H-1Bs by a random lottery. Consequently, each year, many companies are unable to hire the workers they choose to fill their positions. The H-1B system is also somewhat rigid. For instance, firms cannot reallocate an H-1B approval from a lottery winner to a losing job candidate whom it would prefer to hire if they sponsored more than one person for an H-1B.

In addition, the H-1B program is not perfect and there are several proposals to improve it. For instance, close employer/employee links inherent to the program might limit labor mobility and shift market power to firms. While some people emphasize that H-1B workers are "tied" to their company in a way that make them exploitable, evidence in Depew, Norlander, and Sorensen (2017) and Hunt and Xie (2019) suggest that workers are more mobile than critics fear. We have separately written articles describing how to improve the H-1B program by injecting market mechanisms into the allocation process. Sparber (2018) argues that GDP would increase by $26.5 over a six-year period if the government abandoned the lottery and instead allocated H-1Bs according to firm willingness to pay (that is, to applicants with the highest wage offers). Peri (2012) argues for an auction mechanism in which the total number of available H-1Bs would be tied to national labor market conditions, declining in a recession and expanding in a boom. This has nothing in common with the policy of the current administration. First, it would have implied an expansion of the number of H-1Bs during the past ten years when the US was characterized by strong economic growth and – at least in the last three years – tight labor markets. Second, the "right" average number of new H-1B workers is certainly not zero. We have written several papers arguing that the H-1B program should expand, not contract, because there is ample evidence on the long-term benefits of high skilled foreign labor for the American economy.

The Economic Effects of High Skilled Foreign Labor

The National Academies of Sciences, Engineering, and Medicine (2017) survey on the economics of immigration summarized the consensus of economists and social scientists when it stated, "The infusion by high-skilled immigration of human capital... has boosted the nation's capacity for innovation and technological change. The contribution of immigrants to human and physical capital formation, entrepreneurship, and innovation are essential to long-run sustained economic growth. Innovation carried out by immigrants also has the potential to increase the productivity of natives, very likely raising economic growth per capita. In short, the prospects for long-run economic growth in the United States would be considerably dimmed without the contributions of high-skilled immigrants."

These conclusions are driven by evidence from three related lines of research that have emerged over the last decade. The first – mostly associated with work by Hunt and Gauthier-Loiselle (2010) and Hunt (2011, 2015) – argues that immigrants are on average more entrepreneurial and innovative than natives . Part of this can be explained by the drive and motivation that selects several highly entrepreneurial and motivated people to migrate (Anelli et al. 2020). Another part of it is explained by the selection process by US companies and US universities. American-born workers exhibit a full distribution of skills and ability, some of whom are quite innovative and some of whom are not. In contrast, US universities and employers only select the highest skilled foreign students and workers to enter the country. The average skill sets of those immigrants will be highly targeted to success by design. In other words, the US attracts the best and brightest from the world to its universities, companies, and laboratories.

The second reason recognizes important differences in the occupations, college majors, and skill specialization between native and foreign workers. This enriches the set of available skills in the US and the diversity of abilities associated with greater productivity and innovation potentials in the aggregate. Evidence in Peri and Sparber (2011), Orrenius and Zavodny (2015), Shih (2016, 2017), Bacolod and Rangel (2017), Lin (2019) and others argues that among high skilled workers, immigrants tend to specialize in quantitative skills and STEM fields whereas natives specialize in communication and social skills. The combination of these two types of skills allows the US to produce, innovate, and grow at a faster rate. Moreover, the observed skill differences and complementarities between natives and immigrants are a key reason why economists do not find job displacement following the inflow of immigrants (e.g. Ottaviano and Peri 2012, Peri and Sparber 2009). Immigrants, especially the highly skilled ones, generate local opportunities for firms and US workers that imply no overall decline in US employment or wages.

The third reason finds its roots in the research in economic growth (e.g. Jones (2002)) arguing that scientists and engineers create new technologies that generate positive production externalities and are responsible for half of long-run US productivity growth. Such growth, in the long run, is crucial to enhancing income per capita and wages, and hence for sustaining better conditions for large parts of the US economy. As it is true that high-skilled immigrants specialize in STEM work and that STEM workers are responsible for half of US economic growth, then it follows that high-skilled immigrants are responsible for a large share of US economic growth. A number of empirical studies have validated this argument including Kerr and Lincoln (2010), Kerr, Kerr, and Lincoln (2015), and Gunadi (2019). Peri, Shih, and Sparber (2015) argue that "inflows of foreign STEM workers explain between 30% and 50% of the aggregate productivity growth that took place in the United States between 1990 and 2010." An important corollary is that by attracting and hiring high skilled immigrants, US cities and local economies can feed a virtuous cycle of increased growth and more opportunities for US workers. There is strong evidence (e.g. Moretti 2010) that one high-skilled job generates a "local multiplier" attracting other jobs rather than displacing them.

It is in this context for missed growth opportunities that high skilled immigration restrictions cause particular alarm among economists. The world competes for global talent. Lost technological and productivity growth in the US could mean increased growth elsewhere. For example, Glennon (2020) argues that H-1B restrictions cause firms to increase their offshore operations, particularly in Canada, India, and China. Such losses in the competition for productive skilled labor inflows prompt Kerr et al. (2017) and Kerr (2019) to refer to restrictions on H-1B and related skilled labor inflows as a form of "national suicide."

Immigration Policies in Times of Economic Crisis

Times of economic contraction lead to potential changes in immigration dynamics. On one hand, contractions temporarily reduce the incentives to immigrate for economic reasons (see Cadena and Kovak (2016)) and generate a decline in the inflow of immigrants. On the other hand, economic crises may generate anti-immigrant sentiments in the population. These two forces have converged in the past leading governments to pass strong anti-immigration policies with long-term negative effects on the economy. An example is the Hoover administration's encouragement of Mexican repatriation during the Great Depression. These actions violated civil rights (Johnson 2005) and, as shown by Lee et al. (2019), hurt job opportunities for natives since those massive deportations contributed to the decimation of economies close to the Mexican Border, leading firms and other American workers to leave.

The continued reduction of opportunities for legal immigration produced by this administration's executive orders will likely have no positive short-run effects but will risk dire long run implications. This takes place against the backdrop of already declining US immigration in the last ten years (see Immigration Fact by Giovanni Peri). The restrictive policies of the last three years, culminating with the halt of H-1B processing in this latest Executive Order, will deprive the US of skills and talents that would have helped the economic recovery.

Relevant Immigration Policy Changes by the Trump Administration

NAFSA: Association of International Educators (2020) records a non-exhaustive list of 14 executive orders, presidential proclamations, and presidential memoranda aimed at reducing immigration flows that have occurred during the Trump Administration. Particularly significant policy decisions have been followed by several smaller agency-level memoranda that have altered the governance of the nation's immigration system. Taken together they constitute an alarming push towards more restrictive immigration policies, only recently justified by the COVID-19 emergency.

Relevant changes regarding foreign-born college students and skilled workers have included the following:

- Attempts to repeal Deferred Action for Childhood Arrivals (DACA);
- Requirements for USCIS adjudicators to apply the same scrutiny to applications for H-1B renewals as it does for new petitions;
- Increased issuances of Requests for Evidence (RFEs) on H-1B petitions;
- The suspension of premium (fast track) processing for H-1B petitions;
- Increased limitations for workers on H-1B and Optional Practical Training (OPT) status (that is, recent US college graduates) from working at third-party client sites – a significant limitation for software and other consultants;
- Increased site visits by Immigration and Customs Enforcement (ICE) agents (see Fitzgerald and Singh Rogers (2018)).

Thus, even if one accepts the argument that restrictions are justified during downturns, there remains a worrying reality that the June 22 proclamation represents just the latest in a series of the administration's efforts to curtail legal immigration. Economic evidence shows that the long-term consequences of these actions on reduced GDP and productivity growth are potentially disastrous.

About Our Center

The UC Davis Global Migration Center studies immigration with a multi-disciplinary approach to better understand the immigration and integration of vulnerable migrants, including undocumented immigrants, temporary migrants and more.

For more information, visit us online at:

globalmigration.ucdavis.edu

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Hughes Declaration

Exhibit 28

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STEM Workers, H 1B Visas, and Productivity in US Cities
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STEM Workers, H-1B Visas, and Productivity in US Cities

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Science, technology, engineering, and mathematics (STEM) workers are fundamental inputs for innovation, the main driver of productivity growth. We identify the long-run effect of STEM employment growth on outcomes for native workers across 219 US cities from 1990 to 2010. We use the 1980 distribution of foreign-born STEM workers and variation in the H-1B visa program to identify supply-driven STEM increases across cities. Increases in STEM workers are associated with significant wage gains for college-educated natives. Gains for non-college-educated natives are smaller but still significant. Our results imply that foreign STEM increased total factor productivity growth in US cities.

I. Introduction

Science, technology, engineering, and mathematics (STEM) workers are the primary contributors to the creation and adoption of technological in-

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novation, the fundamental driver of sustained economic growth. The importance of STEM innovations has long been recognized by growth economists. Griliches (1992) and Jones (1995), for example, have used measures of scientists and engineers to identify research and development (R&D) contributions to idea production, with the latter study arguing that scientists and engineers are responsible for 50% of long-run US productivity growth. A related literature (e.g., Katz and Murphy 1992; Acemoglu 2002; Autor, Katz, and Kearney 2006) has noted that technological innovation during the past 30 years has not increased the productivity of all workers equally. The development of new technologies—especially information and communication technologies (ICT)—significantly increased the productivity and wages of college-educated workers. They had a much smaller effect on the demand for non-college-educated workers, which has remained rather stagnant.

Importantly, while technological and scientific knowledge is footloose and spreads across regions and countries, STEM workers are less mobile. Tacit knowledge and face-to-face interactions influence the speed with which new ideas are locally adopted. Several studies (e.g., Moretti 2004a, 2004b; Iranzo and Peri 2009) have illustrated that concentrations of college-educated workers spur local productivity. Others have shown the tendency for innovation- and idea-intensive industries to agglomerate (Ellison and Glaeser 1999; Glaeser 2011; Moretti 2012) and for ideas to remain local generators of virtuous innovation cycles (Jaffe, Trajtenberg, and Henderson 1993; Saxenian 2002).

This article sits at the intersection of these literatures. We quantify the long-run effect of increased city-level STEM employment on labor market outcomes for STEM, college-educated, and non-college-educated native-born workers. Sections II and III describe our empirical specification and data. The challenge of the exercise is to identify variation in the growth of STEM workers across US metropolitan statistical areas (MSAs, or cities) that is supply driven and hence exogenous to other factors that affect local wages, employment, and productivity. We do this by exploiting the introduction of the H-1B visa in 1990 and the differential effect that these visas had in bringing foreign-born college-educated workers (mostly STEM workers) to 219 US cities from 1990 to 2010. The H-1B policy changes were national in scope but had differentiated local effects because foreign STEM workers were unevenly distributed across US cities before the inception of the H-1B visa program. Migrant preferences and the availability of information spread by ethnic networks led subsequent inflows of H-1B workers to concentrate in areas with a large preexisting foreign STEM presence.

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Our identification strategy is rooted in methods used by Altonji and Card (1991), Card (2001), and Kerr and Lincoln (2010). First, we measure foreign STEM workers as a share of employment in each MSA in 1980. This share exhibits large variation. Next, we predict the number of new foreign STEM workers in each city by allocating the H-1B visas to 14 foreign nationality groups in proportion to their city-level presence in 1980. This H-1B-driven imputation of future foreign STEM is a good predictor of the actual increase of both foreign STEM and overall STEM workers in a city over subsequent decades. Thus, we use this prediction as an instrument for the actual growth of foreign STEM workers in order to obtain causal estimates of the impact of STEM growth on the wages and employment of college-educated and non-college-educated native-born workers.

The 1980 distribution of foreign STEM and the overall inflow of H-1B workers between 1990 and 2010 could be correlated with unobservable city-specific shocks that affect employment and wage growth, so Section IV explores the power and validity of our instrumental variable strategy. We check that the initial industrial structure of the metropolitan area, the 1980 distribution of other types of foreign-born workers (e.g., less educated and manual workers), and the subsequent inflow of non-STEM immigrants do not predict foreign STEM employment growth. We also show that the trends of native outcomes prior to the inception of the H-1B program (1970–80) were uncorrelated with the H-1B-driven growth in STEM workers from 1990 to 2010. Finally, our demanding regression specifications always include both city and period fixed effects while relying on changes in growth rates of H-1B-driven STEM workers within MSAs over time for identification.

The main regression estimates are in Section V. Our preferred specifications reveal that a rise in foreign STEM growth by 1 percentage point of total employment increases wage growth of college-educated natives by 7–8 percentage points. The same change had a smaller but usually significant effect on non-college-educated native wage growth equal to 3–4 percentage points. We find no statistically significant effects for native employment growth.

Section VI closes the analysis by introducing a simple model of city-level production and combining it with our estimated parameters to simulate the effect of STEM on total factor productivity and skill-biased productivity. When we aggregate at the national level, inflows of foreign STEM workers explain between 30% and 50% of the aggregate productivity growth that took place in the United States between 1990 and 2010. This range is consistent with Jones's (2002) analysis of science and engineering contributions to productivity growth. We also find that foreign STEM inflows account for a more modest 4%–8% of US skill-biased technological change.

II. Empirical Framework

Our empirical analysis uses variation in foreign-born STEM workers across US cities (c) and time periods (t) to estimate their impact on native wages and employment. We discuss identification and its challenges in Section IV. The basic specifications we estimate in Section V take the form

$$y_{ct}^{\text{Native},X} = \phi_t + \phi_c + b_{y,X} \cdot \frac{\Delta \text{STEM}_{ct}^{\text{Foreign}}}{E_{ct}} + b_3 \cdot \text{Controls}_{ct}^{X} + \varepsilon_{ct}. \quad (1)$$

The variable $y_{ct}^{\text{Native},X}$ is the period change in outcome y (either employment or average weekly wages) for the subgroup of natives with skill X (either STEM workers, college-educated workers, or non-college-educated workers), standardized by the initial year outcome level. The term ϕ_t captures period fixed effects, while ϕ_c captures city fixed effects. The variable $\Delta \text{STEM}_{ct}^{\text{Foreign}}/E_{ct}$ is the change of foreign STEM over a period, standardized by a city's initial total employment (E_{ct}). The term Controls_{ct}^{X} includes other city-specific controls, and ε_{ct} is a zero mean idiosyncratic random error. The specification implies that identification relies on variation in the growth of foreign STEM workers within cities over time periods.

Our analysis spans 1990–2010, and we choose to partition these two decades into three specific time periods: 1990–2000, 2000–2005, and 2005–10. This enables us to exploit the large variation in national H-1B policy that occurred between 2000 and 2005 relative to the other periods. Additionally, this facilitates (unreported) robustness checks that remove the 2005–10 period to avoid influence from the Great Recession.[1]

The coefficient $b_{y,X}$ captures the elasticity of outcome y, for worker group X, to an exogenous increase in STEM workers. Interpreting these estimates as causal requires changes in $\text{STEM}_{ct}^{\text{Foreign}}$ that are exogenous to productivity shocks and other unobservable determinants of city-level wage and employment changes. Before turning attention to this challenge, we describe our data, STEM employment measures, the construction of the H-1B-driven foreign STEM instrument, and our instrument's power.

III. Data: STEM Workers in US Cities

We develop two separate methods of defining STEM occupations. Each method also uses both a more inclusive and a more restrictive STEM identification criterion, resulting in four possible STEM definitions. The first method is based on skills that workers use in their occupations. We use the US Department of Labor's (2012) O*NET database, which measures the occupation-specific importance of several dozen skills required

[1] Estimates are robust to removing the Great Recession. Similarly, they remain robust when constructing variables over 1990 2000 and 2000 2010. Results are available on request.

to perform the job. We select four O*NET skills that involve STEM use, namely, mathematics in problem solving, science in problem solving, technology design, and programming. We then compute the average score of each occupation across the four skills and rank the 331 occupations consistently identified in the 1980–2010 census according to the average STEM skill value defined above.[2] We classify STEM occupations as those employing the top 4% (strict definition) or 8% (broad definition) of workers in that ranking in the year 2010; O*NET 4% (or 8%) STEM workers are the individuals with these occupations.

Our second method for identifying STEM occupations is based on the skills workers possess before employment—the college majors found among workers within occupations. The US State Department recognizes a list of STEM majors for the purpose of granting foreign students extended time to work under the Optional Practical Training (OPT) program.[3] We rank occupations on the basis of the 2010 ACS share of individuals with a college degree in a STEM major. We then classify STEM occupations as those employing the top 4% (strict) or 8% (broad) of workers following that ranking in 2010. Major-based 4% (or 8%) STEM workers are the individuals within those occupations. Both the O*NET and major-based strict definitions include mainly census occupations with "scientist" or "engineer" in the title. Major-based STEM occupations largely coincide with O*NET STEM occupations.

A. H-1B Visa Policy Changes

Our analysis exploits large shifts in national H-1B visa policy between 1990 and 2010 as an exogenous source of variation in the inflow of foreign STEM workers across US cities to identify the effect of STEM workers on the wages and employment of native-born workers. The H-1B visa, introduced in 1990, provides temporary permits for college-educated foreign "specialty" workers. The visa has been a crucial channel of admission for many college-educated foreign-born workers employed in STEM occupations.[4] Set initially at 65,000 H-1B visas annually, the cap rose to 115,000 for

[2] We make small refinements to the census occupational classification in order to ensure complete time consistency in the availability of occupations over the 1980 2010 period. A detailed description of both of our STEM definitions, as well as the refinement of occupations, is available in the online appendix.

[3] There is no direct crosswalk between majors listed under the OPT STEM clas sification and major categories in the 2010 American Community Survey (ACS). Thus, our list is consistent with, but not identical to, OPT STEM degree fields.

[4] Lowell (2000) notes that 70% of H 1B visas have been awarded to people em ployed as computer analysts, programmers, electrical engineers, university pro fessors, accountants, other engineers, and architects. Similarly, US Citizenship and Immigration Services (various years) reports that for all years between 2004 and 2011, more than 85% of new H 1B visa holders worked in computer science, health science, accounting, architecture, engineering, and mathematics.

fiscal years 1999 and 2000 and then to 195,000 per year for 2001, 2002, and 2003. It reverted to the original 65,000 beginning in 2004. Though the limit officially remains at 65,000, the first 20,000 H-1B visas issued to individuals who have obtained a graduate degree in the United States became exempt from H-1B limits beginning in 2005, effectively raising the cap to 85,000.[5]

Not only has the size of the H-1B program varied greatly since its inception, but the ensuing inflow of foreign STEM workers has been heterogeneously distributed across US cities as well. Part of these cross-city differences was certainly due to varying economic conditions, industrial structures, and labor demand influencing wage and employment growth. Importantly, however, a portion of this variation was due to persistent immigrant preferences to locate in cities with historical communities of past immigration. The 1980 distribution of STEM workers by nationality proxies for these historical settlements. Our analysis needs to capture only the heterogeneity in foreign STEM created by this differential initial presence (in 1980) of foreign enclaves by nationality that are exogenous to other determinants of future city-level native wage and employment growth. To do this we construct an H-1B-driven instrument that retains only the portion of growth in foreign STEM attributable to national policy fluctuations, and our regressions account for city-specific factors that may have attracted foreign STEM and native workers alike.

B. The H-1B-Driven Increase in STEM

Our data on the occupations, employment, wages, age, and education of individuals come from the Ruggles et al. (2010) Integrated Public Use Microdata Series (IPUMS) 5% census files for 1980, 1990, and 2000; the 1% ACS sample for 2005; and the 2008–10 3% merged ACS sample for 2010. We use data only on 219 MSAs consistently identified from 1980 through 2010. These span a range of US metropolitan sizes, including all the largest cities in the United States down to MSAs with close to 200,000 people (Danville, VA, Decatur, IL, Sharon, PA, Waterbury, CT, Muncie, IN, and Alexandria, PA, are the six smallest). Data on aggregate H-1B flows by nationality and year are publicly available from the US Department of State (2012).

We construct our H-1B-driven increase in STEM workers variable for each city between 1990 and 2010. This captures supply-driven variation in the growth of foreign STEM workers, which we use as an instrumental variable to estimate equation (1). To create this instrument, we first impute the number of foreign STEM workers in city c and year t:

$$\widehat{\text{STEM}}_{ct}^{\text{FOR}} = \sum_{n=1}^{14} \text{STEM}_{c1980}^{\text{FOR}_n} \left(\frac{\widehat{\text{STEM}}_{t}^{\text{FOR}_n}}{\text{STEM}_{1980}^{\text{FOR}_n}} \right). \tag{2}$$

[5] Kerr and Lincoln (2010) and Kato and Sparber (2013) provide more discussion on the H 1B visa and its economic effects.

The term $\text{STEM}_{c1980}^{\text{FOR}_n}$ is the number of foreign STEM workers of nationality n in city c in 1980.[6] The growth factor of all foreign STEM workers for each nationality in the United States between 1980 and year t is represented by $\widehat{\text{STEM}}_t^{\text{FOR}_n}/\text{STEM}_{1980}^{\text{FOR}_n}$. This is calculated by adding the inflow of STEM workers from each nationality between 1980 and t to its initial 1980 level. For the period 1980–90, we simply add the net increase in STEM workers from nationality n as recorded in the US census ($\Delta\text{STEM}_{1980\ 90}^{\text{FOR}_n}$). For later periods we use the cumulative H-1B visas allocated to each nationality ($\#\text{ of H1B}_{1990\ t}^{\text{FOR}_n}$).[7] The imputed growth factor for STEM workers for each foreign nationality in year t is therefore

$$\frac{\widehat{\text{STEM}}_t^{\text{FOR}_n}}{\text{STEM}_{1980}^{\text{FOR}_n}} = \frac{\text{STEM}_{1980}^{\text{FOR}_n} + \Delta\text{STEM}_{1980\ 90}^{\text{FOR}_n} + \#\text{ of H1B}_{1990\ t}^{\text{FOR}_n}}{\text{STEM}_{1980}^{\text{FOR}_n}}. \quad (3)$$

The H-1B-driven change in foreign STEM workers that we use as our instrument is the time period change in $\widehat{\text{STEM}}_{ct}^{\text{FOR}}$ standardized by the initial imputed city employment ($\widehat{E_{ct}}$).[8]

Our identification strategy is closely related to those used by Altonji and Card (1991) and Card (2001), who exploit the initial distribution of foreign workers across US cities. We use the initial distribution of foreign STEM workers across cities rather than all immigrants. In this regard, our

[6] We aggregate to 14 nationality groups: Canada, Mexico, rest of the Americas (excluding the United States), western Europe, eastern Europe, China, Japan, Korea, Philippines, India, rest of Asia, Africa, Oceania, and other. We choose 1980 as the base year in the imputation of foreign STEM for three reasons. First, it is the earliest census that allows the identification of 219 metropolitan areas. Second, it occurs well before the creation of the H 1B visa and hence does not reflect the distribution of foreign STEM workers affected by the policy. Third, it predates most of the ICT revolution so that the distribution of STEM workers was hardly affected by the geographic location of the computer and software industries.

[7] Data on visas issued by nationality begin in 1997. While we know the total number of H 1B visas issued in each year from 1990, we must estimate the total number of visas issued by nationality between 1990 and 1996 as

$$\#\text{ of } \widehat{\text{H1B}}_{n,1990\ t} \quad \#\text{ of H1B}_{1990\ t}\left(\frac{\#\text{ of H1B}_{n,1997\ 2010}}{\#\text{ of H1B}_{1997\ 2010}}\right),$$

where $\#\text{ of H1B}_{n,1997\ 2010}/\#\text{ of H1B}_{1997\ 2010}$ is the share of visas issued to nationality group n among the total visas issued from 1997 to 2010. For t larger than 1997, we have the actual number of yearly visas by nationality.

[8] To avoid endogenous changes in total employment at the city level, we also impute city employment by augmenting employment by nativity and skill level in 1980 by the corresponding growth factor in total national employment. Hence, $\widehat{E_{ct}^x}$ $E_{c1980}^x \times (E_t^x/E_{1980}^x)$, where x is native college educated workers, native non college educated workers, foreign college educated workers, and foreign non college educated workers. Thus, $\widehat{E_{ct}}$ $\Sigma_x\widehat{E^x}$, and the instrument is $\Delta\widehat{\text{STEM}}_{ct}^{\text{FOR}}/\widehat{E_{ct}}$.

methodology is more similar to Kerr and Lincoln's (2010) examination of the impact of H-1B flows on innovation. We distinguish our approach by using the foreign STEM presence in 1980, rather than in 1990, and by further differentiating immigrant groups by nationality, instead of using aggregate immigrants. We also use a more demanding panel specification, measuring variables in growth rates while including both city and time period effects. Before discussing the validity of our instrumental variables approach in detail, we present descriptive statistics that illustrate the significance of foreign-born STEM workers and the importance of the H-1B program in transforming the US STEM workforce.

C. Foreign STEM Summary Statistics

Foreign-born individuals have been persistently overrepresented in STEM occupations and have contributed substantially to the aggregate growth of STEM jobs in the United States.[9] Table 1 displays the foreign-born share of four different employment groups. Columns 1–4 represent the foreign-born percentage among total employment, college-educated workers, STEM occupations, and college-educated STEM workers—all calculated for the aggregate of 219 MSAs that we analyze. While foreign-born individuals represented about 16% of total US employment in 2010, they counted for more than 27% of college-educated STEM workers in the MSAs we analyze. This percentage has more than doubled since 1980.

Columns 1 and 2 of table 2 show that college-educated STEM workers have increased from 1.7% of total employment in 1980 to 3.2% in 2010. The share of college-educated foreign STEM workers has grown from 0.2% to 0.87%. Of the 0.78 point increase in college-educated STEM as a percentage of employment between 1990 and 2010, 0.53 percentage points (two-thirds of the total) were due to foreigners.

Columns 3–5 display changes in STEM employment and H-1B visas between periods. Column 3 reports the net total increase in college-educated STEM workers in the United States over the periods, and column 4 displays the rise in college-educated foreign STEM workers. While only one-fifth of the net increase in STEM workers between 1980 and 1990 was driven by foreigners, they were responsible for 77% of the net STEM growth between 1990 and 2000 and for more than the total growth from 2000 to 2010. Column 5 displays the cumulative number of H-1B visas issued between periods. It is clear that enough H-1B visas were issued to cover the whole growth in college-educated foreign STEM workers in the United States. Remarkably, H-1B issuances were three to four times as large as the net increase in college-educated STEM between 2000–2005 and 2005–10. This implies that many foreign STEM workers,

[9] In the summary statistics and in the empirical analysis we mainly use the O*NET 4% STEM definition unless we note otherwise.

Table 1
Summary Statistics: Percentage of Foreign-Born by Group, 219 MSAs

	Total Employment (%) (1)	College Educated Employment (%) (2)	Employment in STEM Occupations (%) (3)	College Educated Employment in STEM Occupations (%) (4)
1980	6.15	6.81	8.14	11.09
1990	8.82	8.95	10.98	14.24
2000	13.31	12.80	17.47	22.69
2005	15.37	14.81	20.03	25.76
2010	16.37	15.46	21.19	27.15

NOTE. The figures are obtained by the authors' calculations using IPUMS census data from 1980–2010. The relevant population includes only noninstitutionalized individuals between ages 18 and 65 who have worked at least 1 week in the previous year and report identified occupations. The statistics exclude those with unknown, unreported, or military occupations and individuals without a clearly identified birthplace who do not possess US citizenship through parents with US citizenship. STEM occupations are defined according to the O*NET 4% definition. College-educated workers have a bachelor degree or higher. The sample comprises 219 consistently identified MSAs from 1980–2010.

Table 2
Shares and Absolute Net Changes in STEM Employment, 219 MSAs

	Share of Employment (%)		Net Absolute Change from Previous Period (1,000s)		
Period	College Educated Total STEM (1)	College Educated Foreign STEM (2)	College Educated Total STEM (3)	College Educated Foreign STEM (4)	H 1B Visas Issued (5)
1980	1.76	.19			
1990	2.42	.34	915	218	0
2000	2.99	.68	670	518	574
2005	3.01	.77	109	208	659
2010	3.20	.87	164	146	653

NOTE. The figures in cols. 1 4 are obtained by the authors' calculations on data from 219 consistently identified MSAs in IPUMS census data from 1980–2010. The relevant population includes only noninstitutionalized individuals between ages 18 and 65 who have worked at least 1 week in the previous year and report identified occupations. The statistics exclude those with unknown, unreported, or military occupations and individuals without a clearly identified birthplace who do not possess US citizenship through parents with US citizenship. STEM occupations are defined according to the O*NET 4% definition. College-educated workers have a bachelor degree or higher. Data on the total number of H-1B and TN visas issued (col. 5) are from the Department of State (2012). H-1B numbers also include TN visas and are relative to the whole United States.

including H-1B recipients, have left the United States.[10] Overall, table 2 highlights the importance of foreign workers within STEM jobs and confirms that the scope of the H-1B program was large enough to substantially contribute toward foreign STEM growth since 1990.

[10] Depew, Norlander, and Sorensen (2013) provide a detailed analysis of quit and return rates for temporary skilled employees of six large Indian ICT firms. During the course of the survey period (2003 11), 29% of their sample returned to India.

IV. Identification: Power and Validity of the Instruments

Our identification strategy relies on the H-1B supply-driven instrument. Its validity is based, in large part, on the assumption that the 1980 employment share of foreign STEM workers varied across cities because of factors related to the persistent agglomeration of foreign communities in some localities. These historical differences—after controlling for an array of other city characteristics and shocks—affected the change in the supply of foreign STEM workers but were unrelated to shocks affecting city-level native wage and employment growth. Though our modeling choices aim to reduce the risk of correlation between the instrument and unobserved determinants of wage and employment growth, such confounding factors are of great concern. For example, the initial distribution of foreign STEM may be correlated with persistent city factors that influenced future labor market outcomes, resulting in omitted variables bias. Alternatively, aggregate inflows of H-1B workers might have been driven by a few specific cities. The presence of measurement error, more likely in cities with small populations, could lead to attenuation bias. This section tests our instrument's validity and addresses key challenges to our identification strategy.

The following first-stage regression provides a framework to explore these issues:

$$\frac{\Delta \text{STEM}_{ct}^{\text{FOR}}}{E_{ct}} = \phi_t + \phi_c + \beta \cdot \frac{\Delta \widehat{\text{STEM}}_{ct}^{\text{FOR}}}{\widehat{E_{ct}}} + \varepsilon_{ct}. \tag{4}$$

The coefficient β measures the impact of H-1B-driven STEM inflows—our instrument—on the measured increase in foreign STEM workers, the explanatory variable in our second-stage regression (1). This coefficient and its power are the main objects of interest for causal interpretation. The terms ϕ_t and ϕ_c capture period and MSA fixed effects. Changes refer to the periods 1990–2000, 2000–2005, and 2005–10. The zero-mean random error (ε_{ct}) is uncorrelated with the explanatory variable.

A. Basic Specifications and Checks

We tackle several threats to the identification assumptions and begin by showing that the 1980 presence of foreign STEM workers in cities did not always mirror the presence of native STEM workers. Table 3 shows the estimated coefficient (β) and the partial F-statistic from first-stage regression equation (4). The coefficients reported in the first and the second rows are the β and the F-statistics of the instrument when using the O*NET STEM definition for both the endogenous variable and the instrument. Those in the third and fourth rows are the corresponding statistics when using the major-based STEM definition.

Column 1 includes period effects, state effects, and the 1980 employment share of native STEM. Imputed H-1B-driven STEM growth has a

Table 3
First Stage: Power and Validity of H-1B-Driven STEM as an Instrumental Variable

Explanatory Variable	Strict (4%) Definition of STEM (with State Fixed Effects) (1)	Baseline Strict (4%) Definition of STEM (with City Fixed Effects) (2)	Broad (8%) Definition of STEM for Both Endogenous Variable and Instrument (3)	As Col 2, Excluding the 5 Cities with Largest Number of STEM Workers (4)	As Col 2, Excluding STEM from India (5)	As Col 2, Imputation Using Aggregate H-1B Visas (Not by Nationality) (6)	As Col 2, Excluding Cities with Population ≤400,000 (7)	As Col 2, Controlling for Imputed Non-College-Educated Immigrants (8)	As Col 8, Controlling for Bartik Employment and Wage Growth (9)
H-1B-driven growth in foreign STEM, O*Net									
Coefficient	48***	2 56***	4 06***	1 82**	3 53***	3 02***	3 22***	2 48***	2 34***
	(18)	(88)	(1 29)	(83)	(91)	(75)	(86)	(90)	(92)
F-statistic	6 57	8 51	9 95	4 86	15 09	16 43	14 04	7 59	6 46
H-1B-driven growth in foreign STEM, major-based									
Coefficient	44***	2 83***	4 23***	2 13***	3 59***	3 26***	3 34***	2 79***	2 42**
	(16)	(84)	(93)	(63)	(1 00)	(1 04)	(1 08)	(86)	(88)
F-statistic	7 73	11 32	20 53	11 27	12 91	9 86	9 48	10 64	7 50
Fixed effects	State and period	City and period	City and period	City and period	City and period	City and period	City and period	City and period	City and period
Observations	657	657	657	642	657	657	354	657	657
Metro areas	219	219	219	214	219	219	118	219	219

NOTE.—Each cell shows the coefficient from a different regression. The dependent variable is the growth in foreign STEM as a percentage of the labor force. The units of observations are 219 US metropolitan areas over the periods 1990–2000, 2000–2005, and 2005–10. The explanatory variable is the H-1B-driven growth of foreign STEM jobs, as a percentage of initial employment. The top 2 rows use the O*NET-based definition of STEM occupations. The third and fourth rows use major-based STEM definitions. Baseline models use the narrow (4%) definition of STEM. Column 1 also controls for a city's native STEM employment in 1980. Standard errors (in parentheses) are always clustered at the metro area level.

* Significant at the 10% level.
** Significant at the 5% level.
*** Significant at the 1% level.

highly significant impact on foreign STEM growth. This implies that even controlling for the initial native STEM share, the foreign STEM share has significant explanatory power.[11]

The next two columns introduce MSA fixed effects to control for all other initial city-specific conditions so that our identification relies only on deviations in MSA growth rates from MSA-specific trends. We include city fixed effects in all subsequent specifications. Column 2 uses the narrow 4% (STEM or major-based) definitions for both the endogenous variable and the instrument, whereas column 3 uses the broader 8% definitions. The power of the instrument in these specifications is stronger than in column 1. The *F*-statistics are close to or above 10, emphasizing that our H-1B-based instrument is good at capturing changes in the inflow of STEM workers within cities over time. Moreover, we find that the two definitions of STEM produce similar results, though some small differences exist.

Columns 4 and 5 of table 3 address two important concerns. The first is that the correlation between the instrument and the actual change in foreign STEM could be driven by the large high-tech boom in a few large MSAs rather than by the exogenous initial distribution of immigrants. If large metropolitan areas drove most of the country's R&D and produced a large increase in demand for foreign H-1B visas and STEM workers, the instrument and the endogenous variable for large R&D-intensive cities could be spuriously correlated. Alternatively, the presence of a few particular industries (e.g., the ICT sector) might have attracted particular types of immigrants whose growth simply proxies for the success of those industries. The current population of foreign STEM workers from India, for example, is strongly associated with information technology since most of them are employed in computer, software, and electrical engineering occupations. Moreover, Indians have always accounted for at least 40% of H-1B visas.

Column 4 excludes the five metro areas with the largest number of STEM workers in 1980.[12] Column 5 excludes Indian STEM workers from the calculations of the instrument. The coefficients are still highly significant (although somewhat reduced in col. 4 for O*NET STEM), indicating that the correlation between H-1B-driven STEM growth and a city's actual foreign STEM growth is not driven by top STEM cities or by a specific nationality group.

An alternative way to ensure that the predictive power of our instrument is not driven by individual nationality groups—whose location preferences

[11] One reason for the power of foreign STEM after controlling for native STEM is that cities with large native STEM shares in 1980 were associated with traditional sectors that attracted scientists and engineers in the 1970s but did not predict the presence of information technology and computer sectors that dominated R&D in the 1990s and 2000s.

[12] New York, Los Angeles, Chicago, San Jose, and San Francisco account for 24% of STEM workers in our sample.

may be affected by specific industries—is to remove the nationality dimension. We construct an instrument similar to the one used by Kerr and Lincoln (2010) by exploiting only variation in the aggregate number of H-1B visas over time, interacted with the initial overall presence of foreign STEM workers. First-stage results using this instrument are shown in column 6. The estimates remain similar, and *F*-statistics confirm that the instrument retains its power.

Column 7 accounts for another potential weakness of our instrument. The use of 1%–5% population samples may introduce measurement error. Aydemir and Borjas (2011) show how measurement error can produce attenuation bias when estimating the causal effect of immigrants on native outcomes. Small census and ACS samples might fail to record small foreign STEM communities in small cities. In order to see whether this measurement error affects the power of our instrument, column 7 shows the first-stage estimates when eliminating all metropolitan areas with fewer than 400,000 people. This cutoff eliminates all cities from our sample that have a measured zero foreign STEM (or imputed foreign STEM) employment share. Although we retain only 118 of the 219 cities, the coefficient estimates remain significant and stable, while the instrument is still reasonably powerful (more so for the O*NET STEM definition). While we will discuss the potential impact of measurement error on attenuation bias when presenting the second-stage estimates (in table 5 below), it is reassuring that the exclusion of the cities in which measurement error is most likely hardly affects the power of the instrument and the first-stage coefficient estimate.

B. Confounding Shocks

Two types of shocks at the MSA level might be correlated with the inflow of STEM workers, wages, and employment, thereby creating omitted variable bias. The first is a change in the skill distribution of workers related to the inflow of non-STEM immigrants. The second is an industry-driven change in productivity affecting native employment and wages. Directly controlling for such shocks would introduce endogeneity. Instead, we include predicted values formed by interacting the 1980 immigrant and industry distributions with national immigrant and industry shocks, respectively.

As STEM immigrants usually earned a college degree, we introduce a control for the imputed number of non-college-educated immigrants ($\widehat{\text{NoColl}}_{ct}^{\text{FOR}}$) based on their 1980 distribution, by nationality, across metropolitan areas ($\text{NoColl}_{c1980}^{\text{FOR}_n}$) and their subsequent aggregate growth in the United States ($\text{NoColl}_{t}^{\text{FOR}_n}/\text{NoColl}_{1980}^{\text{FOR}_n}$). Using notation similar to (2), we use equation (5) to calculate $\widehat{\text{NoColl}}_{ct}^{\text{FOR}}$ and then construct our control by taking the change over time relative to total initial imputed employment ($\Delta\widehat{\text{NoColl}}_{ct}^{\text{FOR}}/\widehat{E}_{ct}$):

$$\widehat{\text{NoColl}}_{ct}^{\text{FOR}} = \sum_{n\ 1,14} \text{NoColl}_{c1980}^{\text{FOR}_n} \left(\frac{\text{NoColl}_{t}^{\text{FOR}_n}}{\text{NoColl}_{1980}^{\text{FOR}_n}} \right). \quad (5)$$

To control for shocks driven by a city's industrial structure, we construct Bartik instruments (from Bartik [1991]) that predict the wage and employment growth of college- and non-college-educated workers based on each city's industrial composition in 1980. Specifically, let $s_{ic,1980}$ denote the share of total city employment in each three-digit census industry classification sector ($i = 1, 2, \ldots, 212$) in 1980. Then let $\Delta y_t^{i,X}/y_t^{i,X}$ be the real growth of $y = \{\text{Wage, Employment}\}$ over the decade for group $X = \{\text{College, NoCollege}\}$ in sector i. We define our sector-driven Bartik variables as

$$\left(\frac{\Delta y^X}{y^X} \right)_{ct}^{\text{Sector Driven}} = \sum_{s\ 1}^{212} \left(s_{ic,1980} \frac{\Delta y_t^{i,X}}{y_t^{i,X}} \right). \quad (6)$$

Column 8 of table 3 adds the imputed growth of non-college-educated immigrants to the basic first-stage regression of column 2. Cities with large communities of less educated immigrants might also have large communities of highly educated immigrants, although usually from different nationalities. Controlling for these flows will also be important to account for complementarities between college- and non-college-educated workers and their possible effect on wages in the second-stage regressions. Nonetheless, the imputed H-1B-driven instrument retains its power when controlling for the imputed number of non-college-educated immigrants. Column 9 further adds the employment and the wage Bartik instruments. This still leaves the H-1B imputed STEM growth instrument with significant, albeit somewhat reduced, explanatory power, especially when using the O*NET definition.

C. Falsification and Extensions

Our instrument is predicated on two assumptions. First, from the perspective of each metropolitan area, the H-1B visa policy significantly and exogenously affected the inflow of foreign STEM workers to the United States from 1990 to 2010. Second, the initial distribution of foreign STEM was crucial in determining the subsequent city-level inflow of H-1B immigrants and was uncorrelated with other city-level shocks affecting native wages and employment. Columns 1–4 of table 4 test these assumptions.

The aggregate inflow of H-1B workers in the United States could simply be a proxy for aggregate labor demand growth and not policy-driven supply changes. This could induce a positive correlation between the instrument and the explanatory variable even in the presence of city and period effects. Note, however, that this scenario would also imply a positive correlation between the explanatory variable and a falsified instrument

constructed by substituting non-H-1B immigrant flows (or non-college-educated immigrant flows) for H-1B flows. Columns 1 and 2 show that the first-stage point estimates are insignificant and close to zero when we impute foreign STEM growth by interacting the 1980 distribution of foreign STEM with subsequent noncollege immigrant flows (col. 1) or with aggregate immigrant flows net of H-1B flows (col. 2). Hence, the aggregate variation of H-1B visas over time is crucial for predicting subsequent STEM variation across cities. The two "falsified instruments" used in these specifications, therefore, do not covary with foreign STEM changes because they do not incorporate the variation in H-1B aggregate visas. Column 3 similarly finds no evidence of correlation when we substitute the initial presence of foreign workers in manual-intensive jobs (rather than in STEM) across metropolitan areas in the construction of the instrument. Therefore, less skilled immigration—though possibly correlated with STEM immigration—did not drive the explanatory power of the instrument. These results reassure that our preferred policy-driven instrument is not simply reflecting aggregate labor demand or aggregate migration.[13]

Column 4 tests the correlation between the instrument—calculated for the 1990–2000 decade—and the preexisting growth in native college wages from 1970 to 1980. Reassuringly, there is no correlation between the H-1B imputed STEM growth after 1980 and pre-1980 native wage growth despite, as will be seen in Section V, the strong relationship between increased STEM during the 1990s and 2000s and concurrent wage growth. This test ensures that the pre-H-1B (pre-1980) outcomes across MSAs were not correlated with the post-1990 H-1B-driven STEM growth.

As a final check in this section, we explore how H-1B policy affects the total number of STEM workers and, specifically, whether metropolitan areas with large foreign STEM inflows substitute foreign STEM for native STEM or instead increase the overall STEM labor force. If the latter is true, we can consider the H-1B policy as an exogenous shock to assess the impact of total STEM on native wages, employment, and productivity. Columns 5 and 6 examine this by regressing native plus foreign STEM worker growth on the H-1B-predicted inflow of foreign STEM (the instrument). The estimated coefficient is even larger than in the basic specification, implying, as we will see below, a positive response of native STEM to foreign inflows. In column 5, we use the stricter 4% STEM definition (based on O*NET in the top rows and on college major in the two lower rows) for both the endogenous and instrumental variables. In column 6, we use the broader 8% definition of STEM for the endogenous and instrumental variables. The power of the instrument is relatively strong in most cases.

Overall, the specifications and falsifications shown in this section demonstrate that our H-1B imputed instrument has significant power in

[13] The online appendix details the construction of these falsified instruments.

Table 4
First Stage: Falsification and Extensions

	Falsification Endogenous Variable			Dependent Variable		
Explanatory Variable	Growth of Foreign STEM O*NET 4% (1)	Growth of Foreign STEM O*NET 4% (2)	Growth of Foreign STEM Major-Based 4% (3)	1970–80 College-Educated Native Wages; Explanatory Variable, 1990–2000 (4)	Total STEM Growth (Native + Immigrant), 4% STEM Definition (5)	Total STEM Growth, 8% STEM Definition (6)
Predicted Foreign STEM, O*NET definition						
Coefficient				1 66	5 03***	8 50**
				(1 02)	(1 81)	(4 40)
F-statistic				2 62	7 70	3 65
Predicted foreign STEM, major-based definition						
Coefficient				1 12	5 29***	9 63***
				(1 10)	(1 71)	(2 56)
F-statistic				1 05	9 54	14 05

Predicted growth in foreign STEM using flows of noncollege immigrants						
Coefficient	04					
	(03)					
F-statistic	2 24					
Predicted growth in foreign STEM using flows of total immigrants minus H-1B						
Coefficient		043				
		(024)				
F-statistic		3 08				
Predicted growth in foreign STEM using 1980 distribution of manual immigrants						
Coefficient			41			
			(27)			
F-statistic			2 42			
Observations	657	657	657	116	657	657
Metro areas	219	219	219	116	219	219

NOTE.—Each cell shows the coefficient from a different regression and below it the *F*-test of significance. The units of observations are 219 US metropolitan areas over the periods 1990–2000, 2000–2005, and 2005–10. The dependent variable is the growth in foreign STEM in cols. 1–3; the growth in native college-educated wages, 1970–80, in col. 4; and total STEM growth in cols. 5 and 6. The explanatory variables are described at the beginning of the row. Standard errors (in parentheses) are always clustered at the metro area level.

* Significant at the 10% level.
** Significant at the 5% level.
*** Significant at the 1% level.

predicting foreign STEM and total STEM growth, which is not driven by top cities, one ethnic group, or labor demand and survives the inclusion of city effects and controls for industrial composition and low-skilled immigration. The instrument's predictive power is crucially driven by the H-1B program and by the initial distribution of STEM immigrants across cities.

V. The Effect of STEM on Native Outcomes

A. Basic Results

The empirical specifications estimated in this section follow the regression described in equation (1) to identify the impact of STEM workers on native labor market outcomes ($y_{ct}^{\text{Native},X}$) by group X (STEM, college-educated, or non-college-educated) in city c. Outcomes measure growth either in average weekly wages or in employment. The explanatory variable in each regression is the change in foreign STEM relative to the initial level of total employment, $\Delta\text{STEM}_{ct}^{\text{Foreign}}/E_{ct}$. All two-stage least-squares (2SLS) regressions use the H-1B-driven change in foreign STEM relative to initial imputed employment ($\Delta\widehat{\text{STEM}}_{ct}^{\text{FOR}}/\widehat{E_{ct}}$) as an instrument for the actual change.

Each of the six columns of table 5 reports the $b_{y,X}$ coefficient of interest, as defined in equation (1), corresponding to the differing outcome variables. The basic specification includes time period effects, 219 MSA fixed effects, and the Bartik instruments for the relevant wage and employment changes. We always cluster standard errors at the MSA level.

In columns 1–3, the dependent variable is the percentage change of the weekly wage ($\Delta w_X^{\text{Native}}/w_X^{\text{Native}}$) paid to STEM, college-educated, and non-college-educated native-born workers, respectively.[14] We define college-educated workers as individuals who completed 4 years of college, while non-college-educated are those who did not. Columns 4–6 show the effect of STEM on the employment change of these native-born groups as a percentage of total city employment (respectively, $\Delta\text{STEM}_{ct}^{\text{Native}}/E_{ct}$, $\Delta H_{ct}^{\text{Native}}/E_{ct}$, and $\Delta L_{ct}^{\text{Native}}/E_{ct}$).

The different rows of table 5 represent different specifications to test the robustness of the estimates, mirroring in large part the first stage in table 3. Row 1, the baseline specification, shows the results when the O*NET 4% definition of STEM workers is used for both the explanatory variable and the instrument. Row 2 instead uses the major-based 4% definition of

[14] Weekly wages are defined as yearly wage income divided by the number of weeks worked. Employment includes all individuals between 18 and 65 years old who have worked at least 1 week during the previous year and do not live in group quarters. We convert all wages to current 2010 prices using the Bureau of Labor Statistics Inflation Calculator. See the online appendix for full details on the sam ple selection process.

Table 5
The Effects of Foreign STEM on Native Wages and Employment

Explanatory Variable Growth Rate of Foreign STEM	Weekly Wage, Native STEM (1)	Weekly Wage, Native College-Educated (2)	Weekly Wage, Native Non-College-Educated (3)	Employment, Native STEM (4)	Employment, Native College-Educated (5)	Employment, Native Non-College-Educated (6)
1 Baseline 2SLS; O*NET 4% definition	6 65	8 03***	3 78**	53	2 48	5 17
	(4 53)	(3 03)	(1 75)	(56)	(4 69)	(4 20)
2 2SLS; major-based 4% definition	6 64	10 95**	3 22**	60	1 05	7 82
	(5 08)	(4 34)	(1 67)	(63)	(3 99)	(4 90)
3 2SLS; O*NET 8% definition	7 23**	5 64***	2 55**	53	1 85	4 14
	(3 52)	(1 95)	(1 08)	(75)	(3 21)	(3 32)
4 Omitting top 5 STEM cities	11 35	12 78***	5 03	1 65***	8 46	2 51
	(8 63)	(4 99)	(3 42)	(53)	(7 04)	(7 46)
5 Controlling for imputed noncollege immigrants	7 94	7 00**	4 95**	76	3 29	3 39
	(5 38)	(2 98)	(2 09)	(61)	(4 85)	(4 15)
6 Dropping small cities (population <400,000)	5 70	7 18***	4 28***	34	− 60	5 20
	(3 51)	(2 61)	(1 45)	(58)	(1 51)	(3 18)
7 Dropping Indians	3 48	9 38**	3 46*	47	1 31	6 44*
	(5 07)	(4 37)	(2 08)	(51)	(3 61)	(3 54)
8 Aggregate H-1B IV	5 76	6 04**	4 13***	31	1 64	5 56
	(4 05)	(2 75)	(1 34)	(48)	(4 20)	(3 63)
9 Controlling for imputed college natives	2 72	7 58**	2 39	− 32	− 62	7 29
	(4 68)	(3 78)	(2 00)	(47)	(4 19)	(5 15)
10 OLS version of specification 5	3 32	4 10***	1 16	92**	4 97	2 11
	(2 99)	(1 86)	(1 24)	(34)	(3 69)	(2 51)

NOTE.—The instrument is the H-1B imputed growth of foreign STEM. Each cell shows the estimate of the coefficient on the growth in foreign STEM (relative to employment) when the dependent variable is the one described at the top of the column. Each regression includes period effects, metropolitan area effects, and the Bartik for employment or wage of the relevant group. Rows 1 and 4–8 are 2SLS regressions using the O*NET 4% definition of STEM. Rows 2 and 3 use alternative definitions of STEM. Row 10 shows the OLS estimates. Standard errors (in parentheses) are clustered at the metro area level. Units of observations are 219 metro areas over three periods: 1990–2000, 2000–2005, and 2005–10.

* Significant at the 10% level.
** Significant at the 5% level.
*** Significant at the 1% level.

STEM workers, and row 3 uses the broader O*NET 8% definition. Row 4 omits the top five metropolitan areas in terms of STEM employment but is otherwise identical to the specification in row 1. Row 5 adds the growth of imputed non-college-educated immigrants, defined in (5), as a control to the baseline specification. Row 6 excludes MSAs with populations below 400,000. Row 7 excludes Indian STEM workers from the construction of the instrument. Row 8 uses the instrument constructed using aggregate H-1B flows and the initial foreign STEM distribution, thus removing the nationality dimension. Row 9 controls for growth in native college-educated employment by including a shift share instrument for the growth of college-educated natives, constructed by interacting the 1980 number of college-educated natives in each city with the national growth of college-educated natives. Finally, row 10 shows the ordinary least squares (OLS) estimates of the basic specification.

The main results are relatively consistent across specifications. First, there is a large, positive, and significant effect of foreign STEM workers on wages paid to college-educated natives. The estimated effect is significantly different from zero at the 5% significance level in all specifications and is significant at the 1% level in most. The point estimates from the 2SLS specifications are mostly between 5.6 and 9.3, with some larger values. This implies that a rise in foreign STEM growth by 1 percentage point of initial employment increases college-educated native wage growth between 5.6 and 9.3 percentage points.[15]

Second, the estimates of the effects on native STEM wages are comparable to, but less precisely estimated than, the effects on native college-educated wages. While we can never rule out the hypothesis that the estimated effects for the two groups are equal, the native STEM wage effect is only occasionally different from zero at the 5% significance level.[16] As there are fewer STEM natives (about 4% of employment) than college-educated natives (about 25% of employment), measurement error in the average wage of the first group reduces the precision of the estimates.

The third regularity of table 5 is that foreign STEM workers had a positive and usually significant effect on wages paid to non-college-educated natives. Point estimates are mostly between 2.4 and 4.3—results that are both smaller and less significant than those for college-educated natives. This implies that STEM workers generate a productivity effect that is skill

[15] Note that 1 percentage point of employment is a very large increase of STEM workers, comparable to the increase over the whole 1990–2010 period, as shown in table 2.

[16] For instance, a formal test that the estimated coefficient on STEM wages in row 1 is equal to 8.03 (the point estimate for the effect on the college educated) has a p value of .76. At no level of confidence can we reject the hypothesis that they are equal. Similarly for the other specifications, we can never reject the hypothesis of equality at the 10% confidence level.

biased. Foreign STEM workers are closer substitutes for college-educated natives than for non-college-educated natives, yet they generate a larger increase in the wages paid to college-educated natives.

Fourth, the inflow of STEM workers did not significantly affect the employment of any native group. The point estimates are mainly positive for native STEM and college-educated workers and mainly negative for non-college-educated natives. However, they are usually not significant, even at the 10% level. Given the mobility of college-educated natives and their city-level wage gain from STEM flows, this weak employment response is somewhat surprising and suggests the potential existence of additional adjustment mechanisms for college-educated workers at the metropolitan area level. In section 5.4 of the working paper version of this study (Peri, Shih, and Sparber 2014), we argue that STEM flows are also associated with increased housing rents for college-educated natives and that this increase in nontradables prices might absorb up to 50% of the college-educated native wage gain. This might help explain the small employment response while cautioning against interpreting the wage gains of table 5 as full increases in total purchasing power.

B. Robustness Checks

We now comment on the robustness checks performed in table 5. To mitigate endogeneity concerns discussed earlier, row 4 omits the top five STEM-dependent cities and row 7 removes Indian workers. The estimated effects of STEM on native wages remain stable and even increase in some cases, albeit at the cost of larger standard errors. On one hand, this suggests that the fixed effects, instrumental variable strategy, and Bartik controls in the baseline model largely address endogeneity bias. On the other hand, the increase in standard errors indicates that the omitted cities, when included in regressions, afford precision in the estimates due to larger data variation.

Row 5 adds a control for imputed low-skilled immigrants. As above, this also results in minimal changes in the coefficient estimates when compared to row 1. The estimated STEM effect on college-educated wages is somewhat smaller (down to 7.00 from 8.03), and the coefficient for non-college-educated wages is somewhat larger (up to 4.95 from 3.78). This could indicate that the inflow of less educated immigrants, as predicted by the 1980 MSA distribution, was slightly correlated with foreign STEM and that less educated labor inflows complemented college-educated natives but substituted for non-college-educated ones. Explicitly controlling for such imputed inflows helps to isolate the effect of STEM and identifies more balanced productivity effects for college- and non-college-educated natives.

Similarly, a large initial share of foreign STEM in a city might proxy for high initial education levels. If such cities also experienced wage and em-

ployment growth during periods of sizable foreign STEM inflows, it would generate spurious regression results. Row 9 includes a shift share predictor of college-educated native growth to help address this issue. The estimated STEM impact on wages paid to college-educated natives remains quantitatively similar to baseline estimates and is still statistically significant.

Row 6 omits small cities to examine measurement error issues. The point estimates are similar to those in row 5, but the standard errors decrease. Hence, measurement error does not seem to bias the coefficients, but the focus on large MSAs reduces measurement error and improves precision.

Finally, it is worth commenting on the difference between the OLS estimates in row 10 and the corresponding 2SLS results in row 5. Interestingly, while the estimated employment effects have an upward bias in OLS relative to 2SLS, the wage effects have a downward bias. This may be due to the correlation between unobserved shocks and the inflow of foreign STEM. It is likely that foreign STEM inflows are positively correlated with employment growth and a city's openness to new workers. Hence, the cities endogenously attracting foreign STEM workers could be those with fast inflows of workers in general, which could moderate wage growth. Thus, the correlation between STEM growth and omitted employment determinants could be positive, and the correlation between openness and wage growth could be negative, thereby resulting in the observed biases.

Before extending the findings, we provide a sense of the magnitude of the estimated effects. Foreign STEM growth, measured as a percentage of total initial employment in aggregate, was only about 0.53% between 1990 and 2010. Applying the 7.00 2SLS estimates of row 5 to the national growth in foreign STEM implies that the foreign-driven net growth in STEM increased real wages of college-educated natives by around 3.71 percentage points ($= 7.00 \times 0.53$) during this period. For reference, census data suggest that the cumulative growth of college-educated wages in this period equaled about 13 percentage points. Thus, almost one-third of that growth can be attributed to the increased presence of foreign STEM workers. We return to these implications in Section VI when we analyze the implied productivity and skill-bias effects of STEM.

C. Extensions

As shown in the first-stage results in columns 5 and 6 of table 4, our H-1B-driven increase in the STEM instrument raises overall STEM employment, not just foreign STEM. Table 6 generalizes the main second-stage results by replacing the foreign STEM growth explanatory variable with total STEM growth. The estimates confirm that STEM workers generate wage gains for college-educated and non-college-educated natives. More specifically, using the estimates in row 1 of table 6, a 1 percentage point increase in STEM as a share of employment caused a 4 percentage point

Table 6
The Effects of Total STEM on Native Wages and Employment

Explanatory Variable: Growth Rate of Total STEM	Weekly Wage, Native STEM (1)	Weekly Wage, Native College Educated (2)	Weekly Wage, Native Non College Educated (3)	Employment, Native College Educated (4)	Employment, Native Non College Educated (5)
1. 2SLS; O*NET	4.50	3.97***	2.44**	1.86	1.67
4% definition	(2.94)	(1.42)	(1.02)	(2.31)	(2.34)
2. 2SLS; major based	4.90	5.68**	2.40**	1.15	2.92
4% definition	(3.41)	(2.42)	(1.00)	(2.10)	(2.82)
3. 2SLS; O*NET,	4.55	2.64*	1.67**	1.46	1.23
8% definition	(3.01)	(1.43)	(.76)	(1.25)	(1.79)
4. Same as row 1 but	4.50	4.03**	1.97*	3.23	−.28
omitting top 5 STEM cities	(3.39)	(1.74)	(1.12)	(2.38)	(2.33)
5. OLS; O*NET	.37	.73	.75*	2.72***	4.60***
4% definition	(1.08)	(.54)	(.40)	(.77)	(.79)

NOTE. Each cell shows the estimate of the coefficient on the growth in total STEM (relative to employment) when the dependent variable is the one described at the top of the column and the instrument is the H-1B driven STEM growth. Each regression includes period effects, metropolitan area effects, the Bartik for employment and wage of the relevant group, and the imputed growth of non-college-educated immigrants. Standard errors (in parentheses) are clustered at the metro area level. Units of observations are 219 metro areas over three periods: 1990–2000, 2000–2005, and 2005–10.

* Significant at the 10% level.
** Significant at the 5% level.
*** Significant at the 1% level.

increase in college-educated native wage growth and about a 2.4 percentage point wage growth for non-college-educated natives. There is no evidence that either group experiences an employment effect.

These results are robust to using the major-based definition of STEM (row 2), using the broad (8%) definition of STEM (row 3), and omitting top STEM cities (row 4). Also, the OLS estimates continue to exhibit a positive bias (relative to the 2SLS results) for employment effects and a negative one for wage effects. Overall, our estimates confirm that STEM workers raise the demand for college-educated and non-college-educated natives, with a smaller effect for the latter group.

A lot of heterogeneity exists among non-college-educated workers. Table 7 explores whether the wage and employment effects of foreign STEM workers are different for natives without a high school diploma (high school dropouts) and those with a high school diploma (high school graduates). The table presents foreign STEM effects for wages (cols. 1 and 2) and employment (cols. 3 and 4). Rows 1–4 present several specifications of the 2SLS regression mirroring those in the corresponding rows of tables 5 and 6. Row 5 reports the coefficients when using total STEM as the explanatory variable.

Table 7
The Effect of Foreign STEM on Non-College-Educated Natives

Explanatory Variable: Growth Rate of Total STEM	Weekly Wage, Native High School Graduates (1)	Weekly Wage, Native High School Dropouts (2)	Employment, Native High School Graduates (3)	Employment, Native High School Dropouts (4)
1. 2SLS; O*NET 4% definition	5.54** (2.33)	3.30 (4.26)	3.36 (3.72)	−.03 (.55)
2. 2SLS; major based 4% definition	4.87** (2.10)	5.97 (4.67)	5.12 (4.08)	−.50 (.66)
3. 2SLS; O*NET 8% definition	4.10** (1.70)	2.45 (3.01)	2.48 (2.88)	−.02 (.40)
4. Same as row 1 but dropping top 5 STEM cities	7.05* (4.29)	6.28 (7.58)	1.38 (6.65)	.50 (.96)
5. Explanatory variable: total STEM, O*NET 4%	2.73** (1.15)	1.63 (1.99)	1.65 (2.12)	−.02 (.27)

NOTE. Each cell in rows 1 4 shows the estimate of the coefficient on the growth in foreign STEM (relative to employment) when the dependent variable is the one described at the top of the column. Row 5 shows the estimate of the coefficient on the growth in total STEM (relative to employment) as the explanatory variable, still instrumented with H-1B imputed growth of foreign STEM. Each regression includes period effects, metropolitan area effects, the Bartik for employment and wage of the relevant group, and the imputed growth of non-college-educated immigrants. Standard errors (in parentheses) are clustered at the metro area level. Units of observations are 219 metro areas over three periods: 1990–2000, 2000–2005, and 2005–10.

* Significant at the 10% level.
** Significant at the 5% level.
*** Significant at the 1% level.

By separating high school graduates from high school dropouts, we can check whether these two groups exhibit different complementarities with foreign STEM labor. On the one hand, STEM-generated innovation could be skill biased, complementing educational attainment (see Acemoglu 1998, 2002). If so, then foreign STEM would generate the largest positive effects for college-educated workers, followed by high school graduates and, finally, by high school dropouts. On the other hand, it could be polarizing, substituting for intermediate skills but complementing low- and high-end skills (see Autor et al. 2006; Autor 2010). If so, then foreign STEM would generate the largest positive effects at the high and low ends of the educational spectrum at the expense of intermediate-level levels of schooling.

Table 7 shows that STEM effects are significant only for high school graduates, while point estimates for dropouts are smaller but insignificant. Neither group had significant employment effects. The basic specification in row 1 shows that each percentage point increase in foreign STEM employment raised native high school graduate wage growth by 5.54 percentage points. This can be interpreted as evidence that STEM-driven technological progress has been skill (or schooling) biased rather than polarizing.

The difference between the effects on high school graduates and dropouts is not usually significant, however, because of the lack of precision in estimating the effects for dropouts.

VI. Simulated Productivity and Skill Bias Effects

We close our analysis by estimating the long-run effect of STEM on total factor productivity (TFP) and skill-biased productivity (SBP). More specifically, we assume a basic structural model of production and substitute parameter values from our analysis, observed data, and other sources, and then we simulate the TFP and SBP effects that can be explained by growth in foreign STEM workers. The advantage of this approach is that we have an intuitive and standard definition of TFP and SBP based on a city-specific production function. The limitation is its dependence on the assumed nature of productive interactions between different types of labor inherent to the specific production structure.

A full model and derivation are available in the online appendix. Here, we provide just a simple production function and the intuition of the exercise. Suppose that a city (c) produces a homogeneous, tradable, numeraire product (Q_{ct}) in year t. The economy employs three types of labor: non-college-educated (L_{ct}); college-educated, non-STEM (H_{ct}); and STEM workers (ST_c). Production occurs according to the long-run production function in (7):

$$Q_{ct} = (A(ST_{ct})\{\beta(ST_{ct})K_{ct}^{(\sigma_H \ 1)/\sigma_H} + [1 \quad \beta(ST_{ct})]L_{ct}^{(\sigma_H \ 1)/\sigma_H}\})^{\sigma_H/(\sigma_H \ 1)}. \quad (7)$$

Input K is a composite factor combining college-educated and STEM workers such that

$$K_{ct} = [ST_{ct}^{(\sigma_S \ 1)/\sigma_S} + H_{ct}^{(\sigma_S \ 1)/\sigma_S}]^{\sigma_S/(\sigma_S \ 1)}. \quad (8)$$

The parameter $\sigma_H > 1$ captures the elasticity of substitution between non-college- and college-educated labor. Similarly, $\sigma_S > 1$ is the elasticity of substitution between college-educated and STEM workers.

A long literature has recognized STEM workers as the key inputs in developing and adopting new technologies. Equation (7) captures this by allowing the level of TFP, $A(ST_{ct})^{\sigma_H/(\sigma_H \ 1)} > 0$, to be an increasing function of the number of STEM workers in a city. It also allows for STEM workers to potentially raise SBP, $\beta(ST_{ct}) \in [0, 1]$. Note that our model assumes that STEM workers are uniquely capable of generating ideas, innovation, and externalities that benefit productivity even if STEM and college-educated workers are close substitutes in production itself (i.e., if $\sigma_S \approx \infty$).

We assume that labor is paid its marginal product and then calculate the total logarithmic (percentage) change in wages for each group in response to a change in the supply of STEM workers. After normalizing the resulting

demand conditions by the exogenous change of STEM workers expressed as a percentage of total employment, we derive three linear conditions relating the elasticity of each group's wage and employment to STEM (i.e., the $b_{y,X}$ coefficients estimated from eq. [1]). Remaining parameters in the demand functions (including σ_H, σ_s, and wage and employment shares) come from prior studies, our analysis, or census data. By combining them, we can estimate our values of interest: $\phi_A = (\Delta A/A)/(\Delta ST/E)$, the elasticity of TFP to changes in STEM (relative to initial employment), and $\phi_\beta = (\Delta\beta/\beta)/(\Delta ST/E)$, the analogous elasticity of SBP.[17]

Table 8 displays the simulated TFP (col. 1) and SBP (col. 2) changes from 1990 to 2010. We set $\sigma_S = \infty$ since our regression estimates of $1/\sigma_S$ are never significantly different from zero and the elasticity of college-educated wages and STEM wages to STEM supply are always very close to each other (implying high substitutability). Ciccone and Peri's (2005) review of σ_H estimates suggests a value between 1.5 and 2.5. We assume a σ_H value of 2 in our basic simulation and use values of 1.75 and 2.25 in robustness checks. US census data on wages and employment imply a β value equal to 0.57, a share of STEM workers equal to 0.05 in total employment and 0.09 in the total wage bill, and a college-educated share of the wage bill equal to 0.46. Fernald (2009) measures annual TFP growth equal to 0.89%. Our census calculations measure annual SBP growth equal to 1.75%. Foreign STEM increased by 0.04% of total employment each year.

Values for the elasticity of outcome y for group X to STEM workers come from our regression estimates. The first row of table 8 reports the simulated effects when we use coefficients from the basic specification in table 5, row 1. Row 2 uses the estimates from table 5, row 6, in which we control for imputed unskilled immigrants and reduce the attenuation bias by including only large cities in the regression. We label this row conservative estimates because the underlying regression leads to somewhat smaller estimates of the STEM effect on native wages. Row 3 uses the estimates from table 6, row 1, that adopt total STEM as the explanatory variable. These tend to be 40%–50% smaller than those obtained with foreign STEM.[18] Rows 4 and 5 are the same as row 1 but illustrate the robustness of the simulations to changes in values of the parameter σ_H.

Our simulations imply that foreign STEM growth explained only a modest 5%–8% of SBP growth from 1990 to 2010. In contrast, foreign STEM growth explained between one-third and one-half of the average TFP

[17] Note that we can calculate these effects without specifying the labor supply side of the model as long as we have the table 5 and table 6 equilibrium employment elasticity estimates for each factor.

[18] We also use the elasticity of college educated wages (3.96) for STEM since the model implies that the elasticity of college educated wages to foreign STEM cannot be smaller than that of native STEM wages.

Table 8
Simulated Foreign STEM Effects on Yearly Average TFP Growth and SBP Change

	Simulated Foreign STEM Effect on TFP Growth (%) (1)	Simulated Foreign STEM Effect on Skill-Biased Growth (%) (2)	Average US TFP Growth 1990–2010 (%) (3)	Average Change in Skill-Biased Productivity 1990–2010 (%) (4)	TFP Growth Explained by Foreign STEM (Col 3/Col 1) (5)	Skill-Biased Growth Explained by Foreign STEM (Col 4/Col 2) (6)
1 Basic estimates	47	13	89	1 75	53	07
2 Conservative estimates	41	08	89	1 75	47	05
3 Based on total STEM	27	04	89	1 75	30	04
4 $\sigma_H = 1.75$	54	13	89	1 75	61	08
5 $\sigma_H = 2.25$	43	12	89	1 75	48	7

Note.—The table uses the formulas in the online appendix to calculate the implied elasticity ϕ_A and ϕ_B. We then use the growth of US foreign STEM workers as a share of employment to calculate the implied effects on TFP. The average TFP growth 1990–2010 is taken from Fernald (2009) and the average skill-biased growth is calculated using the average US values for the wages and employment (in hours) of college-educated and non-college-educated workers from the 1990 and 2010 censuses. Unless otherwise noted, the elasticity of substitution between college- and non-college-educated workers is $\sigma_H = 2$. The STEM share of employment is 0.05, the STEM share of wages is 0.09, and the college-educated share of wages is 0.46. These values are calculated from the 2000 US census.

growth during the period. While this result might appear to be very high, it is more plausible when assessed in context with two additional figures. First, foreign labor accounted for about-two thirds of the net growth in STEM workers in our data set. Second, STEM workers are the primary source of sustained economic growth. Jones (2002), for example, argued that 50% of long-run US productivity growth in recent decades is attributable to growth in scientists and engineers as a share of employment. The 33% TFP growth implied by combining Jones's figure with our calculation of the foreign contribution to STEM growth aligns with the simulated results presented in table 8.

In income terms, the average annual TFP effect in table 8, column 1, translates to about 0.47 percentage points per year, implying that native income per capita in 2010 was 9.8% larger than it would have been without the growth contributions from foreign STEM. This would be impossible to justify on the basis of the foreign-born increase in skilled labor supply alone; but when considered as a source of technological innovation, foreign STEM workers may credibly generate large productivity and wage increases. Nonetheless, we concede that our simulated results are based on strong assumptions. In particular, we apply parameters that were estimated across cities to simulate national foreign STEM effects. This will overstate productivity effects if the wage coefficients from the underlying regressions are related to the selection of natives. On the other hand, since our regressions capture only within-city productivity effects and ignore spillovers to other cities, we could also be underestimating national productivity gains.

VII. Conclusions

This article uses the inflow of foreign science, technology, engineering, and mathematics (STEM) workers, made possible by the H-1B visa program, to estimate the impact of STEM workers on the productivity of college- and non-college-educated American workers between 1990 and 2010. The uneven distribution of foreign STEM workers across cities in 1980—a decade before the introduction of the H-1B visa—and the high correlation between the preexisting presence of foreign-born workers and subsequent immigration flows allow us to use the variation in foreign STEM as a supply-driven increase in STEM workers across metropolitan areas.

We find that a 1 percentage point increase in the foreign STEM share of a city's total employment increased the wage growth of native college-educated labor by about 7–8 percentage points and the wage growth of non-college-educated natives by 3–4 percentage points. We find insignificant effects on the employment of those two groups. These results indicate that STEM workers spur economic growth by increasing productivity, especially that of college-educated workers.

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Hughes Declaration

Exhibit 29

IMMIGRATION AND AMERICAN JOBS

AMERICAN ENTERPRISE INSTITUTE FOR PUBLIC POLICY RESEARCH
AND THE
PARTNERSHIP FOR A NEW AMERICAN ECONOMY

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Immigration and American Jobs

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Executive Summary

The US labor market has been slow to recover from the deep recession of 2007–2009. As of September 2011, there were almost seven million fewer jobs than before the downturn. Policymakers have debated numerous ways to increase employment, from government spending to tax policy to training and education initiatives. But relatively little consideration has been given to immigration reform as a way to boost the economy, even though immigration policy affects innovation and job growth. Instead, the immigration debate has become painfully deadlocked, with widespread agreement that the current system is broken but little consensus on how it should be fixed. In these challenging times, more should be done to identify incremental changes to immigration policy that could be made immediately to boost employment for US workers and accelerate the country's economic recovery.

To better understand the potential for immigration policy to help rejuvenate the US economy, policymakers need answers to basic questions such as whether the foreign born take jobs from the native born or instead create more jobs, on balance, and what types of immigrants generate the most jobs for native-born workers. Although numerous studies have explored how immigration affects natives' wages, there is relatively little research on how immigration affects employment among US natives. This study seeks to fill this gap and answer the question of what specific changes to immigration policy could speed up American job growth.

There are two basic theories of how immigration affects natives' labor market outcomes. One is that immigrants have the same skills as US natives and the two groups "compete" for jobs. In this view, immigration reduces natives' employment. The other theory is that foreign-born workers "complement" US-born workers. That is, immigrants and natives have different skills, and immigration diversifies the workforce. Immigration results in more productive companies, stronger economic growth, and higher employment among US natives.

This study focuses on two groups most frequently identified by policymakers and employers as vital to America's economy: foreign-born adults with advanced degrees and temporary work visa holders. (For simplicity, all foreign born are referred to here as immigrants, regardless of their visa type.) In trying to establish whether these groups help or hurt job prospects among US natives, the study uses hard numbers—annual data from the US Census Bureau and applications for temporary work-



ers—to perform a state-level comparison that answers the question, "In states with more immigrants, are US natives more or less likely to have a job?" This study also looks at the fiscal effect of the foreign born by comparing the benefits they receive to the taxes they pay.

The analysis yields four main findings:

1. **Immigrants with advanced degrees boost employment for US natives. This effect is most dramatic for immigrants with advanced degrees from US universities working in science, technology, engineering, and mathematics (STEM) fields.** The data comparing employment among the fifty states and the District of Columbia show that from 2000 to 2007, an additional 100 foreign-born workers in STEM fields with advanced degrees from US universities is associated with an additional 262 jobs among US natives. While the effect is biggest for US-educated immigrants working in STEM, immigrants with advanced degrees in general raised employment among US natives during 2000–2007:
   - An additional 100 immigrants with advanced degrees in STEM fields from either US or foreign universities is associated with an additional eighty-six jobs among US natives.
   - An additional 100 immigrants with advanced degrees—regardless of field or where they obtained their degrees—is associated with an additional 44 jobs among US natives.

2. **Temporary foreign workers—both skilled and less skilled—boost US employment.** The data show that states with greater numbers of temporary workers in the H-1B program for skilled workers and H-2B program for less-skilled nonagricultural workers had higher employment among US natives. Specifically:
   - Adding 100 H-1B workers results in an additional 183 jobs among US natives.
   - Adding 100 H-2B workers results in an additional 464 jobs for US natives.
   - For H-2A visas for less-skilled agricultural workers, the study found results that were positive, but data were available for such a short period that the results were not statistically significant.

3. **The analysis yields no evidence that foreign-born workers, taken in the aggregate, hurt US employment.** Even under the current immigration pattern—which is not designed to maximize job creation, has at least eight million unauthorized workers, and prioritizes family reunification—there is no statistically significant effect, either positive or negative, on the employment rate among US natives. The results thus do not indicate that immigration leads to fewer jobs for US natives.

4. **Highly educated immigrants pay far more in taxes than they receive in benefits.** In 2009, the average foreign-born adult with an advanced degree paid over $22,500 in federal, state, and Federal Insurance Contributions Act (FICA, or Social Security and Medicare) taxes, while their families received benefits one-tenth that size through government transfer programs like cash welfare, unemployment benefits, and Medicaid.



The results here point directly to several policy proposals that would boost US employment. These policies would require neither new taxes nor new spending cuts. Specifically, policymakers could create jobs by doing the following:

- **Giving priority to workers who earn advanced degrees from US universities, especially those who work in STEM fields.** The results show that the most dramatic gains in US employment come from immigrants who earned advanced degrees at US universities and are employed in STEM fields. Changing permanent and temporary immigration policies to favor holders of advanced degrees from US universities in STEM fields is an obvious step given the demand for highly skilled workers and the extensive investment the country already makes in such students. Without a clear path to stay in the United States, these foreign students will fuel innovation and economic growth in countries that compete with the American economy.

- **Increasing the number of green cards (permanent visas) for highly educated workers.** This study shows that foreign-born workers with advanced degrees create more jobs for US workers than immigrants overall. Yet only 7 percent of green cards are currently awarded to workers based on their employment. The United States can increase the number of immigrants with advanced degrees in the US workforce by increasing the number of green cards distributed through employment-based categories.

- **Making available more temporary visas for both skilled and less-skilled workers.** The findings here suggest that expanding the H-1B program for skilled temporary foreign workers would increase employment for US natives. Similarly, this study suggests that the H-2B program for seasonal, less-skilled workers in fields other than agriculture leads to significant employment gains for US natives. But both these programs are severely limited under current law. Only 85,000 H-1B visas and 66,000 H-2B visas are available each fiscal year, and the process for obtaining H-2B visas is often prohibitively difficult and costly. This study found a positive but not statistically significant relationship between H-2A temporary agricultural visas and employment among US natives. Further study is warranted to explore whether H-2A visas should be increased as well.

America is currently mired in a period of the slowest economic growth seen in several generations, with persistently high unemployment, anemic job growth, and little bipartisan agreement on how to address these pressing problems. Action is required if America is to get back to work. Immigration policy can, and should, be a significant component of America's economic recovery. Targeted changes to immigration policy geared toward admitting more highly educated immigrants and more temporary workers for specific sectors of the economy would help generate the growth, economic opportunity, and new jobs that America needs.

Introduction

As of September 2011, the United States had almost seven million fewer jobs than before the recession of 2007–2009. The debate on ways to increase employment has focused on government spending, tax cuts, and new training and education initiatives. One area that has received little attention for its job-generating possibilities is immigration policy. Instead, discussion over immigration policy has stalled, with widespread agreement that the current system is broken but little consensus on how it should be fixed. Too little has been done to identify incremental changes to existing immigration policy that could be made immediately and would boost employment and accelerate the country's economic recovery.

Immigrants[1] play a sizable role in the US labor market. Almost one in six workers is foreign born. Over one million people receive lawful permanent resident status each year, and hundreds of thousands more enter illegally in a typical year. A smaller number of workers enter legally through temporary worker programs for skilled and less-skilled workers.

Whether immigrants take jobs from US-born workers or, on balance, create jobs is not well understood. Policymakers particularly need to know how different groups of foreign-born workers affect employment to design immigration policies that benefit the US economy. A growing body of economic research points to economic benefits from immigration. Immigration has a small but positive effect on output, or gross domestic product (GDP).[2] Immigration reduces the cost of labor-intensive goods and services.[3] The foreign born boost invention and innovation, and they are more likely than US natives to start businesses.[4] Immigration appears to encourage US natives to upgrade their skills through additional education or training.[5] Studies indicate that immigration may have a small positive effect on Americans' wages, although there is also some evidence that immigration has no effect or even a negative effect on wages, especially among the least educated.[6]

Despite this voluminous literature on the economic effects of immigration, there is relatively little research on how foreign-born workers affect employment among US natives. This paper uses the prevailing methodology in the economics literature to analyze the impact of immigration on employment for US natives. Specifically, the paper asks:

- Does increasing the number of immigrants with advanced degrees as a fraction of all employment lead to higher rates of employment among US natives?
- What is the impact of immigration on employment among US natives across all sectors and education levels?
- Do temporary foreign workers—both skilled and less skilled—increase or decrease employment among US natives?
- What is the fiscal impact of immigrants, looking at both taxes paid and benefits received?

Based on the answers to these questions, the study then discusses changes in immigration policy that would attract and admit more foreign-born workers in those categories found to correspond with the greatest job creation for US natives.

Background

The 38.5 million foreign born who live in the United States are a diverse group. They are more than three times as likely as US natives to lack a high school diploma, but they are also more likely to have a professional degree or doctorate. Accordingly, the foreign born are overrepresented in both less-skilled occupations, such as construction workers, housekeepers, and agricultural laborers, and highly skilled occupations, such as medical scientists, physicians, and chemists.

Because of their tremendous diversity, the foreign born potentially affect US-born workers in almost every facet of the economy, including the labor market. Some of these effects may be positive while others may be negative. US-born workers who face heightened competition as a result of immigration may face lower wages or lose their jobs. But immigrants may also have different skills than American workers, resulting in a more diverse workforce, greater productivity, and higher wages for US workers. Natives also may benefit from new jobs created by immigrants who develop new technologies or start new businesses.

A simplistic model of supply and demand assumes that immigrants have the same skills as US natives. The two groups *compete* for jobs. If that is the case, then native employment and wages fall as immigration increases.

But immigration could instead increase native employment if foreign-born workers *complement* US-born workers. There are a number of reasons this might occur. The foreign born can have different skills and education than US natives and therefore tend to work in different jobs. Research indicates that immigrants tend to work in intensive manual-labor jobs—jobs that employers often have difficulty filling with US-born workers—while natives specialize in jobs that require more communications skills.[7] For example, having more foreign-born roofers can allow American contractors to build more houses, creating more jobs for US-born workers in higher-paying skilled, supervisory, or white-collar jobs such as foremen or "front office" workers doing sales and coordination. Immigration also can encourage some natives to work more by lowering the cost of hiring help with domestic chores and child care.[8] In addition, immigration can save jobs: in the increasingly globalized economy, some companies will move factories and jobs offshore if they cannot find or bring in workers with the skills needed to fill essential positions.[9]

In addition, immigrants can create jobs for natives through their entrepreneurial activities. For example, 25 percent of high-tech companies founded during 1995 to 2005 had at least one immigrant founder.[10] Over 40 percent of companies in the Fortune 500 in 2010 were founded by an immigrant or the child of an immigrant.[11] Immigrants may also drive innovation, which then leads to job growth. Highly educated immigrants obtain patents at double the rate of highly educated US natives, and their presence appears to spur patent activity by US natives as well.[12]

With two economic theories—"compete" versus "complement"—offering contradictory predictions, the question of how immigration affects employment is ultimately an empirical one. Yet previous economic research offers surprisingly few answers. Although there is an extensive literature on how immigration affects the earnings of US-born workers,[13] only a few studies have looked closely at the relationship to employment. These studies yield mixed results.[14] Recent research on the overall effect of immigration concludes that the foreign born may have a modest negative impact on US employment in the short run, particularly if the economy is in a recession, but a more positive effect in the long run.[15] Another study finds evidence of zero or posi-

tive effects on the employment rate for US natives, including among less-educated natives.[16] These previous studies have looked at the effect of all immigration on native employment. In contrast, this study tries to inform policy by looking specifically at the employment impact of groups of immigrants that have been identified by researchers and policymakers as leading to innovation and job creation.

Methodological Approach. Ideally, we would like to know what would have happened to the employment of US natives in the absence of immigration and then compare that with what actually happened. The difference would be immigration's effect on the employment of US natives. But because it is not possible to know what would have happened without immigration, researchers typically rely either on models that simulate the impact of immigration based on assumptions about how substitutable foreign- and US-born workers are for one another, or on models that compare areas that receive large numbers of immigrants with areas that receive relatively small numbers. This paper takes the latter approach.

This study uses the fact that the percentage of the workforce that is foreign born varies from state to state to examine the relationship between immigration and employment among US natives. In other words, it asks whether having a higher share of workers who are foreign born in a given state increases or decreases the employment rate among US natives in that state. A positive relationship would indicate that more immigration creates jobs for US natives, while a negative relationship would indicate that more immigration decreases employment for US natives. (The method is explained in more detail in the appendix.)

The study specifically looks at groups of immigrants who may be particularly likely to boost job growth by identifying the impact of the following subgroups of immigrants: immigrants with an advanced degree, immigrants with an advanced degree working in a STEM occupation, and immigrants with an advanced degree likely to have been earned at a US university working in a STEM occupation.

ADVANCED DEGREES
2000-2007

100 FOREIGN BORN WORKERS = 262 ADDITIONAL JOBS

Every additional 100 foreign-born workers who earned an advanced degree in the US and then worked in STEM fields created an additional 262 jobs for US natives.

100 FOREIGN BORN WORKERS = 44 ADDITIONAL JOBS

Every additional 100 foreign-born workers with an advanced degree created an additional 44 jobs for US natives.

While some previous research examines the effect of immigrants of certain skill levels on the employment of similarly skilled natives, this paper looks at the effect of highly educated immigrants, temporary high- and low-skilled foreign-born workers, and immigrants as a whole on all US natives. This approach captures not only the foreign born's effect on similarly skilled native born, but also spillovers into other skill categories, where immigrants might complement natives more than substitute for them. For example, an immigrant with a graduate degree in engineering might compete with US-born engineers for a job, but that immigrant will also buy a house and other goods and services, send children to school, and perhaps someday found a company or develop a commercially important patent, all of which create jobs for workers across the skill spectrum.

This paper uses data from the US Census Bureau's Current Population Survey (CPS) covering all fifty states and the District of Columbia, focusing on the

periods 2000–2007 and 2000–2010. The former represents a period of economic recovery and growth while the latter period includes the recent recession, during which the US-born employment rate fell by more than two percentage points. The analysis begins in 2000 to avoid including the high-tech bubble of the late 1990s.[17]

The study relies on the fact that the percentage of the workforce that is foreign born—the immigrant share—varies from state to state. This difference across states allows for comparisons that yield the relationship between immigration and American jobs. But one of the fundamental challenges when using cross-state comparisons to show a relationship between immigrants and jobs is that immigrants tend to be more mobile and go where the jobs are. As a result, evidence of high immigrant shares in states with strong economic growth and high employment could be the *result* of greater job opportunities (as immigrants move to jobs), rather than the *cause*. Cross-state comparisons would then show an artificially high impact of immigrants on the native employment rate. The study avoids "overcounting" the effects of immigrant workers drawn by a recent economic boom by using an estimation technique (known as "two-stage least squares (2SLS) regression estimation" and discussed in the appendix) that is designed to yield the effect of immigration independent of recent growth and employment opportunities. The analysis also controls for state- and time-specific factors that might affect native employment rates.

The findings suggest how smarter immigration policies could help reduce government deficits.

Significantly, the CPS data include both foreign born who are legally present in the country and those whose presence is unauthorized. And while it is not possible in the data to distinguish between legal permanent immigrants, temporary foreign workers, and those here illegally, it is important to recognize that effects might well differ among the groups because they tend to differ in skill level. Unauthorized foreign born (roughly 30 percent of all foreign born) are disproportionately less skilled. Estimates suggest that almost one-half of unauthorized immigrants have not completed high school, and they comprise 22 percent of all adults without a high school degree in the United States. Meanwhile, those here legally (roughly 70 percent of all foreign born, including temporary workers and students) are actually more likely than the US-born to have a bachelor's degree or higher.[18]

This study also examines the specific effect of temporary worker programs on the employment rate among US natives across states. The study looks at the three main temporary worker programs: H-1B visas for skilled workers, H-2A visas for seasonal agricultural workers, and H-2B visas for seasonal nonagricultural workers. For each visa program, it simply asks whether more approved applications for temporary workers in each state, relative to total employment, corresponds to higher or lower employment rates for US natives, controlling for state- and time-specific factors.

There are two reasons to think that this study, which uses annual, state-level data over a ten-year period, may actually underestimate the job-creating effects of highly skilled immigrants. First, it does not capture long-run effects if the economy benefits more from immigrants in the long run than in the short run (as suggested by other recent research).[19] Second, it does not capture "spillover effects" if immigrants create jobs in states other than the one where they work (for example, more immigration in California leads businesses to also create new jobs at a subsidiary in Indiana).

Finally, the study also seeks to examine the fiscal impact of immigrants by using 2009 data on tax

payments and government benefits. Clearly, immigrants' economic impact goes beyond paying taxes and receiving benefits. Immigrants are also consumers, which increases economic activity and GDP and leads indirectly to additional tax revenues. But by focusing strictly on taxes and government transfer programs, this study identifies immigration's most direct fiscal impact on federal and state government budgets. The findings suggest how smarter immigration policies could help reduce government deficits.

Results

The results, presented in detail in the appendix, demonstrate that immigrants with advanced degrees overall create jobs for US natives, but the results are most dramatic for immigrants with advanced degrees from US universities working in STEM occupations. The analysis of temporary worker applications suggests that two of the three primary categories of temporary foreign workers (H-1B and H-2B) are associated with strong job creation for US natives; the third type (H-2A) shows a positive association with job creation but the data series is too short to yield statistically significant results. And including all foreign-born workers—regardless of legal status or education level—the data show no evidence that immigration hurts US employment. Finally, consistent with their positive effect on employment, more educated immigrants pay far more in taxes than they receive in government transfers. Specifically, the analysis finds the following:

Immigrants with advanced degrees from US universities who work in STEM fields dramatically boost employment for US natives. During 2000–2007, a 10 percent increase in the share of such workers boosted the US-born employment rate by 0.04 percent. Evaluating this at the average numbers of foreign- and US-born workers during that period, this implies that every additional 100 foreign-born workers who earned an advanced degree in the United States and then worked in STEM fields led to an additional 262 jobs for US natives. (See Table 2)

In addition, immigrants with advanced degrees in general boost employment for US natives. The overall share of workers who are immigrants with an advanced degree (from foreign and US universities) working in a STEM occupation is also positively associated with the native employment rate. During 2000–2007, a 10 percent increase in the share of workers who are immigrants with advanced degrees working in STEM boosted the US-born employment rate by 0.03 percent. This translates into every additional 100 foreign-born workers with an advanced degree working in a STEM occupation creating about eighty-six additional jobs for US-born workers. The estimates also indicate that simply increasing the number of immigrants with advanced degrees working in all fields, not just STEM, would increase American employment. A 10 percent increase in the share of all workers who are immigrants with advanced degrees boosted the native employment rate by 0.08 percent during 2000–2007. In other words, each additional 100 foreign-born workers with an advanced degree created about forty-four additional jobs for US natives.[20] (See Table 1)

Temporary employment visa programs for both skilled and less-skilled workers are positively related to employment of US natives. Temporary foreign worker programs allow employers to hire foreign workers to fill specific jobs. The three main temporary visa programs are the H-1B temporary high-skilled visa, the H-2B temporary less-skilled

visa for nonagricultural workers, and the H-2A temporary less-skilled visa for agricultural workers. The data show that both the H-1B and H-2B visas are positively associated with native employment rates, while the data for the H-2A visas show a slightly positive association with native employment rate, but the data series was too short to yield statistically significant results. (See Table 4)

The estimates show that a 10 percent increase in H-1B workers, relative to total employment, is associated with a 0.11 percent increase in the native employment rate. During the sample period of 2001–2010, this translates into each additional 100 approved H-1B workers being associated with an additional 183 jobs among US natives. A 10 percent increase in H-2B workers, relative to total employment, is associated with a 0.07 percent increase in the native employment rate during 2000–2010. In other words, each additional 100 approved H-2B workers is associated with an additional 464 jobs among US natives.

The results give clear evidence that both the H-1B and H-2B programs for temporary workers correspond to greater job opportunities for US-born workers. The particularly strong results for the H-2B program, which is for less-skilled nonagricultural workers, may be surprising given that some other studies conclude that less-skilled immigrants compete with similarly skilled US-born workers. The results here may reflect that employers, who find the H-2B program expensive and bureaucratic, tend to reserve it for hard-to-fill jobs that are critical to expanding operations. In addition, the results may be biased upward because the temporary worker analysis could not control for immigrants being drawn to areas experiencing strong economic growth and high employment. Even with these qualifications, the study's very strong results for H-2B suggest reasons to expand and simplify the program beyond its current level. Of course, there may be a breaking point where workers on H-2B visas no longer complement, but instead compete with, US-born workers, but that point appears to be well beyond the current program's limit.

Overall, when looking at the effect of all immigrants on employment among US natives, there is no evidence that immigrants take jobs from US-born workers. The analysis that examines all current immigrants reveals no evidence of an effect, positive or negative, on the native employment rate. More specifically, the foreign-born share of workers is not statistically significantly related to the US-born employment rate during years of growth, 2000–2007, or during the entire decade, 2000–2010. Looking at all immigrants, the data reveal a slight negative, but statistically insignificant, effect that is similar to that estimated in previous research.[21] Interestingly, this "null effect" is true in a system that prioritizes family reunification over employment-based legal immigration and that contains millions of unauthorized immigrants.

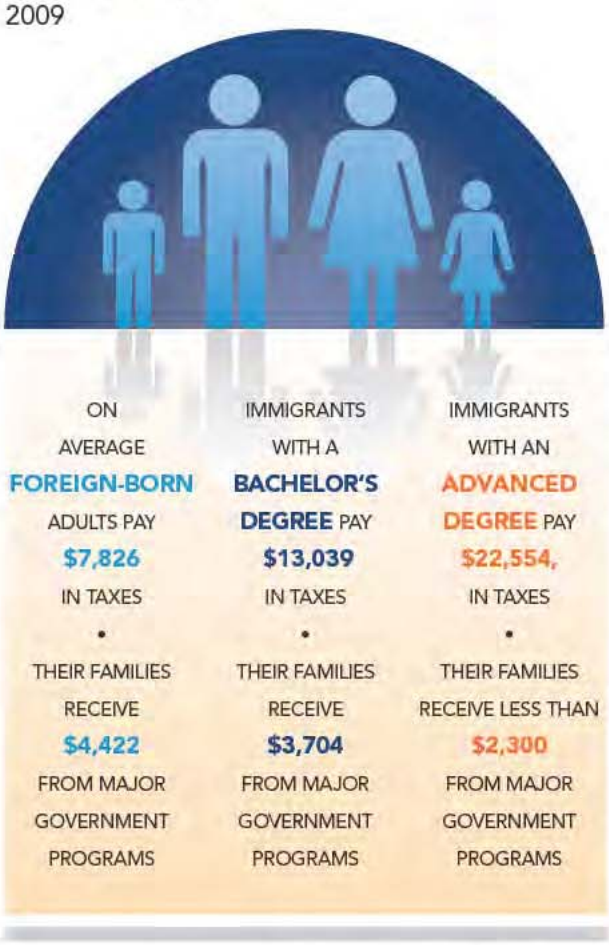
Fiscal Impact

Immigration's effect on US employment is a particularly timely issue given the slow labor market recovery from the 2007–2009 recession, but immigration's fiscal impact is also important, given the sizable federal deficit and many states' budget woes. This paper therefore turns to data on earnings, tax payments, and government transfers among the foreign born in 2009. Details about the data and estimates are in the appendix.

On average, immigrants pay more in taxes than their families receive in federal benefits from the major government programs such as welfare, unemployment benefits, food stamps, and Medicaid. And as immigrants' education level increases, the likelihood of working, annual hours worked, and annual earnings also increase. As a result, increases in the

education level of immigrants lead to increased tax payments. Not surprisingly, an increase in education level also corresponds with a decrease in government benefit payments to immigrants' families.

FISCAL IMPACT
2009



On average, foreign-born adults pay $7,826 in federal, state, and FICA taxes, while their families receive $4,422 in cash and in-kind transfers from major government programs in a given year. For immigrants with a bachelor's degree, tax payments average $13,039, while their families receive cash and in-kind transfers valued at $3,704. And for immigrants with an advanced degree, the average tax payment is $22,554, while their families receive less than $2,300 in cash and in-kind transfers from major programs.

These calculations are a snapshot of the fiscal impact at a point in time and do not account for immigrants' taxes and transfers over their entire lifetimes. Nor does the study capture the more indirect economic impacts of immigration such as increasing economic activity or positively affecting American employment, both of which lead to higher tax revenues and, in the case of greater employment, reduced transfer payments. The direct fiscal impact of the foreign born in a single year is only a small piece of understanding their economic costs and benefits.

Policy Implications

There is no doubt that immigrants play a vital role in the American economy. Each year, the number and characteristics of those who enter the country affect employment, economic growth, and government revenues and expenditures for years to come. America's immigration policy is not geared toward stimulating economic growth and job creation. Only 14 percent of the one million–plus green cards issued each year are allocated based on employment. This includes workers' spouses and children, so the true measure is just 7 percent. Meanwhile, every other major developed country puts more emphasis on admitting immigrants that will meet economic needs. Compared with America's 7 percent, Canada admits 25 percent of its immigrants based on employment, Australia 42 percent, and the United Kingdom and Germany almost 60 percent.[22]

Given America's sluggish economic growth and persistently high unemployment rate, policymakers must do more to identify changes in American pol-

icy that will boost job creation. This study shows that several specific groups of immigrants—advanced degree holders and temporary foreign workers—lead to greater employment among US natives. It therefore offers a roadmap to US policymakers interested in strengthening employment opportunities for Americans. The following recommendations represent the most immediate ways to capitalize on these findings.

Recommendation 1: Prioritize immigration by workers in STEM fields who hold advanced degrees from US institutions. While increases in the total number of immigrants with advanced degrees boost employment, the effect is biggest for immigrants with US degrees who work in STEM fields. This study estimates that an additional 100,000 such workers could lead to an additional 262,000 American jobs.

One of the best sources of highly skilled immigrants is the pool of foreign students who earn their degrees here and have their education subsidized and supported by American resources. About 50,000 foreign students received advanced degrees from US universities in STEM fields in 2009.[23] After graduation, most foreign students are allowed to work for up to one year in a job related to their field of study, with an additional seventeen months for graduates in STEM fields. After that, they and their employers have to scramble for the limited numbers of H-1B temporary visas and employment-based permanent visas. Keeping these graduates here will create American jobs and provide additional benefits: immigrants who entered the United States on a student visa for college or graduate study are more likely than natives to hold a patent, to have a publication, and, for those who came for graduate study, to start a company with ten or more employees.[24] From the perspective of US employment, it makes little sense to force those graduates to leave the United States for home or for other countries eager to capitalize on their first-rate US education.

Recommendation 2: Shift US immigration policy's focus to economic growth by increasing the number of green cards for highly skilled workers. The study estimates that attracting an additional 100,000 highly skilled immigrants with advanced degrees could lead to an additional 44,000 jobs for US natives. The effect is larger still for immigrants with advanced degrees working in STEM occupations. The key takeaway is that bringing in more highly skilled workers will create American jobs.

Despite this, current policy allocates only about 7 percent of green cards based on employment, while the number of H-1B visas for skilled temporary foreign workers is capped at 85,000 annually. Other rules impose further limitations on highly skilled immigration. For example, per-country caps limit each country to no more than 7 percent of green cards issued annually, which creates daunting backlogs for China and India, countries that quickly fill their annual quota. Facing the prospect of working on temporary visas for up to ten years and unable to change employers or even job titles without jeopardizing their initial application, many highly skilled, highly motivated workers from China and India choose to leave for greater opportunities

The key takeaway is that bringing in more highly skilled workers will create American jobs.

back home or in another, more welcoming country. Given what this study shows about the opportunity to boost American employment and contribute to government coffers, policymakers should increase the number of permanent visas for highly skilled workers and rewrite the rules to lift the artificial limits on country caps for green cards.

Recommendation 3: Expand temporary-worker programs for both skilled and less-skilled foreign workers. The study shows that an increase in skilled temporary foreign workers admitted through the H-1B visa program is positively related to the native employment rate: 183 more jobs for US natives for every 100 additional approved H-1B workers. This finding is consistent with other evidence that the H-1B program leads to innovation. For example, companies and cities with more H-1B workers receive more patents than their peers.[25] But US law currently imposes an annual cap of 65,000 new H-1B visas each fiscal year, with another 20,000 new visas for those who hold graduate degrees from US institutions.[26] In most years, those numbers are hit well before the end of the fiscal year, sometimes in a matter of days. And even during the recession, the quota continues to be filled. The results of this study, suggesting that H-1B workers boost American employment, make a strong case for the expansion of the H-1B program to meet the obvious market demand.

The study also shows that a modest increase in H-2B workers can deliver a generous boost to the US-born employment rate: 464 more jobs for US natives for every 100 approved H-2B workers. But under current law, the H-2B visa program is bureaucratic and expensive, requiring employers to navigate three separate federal agencies and onerous documentation requirements. The same holds true for the H-2A program, which offers temporary visas to agricultural workers, whose effect on US workers was found to be positive but, because of limited data, not statistically significant. The results of this study, showing that programs for temporary foreign workers appear to bolster US employment, support the idea that US employers use guest workers not to replace American workers but to fill critical needs, allowing operations to continue or expand, which in turn creates additional jobs for Americans. With such evidence, there is a strong case for streamlining and expanding immigrant guest worker programs to serve the American market more effectively.

Conclusion

In the face of the most profound economic crisis since the Great Depression, policymakers are searching for solutions to spur economic growth and job creation. This study shows that immigration policy can help fix the economy, and it would require neither new taxes nor new spending cuts. Specific, incremental changes to immigration, such as more permanent and temporary visas for highly educated immigrants, especially those in STEM fields, and expanded programs for both skilled and less-skilled temporary foreign workers, can lead to job growth even in the short run. Yet despite these possibilities, America's immigration policy has remained largely unchanged for over two decades.

And there is a cost to this inaction: while America remains deadlocked, the rest of the world competes for talent. Every major developed country is more focused than the United States on admitting immigrants to meet economic needs. Many countries are developing programs aimed at recruiting the next generation of job creators. Chile and Singapore have specialized visas for entrepreneurs

...immigration policy can help fix the economy, and it would require neither new taxes nor new spending cuts.

who want to start new companies and create new jobs. Taiwan, China, and Israel are among the countries that provide incentives for expatriate researchers to return and work in their home countries. Not only is America failing to recruit foreign-born talent to come here, but the country is also losing foreign-born talent who are already here. Graduates of top US universities look elsewhere when they have no easy way to stay and work in the United States. Entrepreneurial immigrants from China and India, many with years of work experience at American companies, are returning home because of outdated, inflexible US immigration policies coupled with improving economic prospects at home.[27] Changes in immigration policy are needed to boost employment, drive economic growth, and keep America competitive in today's global economy.

Appendix

This paper examines the relationship between immigration and employment of US natives at the state level. It estimates a reduced-form model that focuses on the relationship between the immigrant share and the employment rate of US natives. The basic empirical model estimated here is

$$ln\ \frac{L_{st}^{n}}{p_{st}^{n}} = \beta\ ln\ \frac{L_{st}^{f}}{L_{st}^{n+f}} + \delta_s + \delta_t + \varepsilon_{st},$$

with superscripts *n* indicating US natives and *f* indicating the foreign born, respectively, *s* indexing states, and *t* indexing years. The focus is on estimates of β, which indicates how changes in the immigrant share of the employed affect the native employment rate. The δ terms are state and year fixed effects, and ε is a random error term. The error terms are robust and clustered on the state. Observations are weighted using the number of US natives in a state as a share of the total US native population that year. This gives each year the same total weight in the regressions. Regressions are estimated using ordinary least squares (OLS) or 2SLS, as discussed below.

Several variants of the basic model are estimated. The first model examines the relationship between the immigrant share and the native employment rate for all people aged sixteen to sixty-four. Extensions of this model then examine the relationship between the number of foreign-born workers within a specific group relative to all workers and the native employment rate. The specific groups are immigrants aged sixteen to sixty-four with a bachelor's degree or higher, immigrants aged sixteen to sixty-four with an advanced degree (master's, professional, or doctorate), and immigrants aged sixteen to sixty-four with an advanced degree who report a STEM occupation, defined here as engineers, mathematical and computer scientists, and natural scientists. Those results are reported in table 1.

The relationship between the immigrant share and the native employment rate may differ for immigrants educated in the United States and those educated abroad. The regression models for the three specific groups (bachelor's degree or higher, advanced degree, and advanced degree reporting a STEM occupation) are therefore estimated with separate variables for immigrants likely to have received their highest degree in the United States and those likely to have received their highest degree abroad. The data used here do not indicate where an individual's education occurred, so individuals with a bachelor's degree who appear to have entered the United States before age twenty-one and advanced degree holders who appear to have entered the United States before age twenty-five are classified here as US educated. The results for the relationships with the overall native employment rate are reported in tables 2 and 3.

The relationship between temporary foreign workers and employment of US natives is examined by regressing the US-born employment rate on the number of approved temporary foreign workers (as explained below) relative to the number of people aged sixteen to sixty-four employed in a given state and year. Separate models are estimated for H-1B workers, H-2A workers, and H-2B workers. The results are reported in table 4.

Data. Native employment rates and immigrant shares are calculated using the 2000–2010 CPS merged with outgoing rotation groups data.[28] Immigrants are defined here as people who report that they were born abroad (and not to US-citizen parents); the surveys ask about US citizenship status but not about visa status, so it is not possible to distinguish between legal permanent residents, temporary nonimmigrants, and unauthorized migrants in the data.

Some specifications report results using the full sample from 2000 to 2010, while others report results using data from 2000 to 2007. With the full sample, the maximum number of observations is 561. Some specifications drop state-year cells with no employed US natives or with no immigrants because of the log-log specification.

The CPS data include all foreign born, regardless of legal status or visa type. Very little data on the foreign born by legal status or visa type are available. The Department of Labor publishes data on applications for temporary foreign workers through the H-1B, H-2A, and H-2B programs. Those data are used here for the years they are available: 2001–2010 for the H-1B program, 2006–2010 for the H-2A program, and 2000–2010 for the H-2B program.[29] The measure of temporary foreign workers used here is the number of approved foreign workers in a given state and year. These counts of approved workers proxy for the ultimate number of new temporary foreign workers in each state, since data on actual temporary foreign worker inflows by geographic area are not available.[30]

Instrumental Variables. A key concern regarding state-level models like those estimated here is whether the immigrant share is exogenous. If immigration is positively related to economic conditions that also boost the native employment rate, the estimated relationship between the immigrant share and the native employment rate is upward biased, or too positive. The standard method of controlling for this endogeneity bias is to use a variable that is well correlated with the endogenous variable (the immigrant share) but not related to shocks to the outcome variable (the native employment rate) as an instrumental variable for the endogenous variable. 2SLS regressions then capture the relationship between the exogenous component of the immigrant share—the part that is unrelated to economic conditions—and the native employment rate.

This paper uses the number of immigrants in the population as an instrument for the number of immigrants in the workforce in tables 1–3. The first-stage regressions are very strong.[31] There is no instrument available for the temporary foreign worker OLS regressions reported in table 4 because, by definition, the number of temporary foreign workers in the population equals the number of foreign-born workers in the workforce.

Results. The native employment rate is weakly negatively related to the immigrant share during both 2000–2007 and 2000–2010, as shown in the top row of table 1. A 10 percent increase in the immigrant share is associated with a 0.02 percent decrease during 2000–2007 and a 0.01 percent decrease using 2000–2010 in the OLS specifications. In the 2SLS specifications, a 10 percent increase in the immigrant share is associated with a 0.08 percent decrease during 2000–2007 and a 0.13 percent decrease during 2000–2010. None of the estimates are significantly different from zero. As expected, the 2SLS results are more negative, albeit not significantly so.

The other rows in table 1 report results from esti-

mating the model with various subgroups of immigrants. The 2SLS results for immigrants with a bachelor's degree or higher indicate that a 10 percent increase in their share of the total workforce is associated with a 0.03 percent increase in the overall native employment rate during 2000–2007 and a 0.02 percent decrease during 2000–2010 (row 2). A 10 percent increase in the number of immigrants with an advanced degree as a share of the total workforce is associated with a 0.08 percent increase in the overall native employment rate during 2000–2007 and a 0.03 percent increase during 2000–2010 (row 3). A 10 percent increase in the number of foreign-born advanced degree holders with a STEM occupation relative to all workers is associated with a 0.03 percent increase in the overall native employment rate during 2000–2007 and a 0.02 percent increase during 2000–2010 (row 4). In the main text, the 2SLS estimates are evaluated at the national averages during 2000–2007.

Two interesting patterns emerge from table 1. First, the results indicate that the employment effect of immigration becomes more positive as immigrants' education level increases. For example, the point estimate for 2000–2007 is more than twice as large for foreign-born advanced degree holders than for all foreign-born college graduates.

Second, the results suggest more positive employment effects during 2000–2007 than during 2000–2010. There were sizable declines in US-born employment rates in many states during the Great Recession, which officially began in December 2007. From 2008 to 2009, the US-born employment rate fell by an average of 2.7 percentage points—from 64.4 percent to 61.7 percent—across states, for example. The immigrant share of the population aged sixteen to sixty-four actually increased, on average, during that period. The economy therefore had more immigrants to absorb even as the number of jobs was falling. It is not surprising that the relationship between the immigrant share and the native employment rate is more positive during periods of economic growth than during recessions.[32]

The results are generally similar if the immigrant shares of bachelor's degree or higher or advanced degree holders are calculated relative only to similarly educated workers rather than relative to all workers. Measuring the foreign born relative to similarly educated workers rather than relative to all workers is arguably better if immigrants primarily compete with similarly educated US natives for jobs. But over one-fifth of foreign-born college-educated workers—and a slightly lower share of college-educated US-born workers—hold unskilled jobs.[33] Measuring the size of various groups of immigrants relative to all workers may therefore be more appropriate. The results are similar regardless of the measure used.

In general, the relationship between the immigrant share and the overall native employment rate does not appear to vary with whether immigrants are likely to have received their highest degree in the United States or abroad. The results in table 2 (for 2000–2007) and table 3 (for 2000–2010) indicate few differences between the estimated coefficients for the US-educated and foreign-educated variables. The one exception is immigrants with advanced degrees and in STEM occupations during 2000–2007. Here, the share of US-educated immigrants is significantly positively associated with the native employment rate, while the share of foreign-educated immigrants is not. However, the estimated coefficients are not significantly different from each other within either the OLS or the 2SLS specification.

The results are again similar if the immigrant shares by likely place of education are calculated relative to similarly educated workers rather than all workers. In results not shown here, the only notable difference from the tables is that the foreign-educated share with an advanced degree becomes statistically significantly different from zero at the 10 percent level in the 2000–2010 data (but remains not significantly different from the result for the US-educated share with an advanced degree).

The results for temporary foreign workers, shown in table 4, suggest positive employment effects. The native employment rate is positively related to the number of approved applications for H-1B workers relative to the total number of workers. The estimate indicates that a 10 percent increase in H-1B workers is associated with a 0.11 percent increase in the native employment rate. The native employment rate is also positively related to the number of H-2B workers, with a 10 percent increase in the share of H-2B workers associated with a 0.07 percent increase in the native employment rate. The native employment rate is not significantly related to the number of H-2A workers in the five years of data available.

The regressions for temporary foreign workers include all years of data available. Dropping the years 2008–2010 from the H-1B data leaves only six years of data (because the 2007 data are riddled with errors); the estimated coefficient is a statistically insignificant 0.005 for the period 2001–2006. Dropping the years 2008–2010 from the H-2B data gives an estimated coefficient of 0.006, which is significant at the 5 percent level.

Fiscal Impact. Data from the March 2010 CPS are used to examine immigrants' earnings, taxes, and government transfers.[34] The March CPS asks about income from various sources during the previous calendar year, including cash transfer programs like welfare, unemployment insurance, and workers' compensation, in addition to earned income, interest, dividends, and rental income. It includes the market value of food stamps, school lunch, and housing subsidies, and the fungible value of Medicaid and Medicare.[35] The Census Bureau creates estimates of federal, state, and FICA taxes paid by individuals. The estimates of federal taxes are net of the earned income tax credit, child tax credit, and one-time stimulus programs in effect for 2009. Government transfers are reported here at the family level, while employment, earnings, and taxes are reported at the individual level. Census estimates of FICA contributions are doubled to account for the employer contribution.

The sample here is restricted to immigrants aged twenty-five to sixty-four whose earnings are not imputed. Immigrants below age twenty-five are not included because younger people are more likely to have not yet completed their education. The sample includes people who report zero earnings.

Table 5 shows calculations for three groups: all immigrants, immigrants with a bachelor's degree but not an advanced degree, and immigrants with an advanced degree. Immigrants with a bachelor's degree account for 19 percent of immigrants, and those with an advanced degree account for 11 percent.
Employment rates and average hours are higher among immigrants with more education. Individual earned income and tax payments also increase with education. The Census Bureau estimates indicate that immigrants with an advanced degree paid an average of $22,554 in combined federal, state, and FICA taxes in 2009, while immigrants with a bachelor's degree paid an average of $13,039. The average among all immigrants, assuming complete tax compliance, was $7,826. A foreign-born advanced degree holder thus paid almost three times more in taxes than the average foreign-born adult.

Turning to government transfers, the average adult immigrant's family received about $2,328 in benefits from major cash transfer programs (welfare, unemployment insurance, workers' compensation, Social Security, Supplemental Security, and disability). Only a small proportion of cash transfers are from the means-tested cash welfare programs (for example, Temporary Assistance for Needy Families) that are often the focus of public debate. Unemployment insurance was a large component of transfers, likely because of the high unemployment rate in 2009.

The average family of an immigrant bachelor's degree holder received $2,236 from major cash transfer programs in 2009, and the average family of an immigrant graduate degree holder received $1,358.

The value of in-kind benefits from major programs (food stamps, Medicaid, Medicare, and school

lunch) decreases with education as well. The average value of in-kind benefits is $2,094 for all adult immigrants' families, versus $1,468 for families of immigrants with a bachelor's degree and $893 for families of immigrants with an advanced degree. Medicaid, the public health insurance program whose main beneficiaries are low-income children and their mothers, is the most important source of in-kind benefits.

The data on earnings, taxes, and transfers presented in table 5 are an incomplete snapshot of the foreign born in 2009. They do not include all taxes paid; sales taxes, local taxes, and property taxes are omitted. They also do not include other costs of services immigrants receive that are borne by the general public. The most important of these is public education for their children, most of whom are US citizens by birth.

For simplicity, earnings and taxes are reported at the individual level, while benefits are reported at the family level. Many families contain both foreign- and US-born adults and adults with different levels of education.

These data yield partial equilibrium estimates of the fiscal impact of any changes in immigration policy because they do not incorporate any effects of immigration on US natives' or other immigrants' tax payments or transfers. Finally, as discussed in the text, public policy should consider immigrants' tax payments net of government transfers over their entire lifetime, not just at a point in time.

TABLE 1 ESTIMATED EFFECT OF THE IMMIGRANT SHARE ON THE NATIVE EMPLOYMENT RATE

	2000-2007		2000-2010	
	OLS	2SLS	OLS	2SLS
All foreign born	-0.002	-0.008	-0.001	-0.013
	(0.008)	(0.008)	(0.010)	(0.010)
Bachelor's degree or higher	0.008*	0.003	0.003	-0.002
	(0.004)	(0.005)	(0.006)	(0.007)
Advanced degree	0.011**	0.008*	0.005	0.003
	(0.004)	(0.004)	(0.004)	(0.005)
Advanced degree and in STEM occupation	0.004**	0.003*	0.002	0.002
	(0.002)	(0.002)	(0.003)	(0.003)

NOTE: Significance levels are indicated as * p<0.1; ** p<0.05; *** p<0.01. Shown are estimated coefficients (standard errors) from regressions of the log of the employment rate among US natives on the log of the number of employed immigrants in a given group relative to the total number employed in that state and year. The immigrant employment share is instrumented using the immigrant population share. Each coefficient is from a separate regression. Standard errors are robust and clustered on the state, and observations are weighted with the fraction of US natives in that state within each year.

The estimated coefficients give the percentage change in the native employment rate if the immigrant share increases by 1 percent.

TABLE 2 ESTIMATED EFFECT OF THE IMMIGRANT SHARE ON THE NATIVE EMPLOYMENT RATE, BY PLACE OF EDUCATION, 2000–2007

	US		Abroad	
	OLS	2SLS	OLS	2SLS
Bachelor's degree or higher	0.003	0.001	0.004	0.001
	(0.003)	(0.004)	(0.003)	(0.003)
Advanced degree	0.006**	0.005*	0.006**	0.005*
	(0.003)	(0.003)	(0.003)	(0.003)
Advanced degree and in STEM occupation	0.004*	0.0004	-0.0002	-0.001
	(0.003)	(0.002)	(0.0025)	(0.002)

NOTE: Significance levels are indicated as * p<0.1; ** p<0.05; *** p<0.01. Shown are estimated coefficients (standard errors) from regressions of the log of the employment rate among US natives on the log of the number of employed immigrants in a given group relative to the total number employed in that state and year. The immigrant employment share is instrumented using the immigrant population share. Each pair of coefficients is from a separate regression. Standard errors are robust and clustered on the state, and observations are weighted with the fraction of US natives in that state within each year.

The estimated coefficients give the percentage change in the native employment rate if the immigrant share increases by 1 percent.

TABLE 3 ESTIMATED EFFECT OF THE IMMIGRANT SHARE ON THE NATIVE EMPLOYMENT RATE, BY PLACE OF EDUCATION, 2000–2010

	US		Abroad	
	OLS	2SLS	OLS	2SLS
Bachelor's degree or higher	0.001	-0.001	0.002	-0.001
	(0.004)	(0.004)	(0.003)	(0.004)
Advanced degree	0.001	0.001	0.005	0.005
	(0.003)	(0.003)	(0.003)	(0.004)
Advanced degree and in STEM occupation	0.002	0.001	0.001	0.001
	(0.003)	(0.003)	(0.002)	(0.002)

NOTE: Significance levels are indicated as * p<0.1; ** p<0.05; *** p<0.01. Shown are estimated coefficients (standard errors) from regressions of the log of the employment rate among US natives on the log of the number of employed immigrants in a given group relative to the total number employed in that state and year. The immigrant employment share is instrumented using the immigrant population share. Each pair of coefficients is from a separate regression. Standard errors are robust and clustered on the state, and observations are weighted with the fraction of US natives in that state within each year.

The estimated coefficients give the percentage change in the native employment rate if the immigrant share increases by 1 percent.

TABLE 4 ESTIMATED EFFECT OF TEMPORARY FOREIGN WORKER APPLICATIONS ON THE NATIVE EMPLOYMENT RATE

	OLS	
H-1B applications, 2001–2010	0.011*	(0.006)
H-2A applications, 2006–2010	0.001	(0.004)
H-2B applications, 2000–2010	0.007**	(0.003)

NOTE: Significance levels are indicated as * p<0.1; ** p<0.05; *** p<0.01. Shown are estimated coefficients (standard errors) from regressions of the log of the native employment rate in a state and year on the log of the number of approved temporary foreign workers relative to total employment. Standard errors are robust and clustered on the state, and observations are weighted with the fraction of US natives in that state within each year.

The estimated coefficients give the percentage change in the native employment rate if the immigrant share increases by 1 percent.

TABLE 5 AVERAGE EARNINGS, TAXES, AND TRANSFERS AMONG THE FOREIGN BORN, 2009

	All	Bachelor's Degree	Advanced Degree
Percent employed	76	78	84
Annual hours worked	1,422	1,525	1,738
Average annual earnings	$28,945	$40,609	$72,414
Average value of taxes paid			
Federal taxes	$2,406	$5,160	$10,055
State taxes	$954	$1,596	$3,141
FICA taxes	$4,466	$6,283	$9,358
Average value of benefits received by family			
Welfare	$86	$25	$24
Unemployment insurance	$881	$801	$515
Workers' compensation	$88	$35	$1
Social Security	$950	$1,097	$715
Supplemental Security	$213	$173	$74
Disability	$110	$105	$29
Average value of in-kind benefits received by family			
Food stamps	$300	$75	$56
Medicaid	$1,111	$686	$459
Medicare	$516	$651	$343
School lunch	$167	$56	$35

NOTE: Calculations are for immigrants aged twenty-five to sixty-four using data from the March 2010 CPS. All values are for the previous calendar year. Calculations include zero values. Individuals are weighted using final person weights.

Endnotes

1 This study uses the term "immigrants" to refer to all foreign born. This includes naturalized citizens, permanent residents ("green card" holders), temporary visa holders, and unauthorized migrants.

2 Council of Economic Advisers, *Immigration's Economic Impact* (Washington, DC: White House, June 2007), http://georgewbush-whitehouse.archives.gov/cea/cea_immigration_062007.html (accessed June 7, 2011).

3 Patricia Cortés, "The Effect of Low-Skilled Immigration on US Prices: Evidence from CPI Data," *Journal of Political Economy* 116, no. 3 (2008): 381–422.

4 Jennifer Hunt and Marjolaine Gauthier-Loiselle, "How Much Does Immigration Boost Innovation?" *American Economic Journal: Macroeconomics* 2, no. 2 (2010): 31–56; William R. Kerr and William F. Lincoln, "The Supply Side of Innovation: H-1B Visa Reforms and US Ethnic Invention," *Journal of Labor Economics* 28, no. 3 (2010): 473–508; and Robert E. Fairlie, *Estimating the Contribution of Immigrant Business Owners to the US Economy* (Washington, DC: Small Business Administration, Office of Advocacy, 2008), http://archive.sba.gov/advo/research/rs334tot.pdf (accessed June 14, 2011).

5 Jennifer Hunt, "The Impact of Immigration on the Educational Attainment of Natives" (mimeo, McGill University Department of Economics, Montreal, Canada, 2010); and Giovanni Peri and Chad Sparber, "Highly-Educated Immigrants and Native Occupational Choice," *Industrial Relations* 50, no. 3 (2011): 385–411.

6 Studies that find evidence of positive or zero wage effects include David Card, "Immigrant Inflows, Native Outflows, and the Local Labor Market Impacts of Higher Immigration," *Journal of Labor Economics* 19, no. 1 (2001): 22–64; Gianmarco I. P. Ottaviano and Giovanni Peri, "Rethinking the Effects of Immigration on Wages," *Journal of the European Economic Association* (2011, forthcoming); and Heidi Shierholz, *Immigration and Wages: Methodological Advancements Confirm Modest Gains for Native Workers* (Washington, DC: Economic Policy Institute, 2010), www.epi.org/page/-/bp255/bp255.pdf?nocdn=1 (accessed March 4, 2011). For research that reports adverse wage effects, see, for example, George J. Borjas, "The Labor Demand Curve *Is* Downward Sloping: Reexamining the Impact of Immigration on the Labor Market," *Quarterly Journal of Economics* 118, no. 4 (2003): 1335–74.

7 Giovanni Peri and Chad Sparber, "Highly-Educated Immigrants and Native Occupational Choice."

8 Patricia Cortés and José Tessada, "Low-Skilled Immigration and the Labor Supply of Highly Educated Women," *American Economic Journal: Applied Economics* 3, no. 3 (2011): 88–123.

9 Gianmarco I. P. Ottaviano, Giovanni Peri, and Greg C. Wright, "Immigration, Offshoring, and American Jobs" (National Bureau of Economic Research Working Paper No. 16439, Cambridge, MA, 2010), www.nber.org/papers/w16439 (accessed May 20, 2011).

10 Vivek Wadhwa, Ben Rissing, AnnaLee Saxenian, and Gary Gereffi, *Education, Entrepreneurship, and Immigration: America's New Immigrant Entrepreneurs, Part II* (Kansas City, MO: Kauffman Foundation, 2007), http://sites.kauffman.org/pdf/entrep_immigrants_1_070907.pdf (accessed June 8, 2011).

11 Partnership for a New American Economy, "The 'New American' Fortune 500," www.renewoureconomy.org/sites/all/themes/pnae/img/new-american-fortune-500-june-2011.pdf (accessed June 15, 2011).

12 Jennifer Hunt and Marjolaine Gauthier-Loiselle, "How Much Does Immigration Boost Innovation?"

13 For an overview of the wage literature, see, for example, Rachel M. Friedberg and Jennifer Hunt, "Immigration and the Receiving Economy," in *The Handbook of International Migration: The American Experience*, ed. Charles Hirschman, Philip Kasinitz, and Josh DeWind (New York: Russell Sage Foundation, 1999); and David Card, "Is the New Immigration Really So Bad?" *Economic Journal* 115 (2005): F300–F323.

14 Studies that examine employment impacts include George J. Borjas, Jeffrey Grogger, and Gordon H. Hanson, "Immigration and the Economic Status of African-American Men," *Economica* 77 (2010): 255–82; David Card, "Immigrant Inflows, Native Outflows, and the Local Labor Market Impacts of Higher Immigration"; and Christopher L. Smith, "'Dude, Where's My Job?' The Impact of Immigration on the Youth Labor Market" (mimeo, Massachusetts Institute of Technology Department of Economics, Cambridge, MA, 2007), http://client.norc.org/jole/soleweb/8290.pdf (accessed June 3, 2011).

15 Giovanni Peri, *The Impact of Immigrants in Recession and Economic Expansion* (Washington, DC: Migration Policy Institute, 2010), www.migrationpolicy.org/pubs/Peri-June2010.pdf (accessed May 15, 2011).

16 Giovanni Peri, "Rethinking the Area Approach: Immigrants and the Labor Market in California, 1960–2005" (National Bureau of Economic Research Working Paper No. 16217, Cambridge, MA, 2010), www.nber.org/papers/w16217 (accessed May 28, 2011).

17 In addition, the occupation codes in the CPS changed in 2000. Beginning the analysis then allows for a consistent classification of STEM workers.

18 Jeffrey S. Passel and D'Vera Cohn, *A Portrait of Unauthorized Immigrants in the United States* (Washington, DC: Pew Hispanic Center, 2009), http://pewhispanic.org/files/reports/107.pdf (accessed December 2, 2009).

19 See Giovanni Peri, *The Impact of Immigrants in Recession and Economic Expansion*.

20 A 10 percent increase yields a smaller percent increase in US-born employment for those working in STEM than for foreign-born advanced degree holders in general (0.03 versus 0.08) yet more jobs per 100 (eighty-six versus forty-four). This is because STEM workers are a subset of the larger group of all advanced degree holders; as a result, an increase of 100 advanced-degree STEM workers would constitute a greater proportional increase than would an increase of 100 advanced-degree holders in general and therefore would have a larger effect on the number of jobs for US natives.

21 David Card, "Immigrant Inflows, Native Outflows, and the Local Labor Market Impacts of Higher Immigration," reports a comparable estimate of -0.1 to -0.2 percent.

22 Organization for Economic Cooperation and Development, *International Migration Outlook* (Paris, France: OECD Press, 2010).

23 Stuart Anderson, *Keeping Talent in America* (Dallas, TX: National Foundation for American Policy, 2011), www.nfap.com/pdf/KEEPING_TALENT_IN_AMERICA_NFAP_October_2011.pdf (accessed October 9, 2011).

24 Jennifer Hunt, "Which Immigrants Are Most Innovative and Entrepreneurial? Distinctions by Entry Visa," *Journal of Labor Economics* 29, no. 3 (2011): 417–57.

25 William R. Kerr and William F. Lincoln, "The Supply Side of Innovation: H-1B Visa Reforms and US Ethnic Invention."

26 Institutions of higher education and nonprofit and government research organizations are exempt from the cap, as are current H-1B holders who have already counted against the cap and are switching employers.

27 Vivek Wadhwa, Sonali Jain, AnnaLee Saxenian, Gary Gereffi, and Huiyao Wang, *The Grass Is Indeed Greener in India and China for Returnee Entrepreneurs: America's New Immigrant Entrepreneurs, Part IV* (Kansas City, MO: Kauffman Foundation, 2011), www.kauffman.org/uploadedfiles/grass-is-greener-for-returnee-entrepreneurs.pdf (accessed June 16, 2011).

28 The data are from http://nber.org/morg/annual (accessed March 17, 2011).

29 The data are from Foreign Labor Certification Data Center, www.flcdatacenter.com (accessed November 12, 2011), and are for fiscal years. The public-use H-1B data for 2007 contain erroneous codes for the work state, so the analysis here does not include that year. The employer state is used for the work state in 2006 for H-2A applications.

30 The counts based on the Department of Labor data are strongly correlated with state-level counts of admissions of H-1B and H-2B visa holders (I-94 data on arrivals into the United States) published by the Department of Homeland Security for fiscal years 2005 through 2009 for H-1Bs and fiscal years 2006 through 2009 for H-2Bs. They are not as strongly correlated with counts for H-2As.

31 Attempts to use a predicted measure of the number of foreign born based on historical residence patterns of foreign born from the same region of origin were unsuccessful. There is not enough variation within states in annual data over the eleven-year period to obtain a strong first-stage regression that includes state and year fixed effects. Attempts to use a predicted measure based on historical residence patterns of foreign born from the same region of origin and distance from the US-Mexico border and dummy variables for important ports of entry interacted with year dummy variables—as in Giovanni Peri, *The Impact of Immigrants in Recession and Economic Expansion*—did not pass overidentification tests. Using the foreign-born population share (the foreign-born population relative to the total population rather than relative to all workers) as the instrument—as in George J. Borjas, Jeffrey Grogger, and Gordon H. Hanson, "Immigration and the Economic Status of African-American Men"—yields similar or more positive results than those reported here.

32 Giovanni Peri, *The Impact of Immigrants in Recession and Economic Expansion*, also reports that immigration has a more positive effect on native employment when a state's economy is expanding, as measured by the output gap, than when it is contracting.

33 Jeanne Batalova, Michael Fix, and Peter A. Creticos, *Uneven Progress: The Employment Pathways of Skilled Immigrants in the United States* (Washington, DC: Migration Policy Institute, 2008), www.migrationpolicy.org/pubs/BrainWasteOct08.pdf (accessed June 14, 2011).

34 The data are from National Bureau of Economic Research, "NBER CPS Supplements," www.nber.org/data/current-population-survey-data.html (accessed May 12, 2011). This section is similar to David Card, "How Immigration Affects US Cities," in *Making Cities Work*, ed. Robert P. Inman (Princeton, NJ: Princeton University Press, 2009), but disaggregates immigrants by education. The analysis here ignores issues regarding topcoding, so mean earnings and tax payments are understated, particularly for educated immigrants.

35 The Census Bureau values Medicaid and Medicare coverage at the value of the income that the insurance frees up that otherwise would have been spent on medical care. If family income is not sufficient to cover a family's basic food and housing requirements, the fungible-value methodology values Medicare and Medicaid at zero. This method therefore understates the cost of those transfers to low-income families.

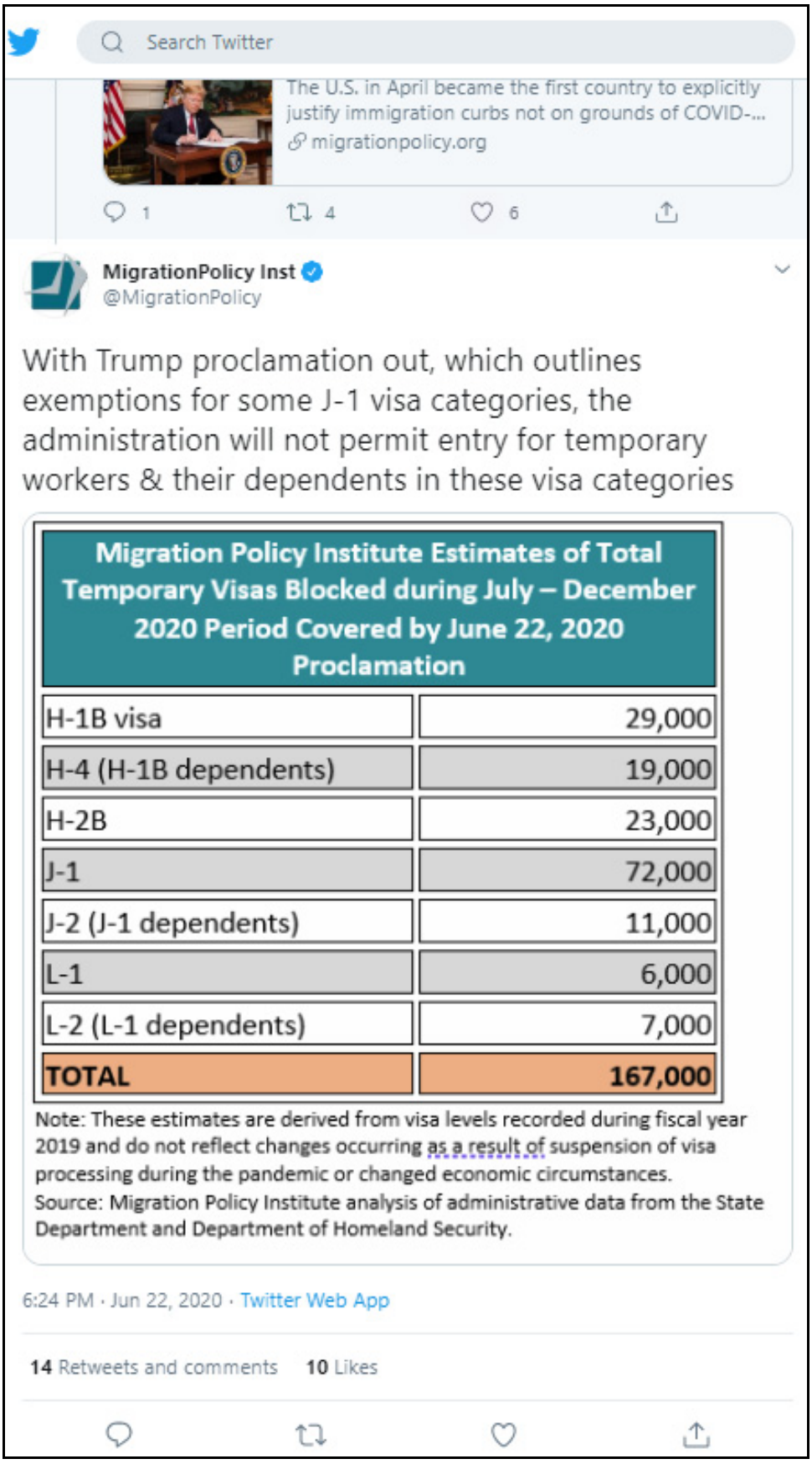
IMMIGRATION AND AMERICAN JOBS

AMERICAN ENTERPRISE INSTITUTE FOR PUBLIC POLICY RESEARCH
AND THE
PARTNERSHIP FOR A NEW AMERICAN ECONOMY

DECEMBER 2011

Hughes Declaration

Exhibit 30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The U.S. in April became the first country to explicitly justify immigration curbs not on grounds of COVID-...
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With Trump proclamation out, which outlines exemptions for some J-1 visa categories, the administration will not permit entry for temporary workers & their dependents in these visa categories
Migration Policy Institute Estimates of Total Temporary Visas Blocked during July – December 2020 Period Covered by June 22, 2020 Proclamation
H-1B visa 29,000
H-4 (H-1B dependents) 19,000
H-2B 23,000
J-1 72,000
J-2 (J-1 dependents) 11,000
L-1 6,000
L-2 (L-1 dependents) 7,000
TOTAL 167,000
Note: These estimates are derived from visa levels recorded during fiscal year 2019 and do not reflect changes occurring as a result of suspension of visa processing during the pandemic or changed economic circumstances.
Source: Migration Policy Institute analysis of administrative data from the State Department and Department of Homeland Security.
6:24 PM · Jun 22, 2020 · Twitter Web App
14 Retweets and comments
10 Likes

Hughes Declaration

Exhibit 31

NATIONAL FOUNDATION FOR AMERICAN POLICY

NFAP POLICY BRIEF » JUNE 2020

UPDATED ANALYSIS OF EMPLOYMENT DATA FOR COMPUTER OCCUPATIONS

The unemployment rate for individuals in computer occupations declined from 3% in January 2020 (before the pandemic spread in the U.S.) to 2.8% in April 2020, and declined again to 2.5% in May 2020, according to an analysis of the Bureau of Labor Statistics' Current Population Survey by the National Foundation for American Policy (NFAP).[1] The 2.5% unemployment rate in May 2020 for individuals in computer occupations is far lower than the 13.5% unemployment rate for all other occupations, indicating that new immigration restrictions based on a claim that computer occupations have been unduly harmed by the economic fallout from the coronavirus would be without a factual foundation.

Table 1
U.S. Unemployment Rate in Computer Occupations

OCCUPATIONS	JANUARY 2020	APRIL 2020	MAY 2020
Computer Occupations	3.0%	2.8%	2.5%
All Other Occupations	4.1%	15.0%	13.5%

Source: National Foundation for American Policy estimates using Bureau of Labor Statistics' Current Population Survey, January 2020, April 2020 and May 2020. Not seasonally adjusted. Computer occupations include Computer and information research scientist, Computer and information systems manager, Computer hardware engineer, Computer network architect, Computer programmer, Computer support specialist, Computer systems analyst, Database administrator and architect, Information security analyst, Electrical and electronics engineer, Network and computer systems administrator, Software developer, Software quality assurance analyst and tester, Web and digital interface designer and Web developer.

The data raise significant questions about the Trump administration's using the unemployment rate for computer professionals to justify the new restrictions on H-1B visa holders and international students working on Optional Practical Training (OPT). Another indicator that demand for high-tech skills remains strong among employers in the U.S. labor market: During the 30-day period ending June 9, 2020, there were over 639,000 active job vacancy postings advertised online for jobs in common computer occupations, including those most common to H-1B visa holders, according to Emsi Job Posting Analytics.[2] For example, there are over 260,000 active job vacancy postings advertised online for software developers (applications).

An April 22, 2020, presidential proclamation suspended the entry of most new immigrants for at least 60 days, and asserted the reason for the proclamation was that "we must be mindful of the impact of foreign workers on the United States labor market, particularly in an environment of high domestic unemployment and depressed demand for labor."

[1] Note: "The Current Population Survey (CPS) is a monthly survey of households conducted by the Bureau of Census for the Bureau of Labor Statistics," according to BLS.
[2] An examination of 12 computer occupations at https://www.economicmodeling.com/job-posting-dashboard/. The number of active job vacancy postings advertised online for jobs in common computer occupations is lower than 12 months ago but still a significant number of vacancy postings.

Updated Analysis of Employment Data for Computer Occupations

The proclamation ordered a 30-day review to recommend additional measures on temporary visas. "The Trump administration is preparing to roll out another set of restrictions on legal immigration, citing the impact of the coronavirus pandemic, even as it argues for the reopening of the US economy, according to sources familiar with the deliberations," reported CNN. "Despite a push from President Donald Trump to move past the pandemic, the administration is continuing to usher forward immigration measures, citing the outbreak and its toll on the economy."[3]

The National Foundation for American Policy analysis of the Bureau of Labor Statistics' Current Population Survey found U.S. professionals in computer occupations – in the same occupations as most H-1B visa holders – had a lower unemployment rate in May 2020 than in January 2020, a decline of about 17% or 0.5 percentage points. (January 2020 was prior to the coronavirus having a significant impact on the U.S. population.)

There are often fluctuations from month-to-month in employment numbers but the big picture is how individuals in computer occupations have fared compared to individuals in other occupations, reflecting the continued demand in the U.S. labor market for their technical skills and knowledge. Table 2 shows the unemployment rate for individuals in computer occupations in 2020 has been fairly consistent at 3% in January 2020, 2.4% in February, 1.9% in March, 2.8% in April and 2.5% in May.

Table 2
U.S. Unemployment Rate in Computer Occupations

OCCUPATIONS	JANUARY 2020	FEBRUARY 2020	MARCH 2020	APRIL 2020	MAY 2020
Computer Occupations	3.0%	2.4%	1.9%	2.8%	2.5%
All Other Occupations	4.1%	3.9%	4.7%	15.0%	13.5%

Source: National Foundation for American Policy estimates using Bureau of Labor Statistics' Current Population Survey, January 2020, February 2020, March 2020, April 2020 and May 2020. Not seasonally adjusted. Computer occupations include Computer and information research scientist, Computer and information systems manager, Computer hardware engineer, Computer network architect, Computer programmer, Computer support specialist, Computer systems analyst, Database administrator and architect, Information security analyst, Electrical and electronics engineer, Network and computer systems administrator, Software developer, Software quality assurance analyst and tester, Web and digital interface designer and Web developer.

In contrast, the overall unemployment rate for individuals in all other occupations went from 4.1% in January 2020 to 15% in April and 13.5% in May due to the impact of businesses affected by the coronavirus, lockdowns and social distancing.

[3] https://www.cnn.com/2020/06/09/politics/immigration-limits-coronavirus/index.html.

Updated Analysis of Employment Data for Computer Occupations

In the NFAP analysis of government unemployment rate data, the computer occupations track those listed in the H-1B "characteristics report" for FY 2019 published by U.S. Citizenship and Immigration Services (USCIS). According to the USCIS report, 66% of H-1B beneficiaries in FY 2019 were in computer-related occupations.[4] The computer occupations included in the NFAP analysis of Bureau of Labor Statistics data were Computer and information research scientists, Computer and information systems manager, Computer hardware engineer, Computer network architect, Computer programmer, Computer support specialist, Computer systems analyst, Database administrator and architect, Information security analyst, Electrical and electronics engineer, Network and computer systems administrator, Software developer, Software quality assurance analyst and tester, Web and digital interface designer and Web developer.

As discussed in the NFAP analysis of April's data, there are several likely explanations for why professionals in computer occupations fared much better in April and May 2020 than workers in other occupations. The skills in computer occupations are those that generally can be performed remotely, an important characteristic during the coronavirus pandemic, according to labor economist and NFAP Senior Fellow Mark Regets. He notes the skills in computer occupations remain in demand today and are going to be in even higher demand in the future as work continues to move online.

This does not mean everything is ideal in the job market even for those in high-tech occupations, but the data show it would be false for government officials to cite the overall U.S. unemployment rate and claim individuals in computer occupations have been harmed in an extraordinary fashion by the economic fallout from the coronavirus.

Members of the Trump administration, including the president, have said the U.S. economy will continue to improve, further undermining the case for new immigration restrictions. In June 10, 2020, Senate testimony, Treasury Secretary Steven T. Mnuchin said, "We remain confident that the overall economy will continue to improve dramatically in the third and fourth quarters."

In remarks on June 5, 2020, President Trump said, "I think we're going to have a very good upcoming few months," he said. "I think you're going to have a very good August, a very good July, but a spectacular – maybe spectacular September, but a spectacular October, November, December. And next year is going to be one of the best years we've ever had, economically. And if you look at the numbers, they bear it out." Chief economic adviser Larry Kudlow made similar statements.

[4] Table 8B, *Characteristics of H-1B Specialty Occupation Workers Fiscal Year 2019 Annual Report to Congress October 1, 2018 – September 30, 2019*, USCIS, March 5, 2020. NFAP included electrical and electronics engineers in the analysis of government unemployment rate data. Other occupations eligible for H-1Bs, such as accountants, appear in much lower numbers in the USCIS report.

Economic research shows foreign-born individuals do not harm the labor market prospects of Americans. "H-1B visa holders do not adversely affect U.S. workers," according to a May 2020 National Foundation for American Policy study by Madeline Zavodny, formerly an economist at the Federal Reserve Bank of Atlanta (and Dallas) and a professor of economics at the University of North Florida (UNF) in Jacksonville. "On the contrary, the evidence points to the presence of H-1B visa holders being associated with lower unemployment rates and faster earnings growth among college graduates, including recent college graduates. Further, the results suggest that, if anything, being in a field with more H-1B visa holders makes it more likely that U.S.-born young college graduates work in a job closely related to their college major. The results here should give pause to policymakers considering imposing additional restrictions on the H-1B program. There is little reason to think doing so will help American workers."[5]

A study by economists Giovanni Peri, Kevin Shih, Chad Sparber and Angie Marek Zeitlin examined the last recession and found that denying the entry of H-1B visa holders due to the annual limits harmed job growth for U.S.-born professionals. "The number of jobs for U.S.-born workers in computer-related industries would have grown at least 55% faster between 2005-2006 and 2009-2010, if not for the denial of so many applications in the recent H-1B visa lotteries," concluded the economists.[6]

Research by Britta Glennon, an assistant professor at the Wharton School of Business at the University of Pennsylvania, found new restrictions on H-1B visas are likely to push jobs out of the United States, concluding, "[A]ny policies that are motivated by concerns about the loss of native jobs should consider that policies aimed at reducing immigration have the unintended consequence of encouraging firms to offshore jobs abroad." [7]

A study by Madeline Zavodny concluded, "There is no evidence that foreign students participating in the OPT [Optional Practical Training] program reduce job opportunities for U.S. workers. Instead, the evidence suggests that U.S. employers are more likely to turn to foreign student workers when U.S. workers are scarcer." The study also found, "The relative number of foreign students approved for OPT is negatively related to various measures of the unemployment rate among U.S. STEM workers. A larger number of foreign students approved for OPT, relative to the number of U.S. workers, is associated with a lower unemployment rate among those U.S. workers."[8]

[5] Madeline Zavodny, *The Impact of H-1B Visa Holders on the U.S. Workforce*, NFAP Policy Brief, National Foundation for American Policy, May 2020.
[6] Giovanni Peri, Kevin Shih, Chad Sparber and Angie Marek Zeitlin (June 2014), *Closing Economic Windows: How H-1B Visa Denials Cost U.S.-Born Tech Workers Jobs and Wages During the Great Recession*, Partnership for a New American Economy.
[7] Britta Glennon, *How Do Restrictions on High-Skilled Immigration Affect Offshoring? Evidence from the H-1B Program*, Carnegie Mellon University, May 2019.
[8] Madeline Zavodny, *International Students, STEM OPT and the U.S. Workforce*, NFAP Policy Brief, National Foundation for American Policy, March 2019.

In March 2020, using a new electronic registration system, H-1B cap selection took place for FY 2021. Individuals selected cannot begin working in H-1B status in the U.S. until October 1, 2020 or later. The next set of new H-1B visa holders (for initial employment) will not be selected until March 2021 and cannot begin working in the United States on an H-1B until October 1, 2021. The annual H-1B limit for employers is, in effect, 85,000, which equals approximately 0.05% of the U.S. labor force.

As noted in the April analysis, it is not sensible to make long-term immigration policy by citing short-term employment situations affected by an unprecedented health crisis, particularly since numerous academic studies show foreign-born individuals do not adversely affect U.S. workers and the president has promised the unemployment picture will improve this year. The latest Bureau of Labor Statistics data show the U.S. unemployment rate in occupations most common for H-1B visa holders has declined, which makes it dubious to cite unemployment in these occupations as a reason for new restrictions on H-1B visas, international students on OPT and others.

ABOUT THE NATIONAL FOUNDATION FOR AMERICAN POLICY

Established in 2003, the National Foundation for American Policy (NFAP) is a 501(c)(3) non-profit, non-partisan public policy research organization based in Arlington, Virginia, focusing on trade, immigration and related issues. Advisory Board members include Columbia University economist Jagdish Bhagwati, Cornell Law School professor Stephen W. Yale-Loehr, Ohio University economist Richard Vedder and former INS Commissioner James Ziglar. Over the past 24 months, NFAP's research has been written about in the *Wall Street Journal*, the *New York Times*, the *Washington Post*, and other major media outlets. The organization's reports can be found at www.nfap.com. Twitter: **@NFAPResearch**

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Hughes Declaration
Exhibit 33

New American Economy
RESEARCH FUND

Sizing Up the Gap in our Supply of STEM Workers: Data & Analysis

Examining Job Postings and Unemployment Data from 2010-2016

Date: March 29, 2017

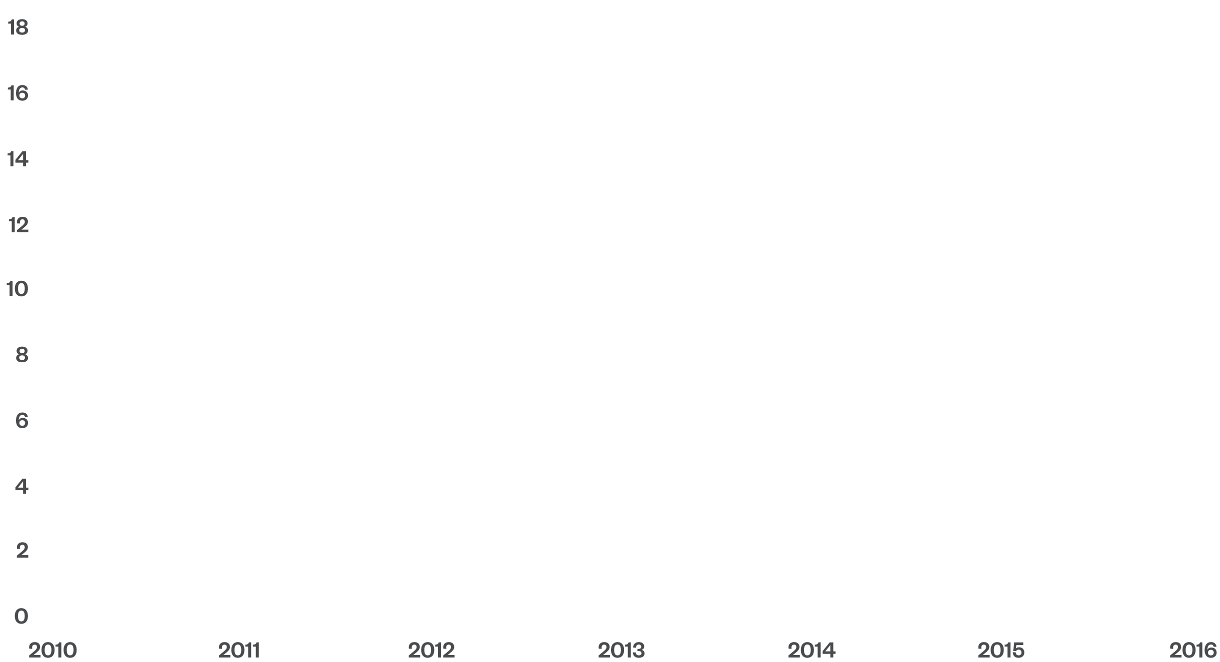
Each year on April 1, the U.S. government begins accepting applications for the H-1B program, a temporary visa program designed to bring in high-skilled workers from abroad. While the H-1B program has long been in need of updates and reforms—particularly since many of the wage requirements designed to protect American workers are almost two decades outdated—many technology firms say it has been instrumental in helping them recruit the talent they need to grow and remain competitive in our increasingly innovation-driven economy. This is because of what experts call our country's skills gap: The U.S. labor force simply doesn't have enough workers with the highly specialized training in Science, Technology, Engineering, and Math (or STEM) that many employers need to grow and add jobs for American workers overall.[1]

In recent years, however, some policymakers have raised questions about whether the shortage of STEM workers is truly as severe as the public has been lead to believe. Individuals making this critique frequently point to data from the U.S. Census showing that three out of every four Americans with undergraduate degrees in a STEM field go on to work in other professional fields after graduation.[2] This leads one to wonder: Are these individuals working in non-STEM occupations because there are not enough STEM jobs available to employ them? Or, could it be that these U.S.-born workers—many of whom are employed in related areas like healthcare and business that are not counted as STEM—have instead opted to pursue jobs that are either more lucrative or appropriate for their underlying interests?

In this brief, we use data from the Burning Glass Technologies, a leading market analytics firm, to look directly at the number of STEM job postings in recent years—one of the best real-time indicators of the jobs available to interested workers with relevant STEM training. Labor Insight, a tool produced by Burning Glass, scours 40,000 job boards daily to study the number of type of unique positions being advertised online by U.S. employers. Using that tool, we compare the number of online STEM job postings in recent years to the number of unemployed STEM workers available to fill them. This technique has been used in the past to determine the magnitude of gaps in our labor market—both by NAE and other groups.[3]

Our work shows that the United States has a persistent and dramatic shortage of STEM workers—a problem that worsened considerably during the first half of the decade. Between 2010 and 2015, the ratio of STEM jobs posted online to unemployed STEM workers grew dramatically. In 2010, just 5.4 STEM jobs were posted online for every one unemployed STEM worker. By 2015, such job postings outnumbered unemployed STEM workers by a factor of almost 17 to 1. While the picture improved moderately in 2016, STEM employers still faced a dire picture: 13 STEM jobs were posted online for each unemployed worker that year—or roughly 3 million more jobs than the number of available, trained professionals who could potentially fill them.

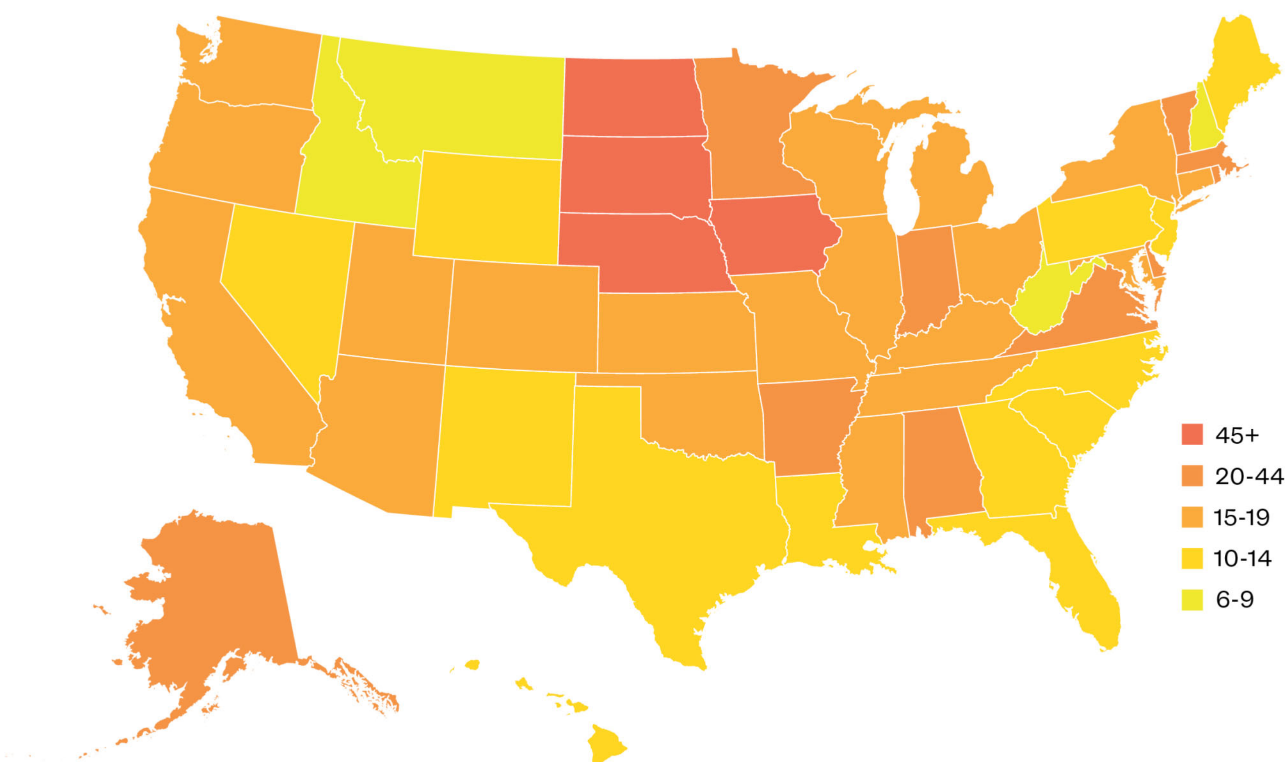
NUMBER OF STEM JOBS ADVERTISED ONLINE FOR EACH UNEMPLOYED STEM WORKER, 2010-2016

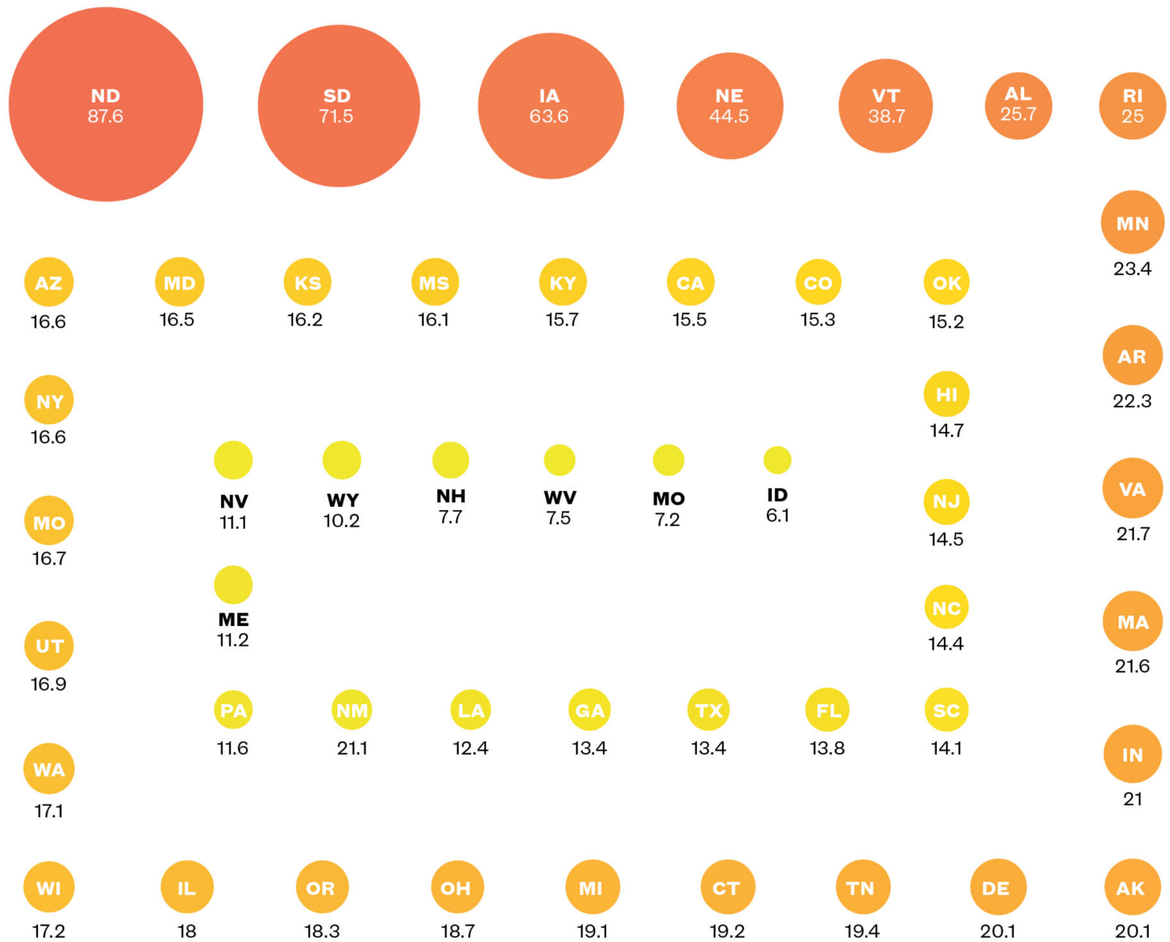


Source: Current Population Survey and Burning Glass Labor Insights.

Drilling down to specific states, we can see that some communities face far greater shortages of STEM talent than others. In 2015, employers in four relatively rural states faced the largest gap between the number of STEM jobs advertised online and the size of the unemployed STEM-trained population who could fill them. In each of these states—North Dakota, South Dakota, Iowa, and Nebraska—there were between 45 and 88 STEM jobs posted online for every one unemployed eligible worker. In a total of 14 states, the number of advertised STEM jobs outnumbered unemployed STEM workers by more than 20 to 1. This group included places as varied as Indiana, Virginia, Arkansas, and Alabama.

NUMBER OF STEM JOBS ADVERTISED ONLINE FOR EACH UNEMPLOYED STEM WORKER, BY STATE, 2015

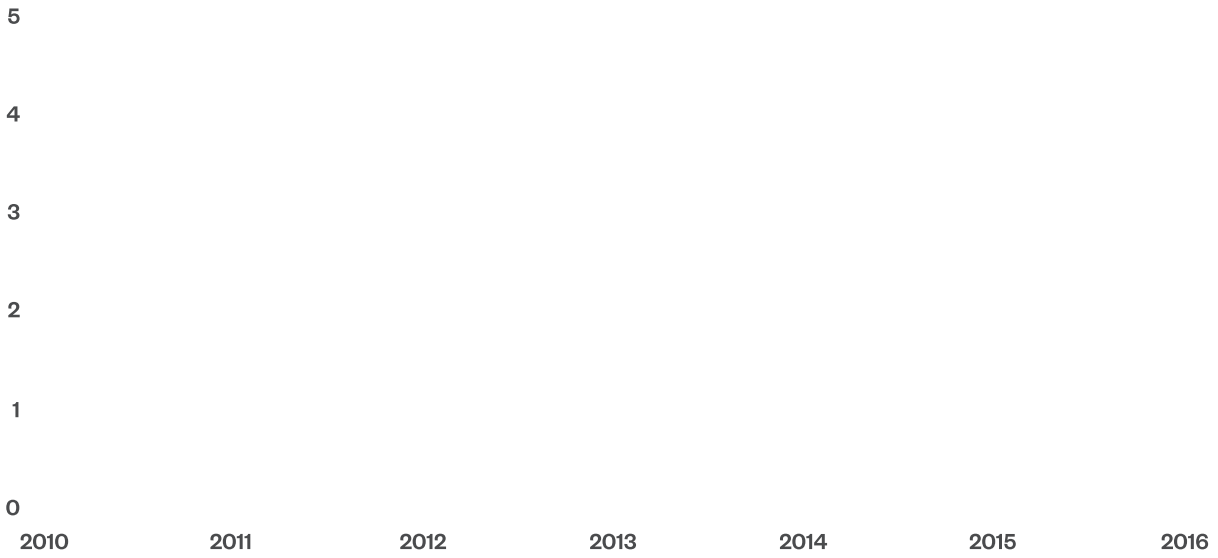




Our work also reveals one of the reasons why employers have struggled to find enough STEM workers in recent years. Even in 2010, a period of relatively high unemployment, the share of unemployed STEM workers was incredibly low. In 2010, the unemployment rate of U.S. STEM workers was just 5.9 percent, compared to 9.6 percent for the entire population of American workers. By 2016, the STEM unemployment rate had fallen to just 2.7 percent. To put that figure in context, the U.S. government generally defines "full employment" as a period when unemployment falls at 4 percent or below.

PERCENT OF STEM WORKERS UNEMPLOYED, 2010-2016

- Full Employment
- Unemployment Rate



Source: Author's analysis of the Current Population Survey, Annual Social and Economic Supplement, 2010-2016.

Methodology

Our analysis of the number of jobs posted for healthcare workers or individual occupations makes use of the Labor Insight tool developed by Burning Glass Technologies, a leading labor market analytics firm. Burning Glass, which is used by policy researchers and academics, scours almost 40,000 online sources daily and compiles results on the number and types of jobs and skills being sought by U.S. employers. This search includes online job boards, individual employer sites, newspapers, and public agencies, among other sources. An artificial intelligence tool eliminates duplicate listings.

To calculate the number of unemployed workers we rely on two data sources—the Current Population Survey and the American Community Survey, both from the U.S. Census. The CPS is used for our national-level results because it allows us to carry out analysis through 2016. At the state level, however, we chose to use the ACS to estimate the number of unemployed STEM workers. That is because the smaller sample size of the CPS makes this result less reliable when viewed at the state level, particularly for smaller states.

We use the STEM occupation list released by U.S. Census Bureau to determine the number and share of foreign-born STEM workers who are unemployed each year. Per U.S. Census classification, healthcare workers such as physicians and dentists are not

counted as working in STEM occupations.[4] All unemployed workers who list their previous job as a STEM occupation are counted as unemployed STEM workers. The unemployment rate for that group is the share of such workers who are unemployed at the time of the survey.

Sources

1 "The 21st Century Workforce: Skills Gap & The STEM Dilemma," MathMovesU from Raytheon, 2013, Available online; "Solving the Skills Gap," Text, Change the Equation, (December 3, 2014), Available online.

2 "Where Do College Graduates Work? A Special Focus on Science, Technology, Engineering, and Math," U.S. Census Bureau, July 10, 2014, Available online.

3 Jonathan Rothwell, "Still Searching: Job Vacancies and STEM Skills | Brookings Institution" (Brookings, November 30, 2001), Available online; "STEM Help Wanted" (Change the Equation, March 2012), Available online; "Who Will Care for Our Seniors?" (New American Economy, September 2016), Available online.

4 U.S. Census Bureau, "STEM, STEM-related, and NonSTEM Occupation Code List 2010," 2010. Available online.

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Type: Research

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Hughes Declaration
Exhibit 34

PARTNERSHIP FOR A NEW AMERICAN ECONOMY

THE H-1B EMPLOYMENT EFFECT

H-1BS AWARDED BETWEEN 2010-2013 WILL CREATE MORE THAN 700,000 JOBS FOR U.S.-BORN WORKERS BY 2020

When the Department of Homeland Security denied Amit Aharoni a high-skilled, H-1B visa in 2011, the decision had consequences far beyond a single potential worker in the American economy. At the time, Aharoni was the CEO of CruiseWise, a travel-booking firm he founded in 2010 that had hired nine U.S.-born employees in a single year. Without the visa, Aharoni had to relocate to Vancouver, Canada, and he began considering moving his company to that country as well. Given Aharoni's plans to rapidly expand his firm—and quickly bring on dozens more U.S. workers—the visa decision didn't seem to make sense from an economic perspective. "I fear that I may be forced to move the center for gravity of CruiseWise to a different place," Aharoni said at the time, "And that means hundreds of jobs that we'd hope to create, would be not be created in the U.S. but somewhere else."

In Aharoni's case, a story in the national media brought attention to his case and U.S. Citizenship and Immigration Services ultimately reconsidered his petition and granted him an H-1B. In the years since, a larger firm brought Aharoni's company - and today CruiseWise continues to support jobs as part of a larger firm. But this year, many H-1B applicants will not be nearly as lucky as Aharoni was. It is widely expected that this April, during the first five days of the application cycle, the government will receive far more applications for H-1B visas than the number available each year to private companies. Last year, for instance, 172,000 applications were received in a single week for just 85,000 slots. [1]

Aharoni's story demonstrates why everyday Americans should care about the country's broken H-1B visa system. Immigrants in the country on H-1B visas are often talented innovators or entrepreneurs. Their presence in the United States—and the companies and technologies they create—often result in attractive job opportunities for American workers. Many employers also say H-1B workers are necessary to help them fill positions requiring niche or specialized skills that they would be unable to fill otherwise with local or interested workers. Having the workers to fill such

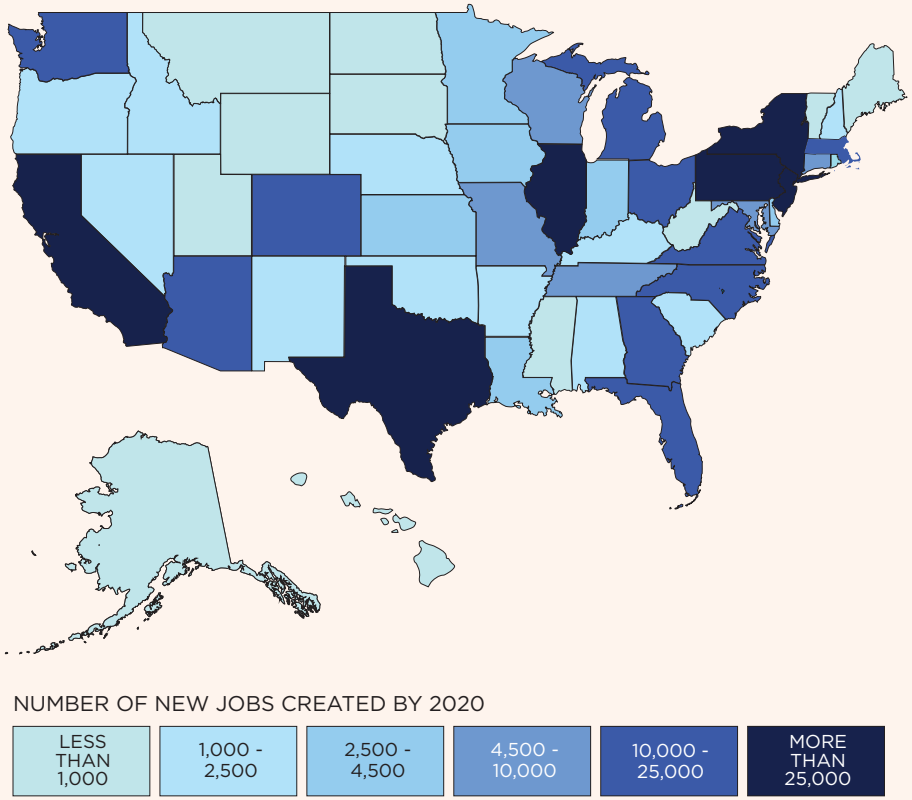
jobs allows American employers to continue basing individual operations or offices in the United States, a move that creates jobs at all levels—from the engineers and computer programmers based in American offices to the secretaries, HR staff, and mailroom employees that support them.

This fact that H-1B visa holders actually create—not take away—jobs from Americans has been widely supported in the literature. A 2013 paper written by professors at Harvard University looking at the 1995 to 2008 period found that 1 additional young, high-skilled immigrant worker hired by a firm created 3.1 jobs for U.S.-born workers at that same company during the period studied.[2] Other academics have tied each H-1B visa award or labor request with the creation of four [3] or five[4] American jobs in the immediate years that follow. In this brief, we rely on a more conservative estimate of the impact of the H-1B program on the American workforce. Specifically, our brief uses a 2011 report produced by the Partnership for a New American Economy and the American Enterprise Institute that found that every 1 additional H-1B visa awarded to a state was associated with the creation of 1.83 more jobs for U.S.-born workers in the following seven years.[5]

In this brief, we rely on data PNAE obtained through a Freedom of Information Request that allows us to see how many H-1B visas were awarded to each state in the 2010-2013 period. Using those state totals, we apply the PNAE study finding detailed above—that every 1 H-1B visa awarded to a state translates into 1.83 jobs for native-born workers in the seven years that follow—to estimate how many jobs the 2010-2013 H-1B visa awards will create in our economy by 2020. Our findings show that the H-1B program, and the skilled workers it brings, results in a valuable stimulus for our economy by creating jobs for U.S.-born workers. Although the available data allows us to analyze the impact of just four years worth of H-1B visa awards, the impact those visa holders will have expanding employment in the coming decade is quite dramatic. Workers who received H-1B visas from 2010-2013 will create more than 700,000 jobs for U.S.-born workers by 2020.

FIGURE 1

BY 2020, THE H-1B VISAS AWARDED FROM 2010 TO 2013 WILL HAVE CREATED A MEANINGFUL NUMBER OF JOBS FOR U.S.-BORN WORKERS IN EVERY STATE



In some states, the impact of recent H-1B awards over the next decade will be particularly notable. In California, for instance, a state that received more than 64,000 H-1B visas for new workers from 2010 to 2013, more than 118,000 new jobs will be created for U.S.-born workers by 2020. Texas will gain almost 81,000 new jobs. All together, 15 states will see more than 10,000 jobs created in their economy by 2020 as a direct result of the 2010-2013 H-1B visa awards. Of these, four states will see more than 50,000 jobs created for U.S.-born workers.

1 Maurer, Roy. 2014. "51% of FY 2015 H-1B Petitions Rejected in USCIS Lottery," SHRM, April 14.

2 Madeline Zavodny. "Immigration and American Jobs." Partnership for a New American Economy and American Enterprise Institute, New York, NY. 2011. http://www.renewoureconomy.org/wp-content/uploads/2011/12/NAE_Im-AmerJobs.pdf

3 Matthew J. Slaughter. "Job Clocks Backgrounder." Hanover, NH, 2013. (available online).

4 "NFAP Policy Brief: H-1B Visas by the Numbers." National Foundation for American Policy, Washington, DC, March 2009.

5 Madeline Zavodny. "Immigration and American Jobs." Partnership for a New American Economy and American Enterprise Institute, New York, 2011. (available online).

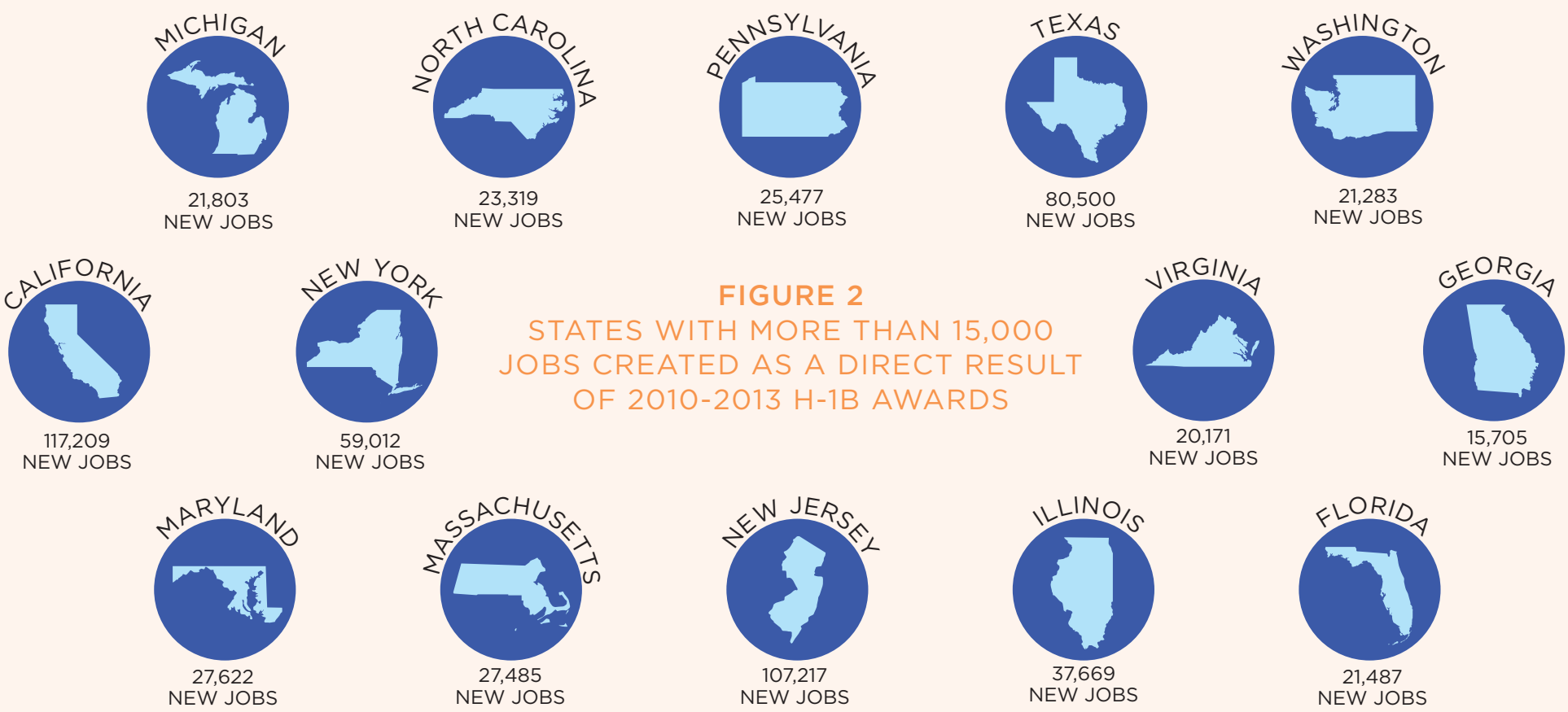


FIGURE 2
STATES WITH MORE THAN 15,000 JOBS CREATED AS A DIRECT RESULT OF 2010-2013 H-1B AWARDS

The job creation story also is good news for some areas not typically thought of as centers for high-tech industry, particularly some of the Rust Belt states. Pennsylvania, for instance, was awarded almost 14,000 new H-1B visas during the time period considered in this brief. Those visa awards will translate into more than 25,000 new jobs for American workers by 2020. Similarly, Michigan's U.S.-born workforce will gain almost 22,000 new jobs by 2020. The figures are similar in Virginia, Washington, North Carolina, and Florida.

While this report demonstrates the valuable role that recent H-1B visa awards will play expanding employment and job opportunities for U.S.-born workers in the next five years, the current state of the H-1B program indicates there is much work left to be done. The large unmet demand for visas among companies means that many employers will not get the talent they need in this year's H-1B visa lottery. For many employers this may slow expansion of their firms—or force them to eventually move some of their operations elsewhere, once again depriving U.S.-born workers of attractive jobs in our innovation-driven economy.

Mat Ellis, the CEO and founder of Cloudability, a Portland, Oregon-based cloud-computing firm, knows this dilemma very well. In 2011, one of his most promising early-stage employees—a U.S.-educated product manager – was forced to leave the United States when she was unable to obtain an H-1B visa. Ellis says without her, a superior had to do much of her work, slowing down the ability to expand in its earliest years. Today he has 40 employees at the firm based in America, but says if he grows much beyond 100 people he will likely open up a second office in another country where he can more easily sponsor and retain talent. "The United States is the best place in the world to find investment capital and support," Ellis says, "but our immigration policies are making it so we're not the best place anymore to find the workers you need to really grow a business."

APPENDIX CHART:
JOB CREATION EXPECTED AS A RESULT OF 2010-2013 H-1B VISA AWARDS

STATE	JOBS CREATED BY 2017	JOBS CREATED BY 2018	JOBS CREATED BY 2019	JOBS CREATED BY 2020
ALABAMA	498	1,095	1,778	2,355
ALASKA	59	108	160	214
ARIZONA	1,238	2,894	4,493	6,120
ARKANSAS	487	1,135	1,771	2,433
CALIFORNIA	22,358	51,623	81,559	117,209
COLORADO	897	2,058	3,402	4,708
CONNECTICUT	1,796	3,954	6,167	8,153
DELAWARE	915	1,803	2,392	2,957
DST. OF COLUMBIA	938	2,015	3,178	4,226
FLORIDA	4,757	10,473	16,367	21,487
GEORGIA	2,998	7,078	11,293	15,705
HAWAII	207	421	628	840
IDAHO	250	531	807	1,067
ILLINOIS	6,388	15,027	25,366	37,669
INDIANA	841	1,774	2,727	3,824
IOWA	542	1,232	1,903	2,620
KANSAS	523	1,205	1,858	2,604
KENTUCKY	545	1,206	1,859	2,495
LOUISIANA	704	1,338	2,040	2,674
MAINE	149	317	460	635
MARYLAND	3,174	8,518	17,835	27,622
MASSACHUSETTS	5,352	12,178	20,325	27,485
MICHIGAN	3,639	8,553	14,523	21,803
MINNESOTA	1,271	2,808	4,295	6,055
MISSISSIPPI	177	380	583	772
MISSOURI	1,304	2,894	4,354	6,115
MONTANA	48	95	124	173
NEBRASKA	401	843	1,287	1,836
NEVADA	279	583	903	1,222
NEW HAMPSHIRE	240	583	956	1,339
NEW JERSEY	17,458	42,480	79,000	107,217
NEW MEXICO	233	481	833	1,128
NEW YORK	13,368	28,745	44,597	59,012
NORTH CAROLINA	3,939	9,406	15,946	22,319
NORTH DAKOTA	127	254	419	569
OHIO	2,427	5,484	8,454	11,855
OKLAHOMA	405	923	1,491	1,919
OREGON	499	1,080	1,595	2,183
PENNSYLVANIA	5,138	11,632	18,802	25,477
RHODE ISLAND	443	886	1,366	1,900
SOUTH CAROLINA	368	763	1,164	1,549
SOUTH DAKOTA	68	158	257	335
TENNESSEE	1,162	2,785	4,345	5,879
TEXAS	16,025	32,967	55,960	80,500
UTAH	335	752	1,200	1,662
VERMONT	159	378	604	813
VIRGINIA	3,740	9,034	14,612	20,171
WASHINGTON	4,156	9,494	15,147	21,283
WEST VIRGINIA	129	245	378	491
WISCONSIN	1,082	2,422	3,806	5,433
WYOMING	37	70	124	171

IN THE UNITED STATES DISTRICT COURT

IN AND FOR THE NORTHERN DISTRICT OF CALIFORNIA

NATIONAL ASSOCIATION OF MANUFACTURERS, CHAMBER OF COMMERCE OF THE UNITED STATES OF AMERICA, NATIONAL RETAIL FEDERATION, TECHNET, and INTRAX, INC.,

Plaintiffs,

v.

UNITED STATES DEPARTMENT OF HOMELAND SECURITY, UNITED STATES DEPARTMENT OF STATE; CHAD F. WOLF, in his official capacity as Acting Secretary of Homeland Security; and, MICHAEL R. POMPEO, in his official capacity as Secretary of State,

Defendants.

Case No. 4:20-cv-4887-JSW

DECLARATION OF JONATHAN BASELICE IN SUPPORT OF PLAINTIFFS' MOTION FOR A PRELIMINARY INJUNCTION

McDERMOTT WILL & EMERY LLP
ATTORNEYS AT LAW
MENLO PARK

I, Jonathan Baselice, declare as follows:

1. I am the Executive Director of Immigration Policy at Plaintiff Chamber of Commerce of the United States of America (the U.S. Chamber). I make this declaration based on my own personal knowledge.

2. The U.S. Chamber is a 501(c)(6) nonprofit organization headquartered in Washington, DC. The U.S. Chamber is the world's largest business federation, representing approximately 300,000 direct members and indirectly representing the interests of more than 3 million businesses and professional organization of every size, in every industry sector, and from every region of the country.

3. For more than 100 years, the U.S. Chamber has advocated for pro-business policies that help businesses create jobs and grow our economy. The U.S. Chamber fulfills this purpose in part by leading pro-business initiatives on legislation and regulation. The U.S. Chamber regularly brings litigation against federal, state, and local governments to challenge governmental action that causes its members undue harms, such as the current challenge to the legality of Proclamation 10052 and its implementation.

4. Part of the U.S. Chamber's mission is advocating for its members' abilities to bring the world's best and brightest to America to foster innovation and economic growth. Many members use L-1 visas to relocate their leading talent to the United States. When outstanding employees gain specialized knowledge about a company, it is natural that a business may ask that individual to relocate to America to perform crucial services for the business. Similarly, when businesses seek to open a new facility or launch a new division in the U.S., they oftentimes want their executives from abroad to come to America and lead these initiatives that are critical for their firm's growth. Many businesses across several industries, including retail, technology, the pharmaceutical industry, financial services, manufacturers, among others, view the L-1 visa as an indispensable tool for the standard transfer of employees. The Defendants' implementation of Proclamation 10052 with respect to the L visa program has caused a significant amount of disruption in the aforementioned industries, as the inability of these critical workers has caused significant delays in business expansions and critical research initiatives. Enjoining the

Defendants' implementation of this Proclamation will allow businesses in these sectors of our nation's economy to continue generating economic growth and job creation in the U.S., as well as ensure that our nation can continue to remain competitive in the global marketplace for the world's best and brightest.

5. Similarly, many members of the U.S. Chamber face acute labor shortages as to certain specialty occupation workers. When they cannot find sufficient talented individuals for the positions they need to fill, they may turn to workers from abroad who enter the United States via an H-1B visa. Like L-1 workers, H-1B workers are a key driver of innovation and productivity gains for many U.S. Chamber members. Oftentimes, the innovation and productivity growth obtained by the efforts of these H-1B workers is achieved through the patent production that is a byproduct of the research and development efforts of these firms. These research efforts span across various industries, as they are critical to the strength of America's energy producers, pharmaceutical companies, cybersecurity firms, information technology companies, heavy equipment manufacturers, and automobile companies, among many others. The disruptions to the H-1B program caused by the Defendants' implementation of Proclamation 10052 are hampering the efforts of many of our members to engage in critical research initiatives. Enjoining the Defendants from imposing these restrictive policies will allow American businesses to meet their critical workforce needs so they can perform the critical research initiatives that will move our nation and our economy forward.

6. Some U.S. Chamber members run J-1 cultural exchange programs, providing valuable opportunities to both the program sponsors as well as the individuals who participate in these programs. Many of the various J-1 programs our members engage in provide employment opportunities for the program participants that come to America, including the intern, trainee, and summer work and travel programs. These programs provide employment authorization for foreign nationals that are foreign college students, recent college graduates from abroad, and even foreign professionals. In many cases, the employment opportunities for these individuals are in sparsely populated areas of the country where it is difficult for employers to meet their workforce needs with domestic laborers. Lastly, the cultural exchange component of these J-1 programs is

a unique soft-power tool for American diplomacy, as it provides foreign nationals with direct exposure to American citizens, American business practices, American culture, and American values. The implementation of Proclamation 10052 by the Defendants will not only disrupt the ability of many J-1 employers to meet their workforce needs; these disruptions will hinder our nation's ability to project its influence around the world at this critical juncture. Enjoining the implementation of this Proclamation will prevent further workforce disruptions for J-1 employers and ensure that our country can continue to use this effective public diplomacy tool.

7. Other members of the U.S. Chamber employ seasonal, nonagricultural workers entering the United States on H-2B visas, in fields such as landscaping, forestry, specialty trades, construction, outdoor amusement services, among many others. Given that H-2B jobs are seasonal and, in many cases, are located in sparsely populated areas of the country, businesses relying upon H-2B workers oftentimes cannot meet their workforce needs with domestic laborers. To that end, H-2B workers complement their U.S. coworkers by allowing their employers to take on more contracts, expand their business operations, and provide advancement opportunities for the American workers employed by H-2B employers. Without these critical H-2B workers, many businesses, a significant portion of which are small and operate on thin profit margins, cannot expand their operations. In many cases, these businesses must downsize when their company cannot meet their seasonal workforce needs, and in the worst-case scenarios, these businesses might be forced to close permanently, putting the American workers at these businesses out of a job. H-2B workers support the jobs of their American colleagues. The Defendants' implementation of Proclamation 10052 bans the entry of H-2B workers into America, which is significantly harming many businesses and the American workers who depend upon the contributions of their H-2B coworkers during busy seasons. Enjoining the implementation of this Proclamation will provide much needed certainty for seasonal businesses and the Americans who work for them.

8. As Executive Director of Immigration Policy for the Chamber, I have worked closely with many U.S. Chamber member businesses to understand how the implementation of Proclamation 10052 by the Defendants will affect member businesses and the American

economy. Based on my evaluation of the relevant markets, the information I have obtained since the Proclamation's implementation from various sources, and my expertise on immigration policy and the needs of our members and the broader business community, I believe that the implementation of Proclamation 10052 by the Defendants will result in irreparable changes to American labor markets and inflict substantial harm upon many of the U.S. Chamber's members of all sizes and across several economic sectors.

9. I am aware that governmental officials have stated that the purpose of the Proclamation, along with other actions taken, is to "open up about 525,000 jobs" that otherwise would be filled by talented individuals from around the world who would come to America to live and work.[1] I am aware that Ken Cuccinelli, who is now performing the duties of the Deputy Secretary of Homeland Security, stated that the Proclamation is a significant part of causing "over 500,000 job openings for Americans in the latter half of this year. That is a very big deal. Unprecedented level of effort by a president to clear the American job market of competition like this."[2]

10. In the aggregate, members of the U.S. Chamber employ tens of millions of individuals in the United States. Because the express purpose of the Proclamation is, as Administration officials have stated, to fundamentally alter hiring practices in the United States in the third and fourth quarters of 2020, the implementation of the Proclamation will have a direct and immediate impact on the many business members of the U.S. Chamber that routinely seek to employ talented individuals from around the world who enter the U.S. on L-1, H-1B, H-2B, and J-1 visas.

11. The harms to business from the Defendants' implementation of Proclamation 10052 will be irreparable in part because hiring decisions made by employers are durable. If a company foregoes hiring an individual in the third or fourth quarter of 2020, that decision will have implications that last far beyond 2020. Employees that are not hired for positions in America

[1] Transcript of White House Background Press Call Concerning the June 22 Presidential Proclamation Suspending Entry of Certain Nonimmigrants, available at perma.cc/Z9YU-MUZK.

[2] See Ken Cuccinelli (@HomelandKen), Twitter (June 22, 2020), perma.cc/HTT5-AUC8.

will take other jobs, outside the United States, and the economic growth that they bring will follow them to those other countries. Employers that cannot hire the talent they require in the United States will face loss of productivity and business opportunity, none of which can be recouped later.

12. Some employers will respond by hiring employees outside the United States and by locating facilities abroad. That is to the detriment of the U.S. workforce, as businesses will hire additional employees to support those workers. It is also to the detriment of the broader U.S. economy and the U.S. tax base.

13. Enjoining the Defendants' implementation of the Proclamation would remedy the future harms that, absent an injunction, the Proclamation otherwise would cause to the U.S. Chamber's members and the broader business community. It would allow American businesses to resume hiring workers via these visa categories. It would enable American businesses to transfer their employees to the United States. It would ensure that existing employees who were outside the United States at the time the Proclamation issued may return to their homes and places of work. It would enable American businesses to locate critical employees in the United States and locate facilities and operations here.

14. For these reasons, not only would enjoining the Defendants' implementation of the Proclamation remedy substantial ongoing harm to the members of the U.S. Chamber, but it would benefit the public as a whole. The Nation benefits through job growth and economic productivity, all of which is served by enabling businesses to locate their important operations domestically, and to have the labor necessary to grow and thrive.

15. The U.S. Chamber has a diverse range of businesses as its members, including Microsoft Corporation, Amazon.com, Inc., Gentle Giant Moving Company, Singing Hills Landscape, Inc., Brummel Lawn & Landscape LLC, Intrax, Inc., and Alliance Abroad Group.

I declare under penalty of perjury that the foregoing is true and correct.

Dated: July 31, 2020
Washington, DC

JONATHAN BASELICE

IN THE UNITED STATES DISTRICT COURT

IN AND FOR THE NORTHERN DISTRICT OF CALIFORNIA

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UNITED STATES DEPARTMENT OF HOMELAND SECURITY, UNITED STATES DEPARTMENT OF STATE; CHAD F. WOLF, in his official capacity as Acting Secretary of Homeland Security; and, MICHAEL R. POMPEO, in his official capacity as Secretary of State,

Defendants.

Case No. 4:20-cv-4887-JSW

DECLARATION OF JAMES BELL IN SUPPORT OF PLAINTIFFS' MOTION FOR A PRELIMINARY INJUNCTION

I, James Bell, declare as follows:

1. I am the Chief Operating Officer of the Alliance Abroad Group, a member of Plaintiff Chamber of Commerce of the United States of America. I make this declaration based on my own personal knowledge and if called as a witness could and would testify completely to this information.

2. Alliance Abroad operates four State Department-regulated cultural exchange visitor programs—summer work travel, intern, trainee, and teacher—all of which are entirely shut down by Presidential Proclamation 10052 (the Proclamation). Alliance Abroad works via its overseas offices and foreign partners to recruit participants, places them with domestic companies or schools, and oversees the entire end to end placement process

3. The participants in all of these exchange programs enter the country on J-1 visas, which are suspended by the Proclamation. As a result, the Proclamation has forcibly shut down all of Alliance Abroad's operations.

4. With respect to the teacher exchange program in particular, Alliance Abroad has substantial expertise in placing special-education teachers with schools and school districts that would otherwise be unable to provide special-education programming, given the shortage of special-education teaching expertise among domestic teachers. These special-education teachers are barred from entering the country by the Proclamation, resulting in the cancellation of special-education programs for students in need. As the Governor of Nevada wrote to the President in the wake of the Proclamation, "[t]he suspension of these visas undermines access to talents and skills that have historically enriched and enhanced our State and our nation and will potentially leave thousands of special education students without a teacher."[1] That is consistent with the experience and understanding of Alliance Abroad as well.

5. While Alliance Abroad faced some program disruption occasioned by COVID-19 related travel restrictions, the Proclamation is what has fully shut down the entirety of Alliance Abroad's business. Notwithstanding COVID-19 travel restrictions, Alliance Abroad had at the time

[1] Press Release: *Governor Sisolak pens letter to President Trump imploring him to reverse course on his suspension of J-1 visas* (July 2, 2020), https://perma.cc/J5JE-AZGW.

of the Proclamation close to 4000 students recruited for the summer work and travel program; 1,000 for the intern and trainee program, and 150 teachers hired. All or virtually all of these individuals would have entered the United States and participated in Alliance Abroad's programs, but for the Proclamation. This amounted to $7.5M in revenues. All of that was rendered impossible by the Proclamation.

6. On July 22, 2020, the State Department published its interpretation of the Proclamation's national-interest exception, establishing categories of noncitizens whose entry will be considered exempt from the Proclamation's entry ban.[2] None of the stated exceptions will have any bearing on Alliance Abroad's business. The categories of individuals we are unable to bring into the country now are not captured by the exceptions identified by the State Department.

7. Alliance Abroad employed 115 staff as of March 2020. As a result of the travel disruptions caused by the Coronavirus and the Proclamation, it has had to lay off all but 28 staff members. If the travel ban imposed by the Proclamation were lifted, Alliance Abroad would be able to rehire at least some of those laid-off employees, recouping some of the economic loss caused by the Proclamation.

8. Alliance Abroad cannot remedy the loss of revenue it currently faces. Nothing will make Alliance Abroad whole for the losses it is suffering as a result of the Proclamation.

9. Alliance Abroad has created its entire business in reliance on an operating J-1 program, a visa category which has existed without interruption for decades. Alliance Abroad has invested large sums of money in established its business, the core mission of which is to facilitate cultural exchange programs. It has hired an expert staff to accomplish this mission. The Proclamation entirely upsets the fundamental program on which out entire business is built. If the Proclamation continues, virtually all of the investment in Alliance Abroad will be rendered valueless.

10. The national interest exceptions identified by the State department have no bearing

[2] *See* U.S. Dep't of State, Bureau of Consular Affairs, *National Interest Exceptions to Presidential Proclamations (10014 & 10052) Suspending the Entry of Immigrants and Nonimmigrants Presenting a Risk to the United States Labor Market During the Economic Recovery Following the 2019 Novel Coronavirus Outbreak* (July 22, 2020).

on the dire loss of revenue inflicted by the Proclamation. The vast majority of individuals that would participate in Alliance Abroad's programs remain barred from entering the United States, notwithstanding the State Department's interpretation of the national interest waivers available.

11. In addition to the cancellation of programs in 2020, Alliance Abroad has had substantial difficulties generating demand for its programs for 2021 due to the uncertainty caused by the Proclamation. Potential exchange visitors are unwilling to commit to a months-long (at a minimum) programs abroad without knowing whether they will in fact be allowed to enter the country. Alliance Abroad is therefore taking in almost no revenue.

12. The uncertainty about the future availability of J-1 visas has left banks and other potential lenders unwilling to lend to the company given that the risk is too great and, or situation does not meet the lenders' underwriting criteria.

13. The injury to Alliance Abroad is exacerbated by the State Department's refusal to process J-1 visas at consulates abroad during the duration of the Proclamation. The Proclamation does not direct the suspension of consular processing of J-1 visas. But the State Department has stated in official tweets, which I have reviewed, that it "will not be issuing H-1B, H-2B, L, or certain J visas, and their derivatives through December 31, 2020, unless an exception applies. See Proclamation for exceptions."[3] By not processing J-1 visas, the State Department is causing a massive backlog that will substantially restrict the ability of cultural exchange participants to enter the country if the Proclamation's entry bar is lifted.

14. The State Department's refusal to process J-1 visas is harming the business of Alliance Abroad. If J-1 visas were processed now, individuals could enter the United States on cultural exchange programs immediately following the expiration of the Proclamation. Because individuals outside the country cannot proceed with visa processing, they are declining to sign up with cultural exchange programs through Alliance Abroad.

15. Individuals outside the United States have many options for cultural exchange programs. The United States is not the only place where those individuals may go. To name just a

[3] *See, e.g.*, U.S. Dep't of State, Bureau of Consular Affairs (@TravelGov), Twitter (June 30, 2020), https://twitter.com/TravelGov/status/1277938802259042304.

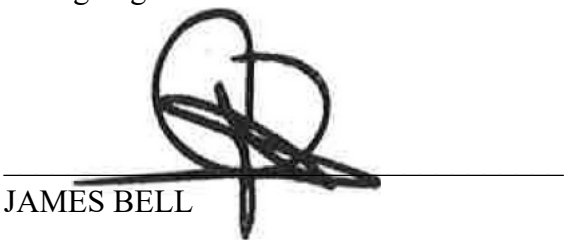
few, Canada, Japan, France, Germany, Argentina, South Africa, and many other countries provide cultural exchange opportunities.

16. Because many individuals outside the United States cannot pursue a cultural exchange program in the United States with Alliance Abroad, they are choosing instead to take opportunities with programs in other nations. Alliance Abroad will forever lose the opportunity to work these individuals—and it will forever lose the revenue associated with them.

17. The Proclamation is an existential threat to Alliance Abroad as a company. Unless the Proclamation is lifted within the next few months, Alliance Abroad will likely have to cease operations.

I declare under penalty of perjury that the foregoing is true and correct.

Dated: July 29th, 2020
Austin, Texas



JAMES BELL

UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF CALIFORNIA

NATIONAL ASSOCIATION OF MANUFACTURERS, CHAMBER OF COMMERCE OF THE UNITED STATES OF AMERICA, NATIONAL RETAIL FEDERATION, TECHNET, and INTRAX, INC.,

Plaintiffs,

v.

UNITED STATES DEPARTMENT OF HOMELAND SECURITY, UNITED STATES DEPARTMENT OF STATE, CHAD F. WOLF, in his official capacity as Acting Secretary of Homeland Security, MICHAEL R. POMPEO, in his official capacity as Secretary of State,

Defendants.

Case No.: 20-cv-4887

DECLARATION OF ZANE BROWN IN SUPPORT OF PLAINTIFFS' MOTION FOR PRELIMINARY INJUNCTION

I, Zane Brown, declare as follows:

1. I serve as Vice President & Associate General Counsel, Labor and Employment at Amazon.com, Inc. ("Amazon"). I have been employed at Amazon for more than 19 years. As Vice President & Associate General Counsel, my team and I are responsible for establishing Amazon's legal and corporate policies relating to U.S. immigration and workforce/employment policy. Amazon is a member of Plaintiff organization the Chamber of Commerce of the United States of America.

2. Amazon, a global and Fortune 100 company based in Seattle, Washington, offers millions of unique products through Amazon Marketplace. Any approved business or entrepreneur can sell virtually any item to Amazon.com's millions of customers. Amazon.com is also a leading cloud-computing provider, and provider of other services including digital streaming and grocery delivery.

3. I am familiar with Presidential Proclamation 10052 ("Proclamation"), issued on

June 22, 2020. While the stated intent of the Proclamation was to assist America's economic recovery in the wake of the COVID-19 pandemic, the reality is that this directive will restrict entry of individuals that have historically played a vital role in our economy.

4. Amazon believes the U.S. should welcome the best and the brightest talent from around the world, which is imperative for our country's competitiveness. As a global company, Amazon's hiring and employment practices aim to attract and develop locally available and qualified talent and move internal high-skilled and knowledgeable employees where they are most needed within the company. Today, Amazon has more than 590,000 employees in the U.S. from all backgrounds, including H-1B and L-1 visa holders, who are dedicated to inventing on behalf of and serving our customers.

5. As most states and cities in the U.S. have implemented various "shelter at home" or "self-quarantine" orders, U.S. consumers have relied on Amazon and other companies to obtain critical items during the pandemic. Throughout the COVID-19 crisis, Amazonians have been working very hard to get necessary supplies delivered to customers who need them. In response to the tremendous increase in demand for our online retail services, Amazon has continued to grow its U.S.-based workforce and deployed additional technical resources to strengthen and maintain its e-commerce services.

6. Amazon Web Services ("AWS"), the part of our company that provides cloud based computing services, has also experienced extraordinary demand during the pandemic, as working remotely has become the new common practice of U.S. enterprises. AWS has built solutions that help customers address the needs and challenges of today. These include information technology infrastructure, remote work, and e-learning, as well as other solutions that can help expedite businesses to work in the cloud.

7. Before the COVID-19 pandemic, certain Amazon employees traveled overseas to obtain a visa that would enable them to return to work in the U.S. but were not able to secure appointments with most routine U.S. consulate services closed. Now, due to the Proclamation, these employees will have to remain overseas even after U.S. consular services reopen. This will add inefficiency and cost and be disruptive to business operations.

8. With several operating entities across the globe, Amazon typically is able to bring in high caliber and experienced personnel from foreign operations to the U.S. on L-1 visas, which allows us to create and retain jobs in the United States. Amazon has relied on the L-1B visa process to bring certain high-skill foreign-based employees to the U.S. to share in-depth technical expertise with their U.S. co-workers. Similarly, a number of Amazon's senior managers have entered the U.S. in a managerial or executive capacity under the L-1A visa program to contribute uniquely Amazonian leadership experience to regional strategic planning and help identify emerging growth opportunities. However, the Proclamation's suspension of certain visa processing and issuance has hindered Amazon's ability to transfer highly skilled employees from other countries and bring key contributors from various regions of the world to the U.S.

9. In addition to the impact of the suspension of L-1 visa processing, Amazon's H-1B employees are also affected by the Proclamation. Amazon's H-1B employees provide high-level technical expertise. Their industrial experience and intimate knowledge of Amazon's business operations are an integral part of Amazon's continuous success and growth. The sudden suspension of H-1B visa issuance pursuant to the Proclamation stranded several H-1B employees who perform critical services to various Amazon operations.

10. For example, an Indian national, employed by Amazon for approximately 6 years, had been working in the U.S. as a senior manager with Amazon's Transportation Operations Management (TOM) team where he was responsible for forecasting, planning, and predictive simulation capabilities for Amazon Fresh, Amazon Pantry and all Amazon Middle Mile transportation networks. TOM is a growing business covering field transportation logistics and operations. The TOM team plays a critical role in fast and efficient delivery to customers.

11. In March 2020, the employee travelled to India to visit family, and then was unable to return to the U.S. due to the COVID-19 travel restrictions and border closures. Since he will need a new H-1B visa stamp to return to the U.S., he will be unable to do so due to the Proclamation.

12. His inability to return to the U.S. makes it difficult for Amazon to leverage his expertise and knowledge to drive continuous improvements in resource optimization and further

improve speed of transportation execution, which has taken on a new importance during the global pandemic when delivery of items and transportation efficiency is a necessity.

13. The inhibition of Amazon's ability to transfer key personnel from overseas operations will have a detrimental effect on business operations. U.S. customers' reliance on online retail services has grown significantly during the COVID-19 pandemic and continues to grow. That growth has placed extraordinary demands on Amazon's technology and system design, systems that must be scalable and deployed quickly to meet the needs of customers.

14. Like other Fortune 100 companies, Amazon builds its business plans around short-term and long-term goals. Many L-1 transfers from overseas operations were planned prior to the COVID-19 pandemic, and the transferees were expected to help implement Amazon's operational growth plans. These are not jobs that Amazon can simply recruit and fill locally.

15. Amazon has relied on the availability of the H-1B and L-1 visas for staff planning and business operations. Sudden implementation of the Proclamation fails to take into account impact on routine business operations, including Amazon's ability to source needed talent in the U.S.

I declare under penalty of perjury and under the laws of the United States that the foregoing is true and correct. Executed at Seattle, Washington, on July 31, 2020.

Authorized Representative,

DocuSigned by:
Zane Brown
DDF214FDD377494...

Zane Brown

Vice President & Associate General Counsel

IN THE UNITED STATES DISTRICT COURT

IN AND FOR THE NORTHERN DISTRICT OF CALIFORNIA

NATIONAL ASSOCIATION OF MANUFACTURERS, CHAMBER OF COMMERCE OF THE UNITED STATES OF AMERICA, NATIONAL RETAIL FEDERATION, TECHNET, and INTRAX, INC.,

Plaintiffs,

v.

UNITED STATES DEPARTMENT OF HOMELAND SECURITY, UNITED STATES DEPARTMENT OF STATE; CHAD F. WOLF, in his official capacity as Acting Secretary of Homeland Security; and, MICHAEL R. POMPEO, in his official capacity as Secretary of State,

Defendants.

Case No. 4:20-cv-4887-JSW

DECLARATION OF NICHOLAS BRUMMEL IN SUPPORT OF PLAINTIFFS' MOTION FOR A PRELIMINARY INJUNCTION

I, Nicholas Brummel, declare as follows:

1. I am the Chief Executive Officer and a member of Brummel Lawn & Landscape LLC. I make this declaration based on my own personal knowledge and if called as a witness could and would testify completely thereto.

Brummel Lawn & Landscape's Business

2. Brummel Lawn & Landscape is a member of Plaintiff Chamber of Commerce of

the United States of America.

3. Brummel Lawn & Landscape is a full service lawn and landscaping company serving the Kansas City area. Brummel Lawn & Landscape's services include landscape design, landscape maintenance, lawn maintenance, irrigation, and mowing.

4. I founded Brummel Lawn & Landscape in 2006 with a classmate, after I graduated from Northwest Missouri State University with a degree in horticulture. When I began the business in 2006, it was just the two of us. Since then, however, we experienced substantial growth. We now generate over $5 million in annual revenue and employ 70 people.

5. Of our current 70 employees, 50 are domestic employees and 20 were hired as seasonal workers on H-2B visas.

6. We hire seasonal employees on H-2B visas for several reasons. The first is because of domestic labor shortages. We simply cannot find sufficient numbers of domestic workers. That is not for lack of effort. We employ a full time human resources specialist whose job it is to identify any individuals interested in joining our team. I also personally engage in labor pool outreach. This includes radio spots to talk about the business and to encourage folks to consider work in the landscape industry. We even offer starting compensation at more than double the minimum wage. Nonetheless, we are always hard pressed to find enough workers to meet our seasonal labor needs. Even today, in the face of a global pandemic, we have been unable to meet our labor needs.

7. Although I am aware that many individuals lost their jobs as a result of the COVID-19 pandemic, I still have not been able to fill many available openings.

8. Hiring H-2B seasonal workers also helps us meet other business objectives. We participate in the Landscape Management Apprenticeship Program sponsored by the National Association of Landscape Professionals. Through the program, we provide on-the-job training to future landscape professionals. We train these apprentices and other domestic workers not only to become high quality landscape professionals but also to fill management roles. By filling some laborer roles with H-2B seasonal workers, we can promote more domestic workers to foreman or other supervisory and management roles. Doing so thus increases the pay for these domestic

workers and grows our business.

The Landscape Industry Business Cycle

9. Because of ordinary seasonal rotation, in places like Kansas City, the landscaping industry follows a particular business cycle. Bidding on commercial accounts for the next year typically begins in July. These types of commercial contracts make up approximately 70% of Brummel Lawn & Landscape's annual revenue.

10. The landscape industry is labor intensive. Thus, when bidding on these commercial contracts, landscape businesses need as accurate-as-possible a projection of the labor force they will be able to assemble for the upcoming year. If the landscape business incorrectly projects its available workforce, then it is highly likely it will not be able to complete the job as promised in its bid. These projections generally account for the business's expected number of H-2B seasonal workers.

11. As noted above, Brummel Lawn & Landscape currently has 20 H-2B seasonal workers. And, due to business growth, Brummel Lawn & Landscape must hire 25 H-2B seasonal workers in 2021 to meet demand.

12. After bidding in July based on expected 2021 work force, Brummel will then need to apply for H-2B petitions for these expected seasonal workers around October 15, 2020, for a February 15, 2021 date of need. Brummel Lawn & Landscape thus spends the fall months of October, November, and December making arrangements for the next year's H-2B seasonal work force.

Consequences of the Proclamation

13. Unless enjoined, the Proclamation will have devastating consequences to Brummel Lawn & Landscape. It would result in substantial irreparable harm to our business.

14. Because of the Proclamation, I understand that neither the Department of Homeland Security nor the Department of State are processing petitions for H-2B workers. If these agencies do not process our requests for H-2B workers, the result is that we will not hire the labor force we need. We will not have the labor necessary for our substantial landscaping operations scheduled in early 2021.

15. The immediate result would be the loss of substantial revenue. Once lost, we have no means of regaining this revenue, and this harm cannot be remedied by later action.

16. If we cannot secure the 25 H-2B workers we projected for next year, we will not be able to handle the volume of work on which we are currently bidding and which our business is otherwise ready to support. Right now, I estimate that we would not be able to complete about 40% of the business we expect to have next year without these H-2B workers.

17. These consequences reach much further than revenue losses. If we cannot fulfill the contracts we bid on and won to the customer's satisfaction, then we will not be allowed to bid on that work next year. Thus, inability to ensure our H-2B workforce for next year will result in lost customers for years to come.

18. And even for customers that we could maintain, I expect a significant loss of customer goodwill and damage to our business reputation if we cannot ensure our full H-2B workforce. This loss of goodwill and reputational harm could result due to backlogs in service or inability to take on special projects.

19. It is also likely that we would need our office workers to help out on landscape teams. This would mean neglecting business development and other community outreach functions simply to have enough people to mow. Neglecting these other functions will harm our business for the future.

20. We also would not have need for as many foremen or supervisors on jobs without the H-2B workforce. Thus, domestic employees slated for a foreman or supervisory role would face wage reduction or job elimination and have to perform laborer roles.

21. Due to the uncertainty regarding our available H-2B workforce, we have also foregone substantial capital investments, for example, in procuring more equipment to serve more customers. Though we have the capital and the customer demand, we cannot make capital investments in equipment that we know we will not have the workforce to use.

22. Forgoing these capital investments means that Brummel Lawn & Landscape will not be able to grow its business and service more customers and will miss out on market share gains it otherwise could have made in the absence of the Proclamation.

23. I have also devoted substantial time and attention to dealing with the uncertainty regarding our H-2B workforce and developing contingency plans in the event the Proclamation remains in place. This is time I could have spent focusing on growing my business to the benefit of my customers, my employees, and my community. This time I cannot focus on growing my business, particularly during bid season, causes irreparable harm to my business.

I declare under penalty of perjury that the foregoing is true and correct.

Dated: July 27, 2020
Blue Springs, Missouri

NICHOLAS BRUMMEL

UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF CALIFORNIA

NATIONAL ASSOCIATION OF MANUFACTURERS, CHAMBER OF COMMERCE OF THE UNITED STATES OF AMERICA, NATIONAL RETAIL FEDERATION, TECHNET, and INTRAX, INC., Plaintiffs, v. UNITED STATES DEPARTMENT OF HOMELAND SECURITY, UNITED STATES DEPARTMENT OF STATE, CHAD F. WOLF, in his official capacity as Acting Secretary of Homeland Security, MICHAEL R. POMPEO, in his official capacity as Secretary of State, Defendants.	Case No.: 20-cv-4887 **DECLARATION OF JACK CHEN IN SUPPORT OF PLAINTIFFS' MOTION FOR PRELIMINARY INJUNCTION**

I, Jack Chen, declare as follows:

1. I serve as Associate General Counsel, U.S. Immigration at Microsoft Corporation ("Microsoft"). Microsoft is a member of Plaintiff organizations National Association of Manufacturers, Chamber of Commerce of the United States, and TechNet.

2. Microsoft is a global technology leader that develops, licenses, and supports software, services, devices, and technology solutions that deliver new value for customers and help people and businesses realize their full potential. Microsoft is headquartered in Redmond, Washington. It has offices and subsidiaries located around the world.

3. In my role as Associate General Counsel, I lead the team responsible for Microsoft's U.S. immigration program, which provides strategic advice and operational management of the various employment-based immigration programs and benefits related to work authorization and sponsorship for permanent residence in the U.S.

4. I have served in my current role since April 2019 and have been employed at Microsoft since February 2007. During my tenure at the company, I have held various roles

providing legal advice and strategy on employment-based immigration programs, immigration policy and reform, and broader workforce public policy issues.

5. I am familiar with Presidential Proclamation 10052, issued on June 22, 2020. The Proclamation—which is scheduled to remain in effect until at least December 31, 2020, and may continue thereafter—has caused disruption to Microsoft's business operations and will continue to hamper its productivity and business planning, particularly its operations in the United States.

6. In drawing on and developing a global talent pool while siting facilities in the United States, Microsoft has utilized key provisions of the Immigration and Nationality Act that permit companies to employ top global talent in the United States. In addition to its domestic recruitment and professional development programs, Microsoft has made short- and long-term business plans that depend upon the ability to transfer employees—including critical leadership and those with highly specialized technological skills—from a location outside the United States to Microsoft's domestic operations, and to recruit highly qualified non-U.S. citizens to join Microsoft's U.S.-based operations.

7. The Proclamation has already caused a loss of productivity. It has affected Microsoft employees, including those in H-1B and L-1 status who have been living in the United States and working for the company in U.S.-based roles for years, who happened to be overseas when the Proclamation came down.

8. It has also affected Microsoft's ability to leverage its talent located overseas, inhibiting the company's ability to build and broaden U.S.-based teams on which non-U.S. citizens play critical roles. Critical Microsoft teams include key contributors located around the world, whom Microsoft had planned to relocate to the United States. Those teams are experiencing daily challenges maintaining productivity and efficiency.

9. Moreover, because the expiration date of the Proclamation remains unclear, Microsoft faces significant uncertainties in longer-term planning for its U.S.-based teams. Already, Microsoft has been forced to take steps to build temporary teams overseas that the company originally had planned to base in the United States. Temporary teams, however, often

become permanent teams, and it may be impracticable to relocate entire teams to the United States at a later date, meaning that these jobs will remain overseas.

I. The Proclamation Has Impaired Business Planning for Microsoft's U.S.-Based Workforce by Suspending U.S. Immigration Programs With an Uncertain End-Date.

10. Most relevant to Microsoft's business planning are two categories of nonimmigrant visas affected by the Proclamation critical to Microsoft's global workforce management.

11. First, Microsoft generally includes in its business and workforce planning the availability of H-1B visas. These visas are issued to highly skilled workers with particular expertise in a specialty field—most often, for Microsoft, in a highly technical subspecialty of computing, software engineering, or a related field. Microsoft typically uses these visas where it cannot fill its open positions exclusively with U.S. workers.

12. Second, Microsoft utilizes L visas for key intracompany transfers. This is particularly important to Microsoft, which has global offices and subsidiaries but maintains a U.S.-based headquarters. L-1 visas facilitate the transfer to the United States of certain essential personnel who have worked at the company for more than a year, either to serve in a "managerial" or "executive" function (L-1A visas), or due to "specialized knowledge" (L-1B visas).

13. Microsoft, like other multinational corporations, is constantly engaged in forward-looking global workforce planning. That planning includes strategically matching skill development with forecasted business needs. Thus, the experience and technical depth Microsoft employees gain while working on teams in one region of the world, by design, become essential in advancing work on different teams and for different products in the United States.

14. As a complement to Microsoft's extensive domestic recruiting and hiring efforts in the U.S., the company's particular talent pool of international transferees brings skill sets that cannot easily be replicated by other hiring measures. Specifically, Microsoft builds business plans around anticipated transfers of its employees from subsidiaries outside of the U.S. into essential U.S.-based roles. These are roles that Microsoft has designed and planned for certain personnel, based on their managerial experience, specialized knowledge, or both. To that end, these are not jobs that would or will be available to or suitable for other individuals; these personnel will

necessarily leverage their experience gained from their time at Microsoft's subsidiaries in order to serve effectively in these U.S.-based roles. Microsoft depends upon these individuals' unique skills and experiences to carry out these essential job functions.

15. Suspending the issuance of H-1B and L-1 visas does not result in more U.S.-based job openings. Rather, the intended recipients of these visas will remain in their jobs at Microsoft—but they will have to do their jobs from a distance, causing workflow and business disruptions, as well as diminished productivity, opportunity, and competitiveness for Microsoft. In some cases, teams will be built around these key people overseas—so jobs that would have been created in the United States instead will end up being based overseas.

16. For example, a French national, currently employed as a Software Engineering Manager with Microsoft in France, was scheduled to the be transferred to the U.S. on an L-1A visa in spring 2020. He has worked for Microsoft since 2011. Due to interruptions caused by COVID-19, he was initially unable to get a visa appointment at the U.S. Consulate before it closed as a response to the pandemic. Now, however, the Proclamation prevents him from obtaining an L-1A visa needed to come to the U.S. in accordance with Microsoft's original business plan.

17. Microsoft chose this individual to lead a new team that would be based in the United States. The team is tasked with building a new service around Microsoft's business analytics, as part of the company's "Power Platform" division, which accelerates process efficiencies for customers. This sector, in particular, is a major focus for the company. Microsoft has planned for this team to be a billion-dollar U.S.-based initiative over the course of the next three to four years. In spearheading the team, the French transferee was supposed to hire 25 new software engineers in the U.S. in 2020, with a goal to grow the domestic team to 50 by early 2021.

18. But this individual is unable to come to the United States under the Proclamation, and it is unclear when that will change. He thus cannot practically or successfully start and lead a major new U.S.-based team as planned. As a result, Microsoft has determined that the only reasonable course is to start building the team in France. Microsoft has hired a team of 10 software engineers based in France to get the project underway. There is a skeleton team in the U.S.

contributing to this effort, but Microsoft has not been able to hire domestically for these roles anywhere close to the originally planned numbers.

19. This disruption to Microsoft's business planning will have lasting effects. Once a team is established overseas, it will be difficult and unduly disruptive to relocate the team's key personnel to the U.S., as Microsoft had hoped and planned.

20. The Proclamation's effects are particularly counterproductive because, even amid the broader economic downturn, the Power Platform division is an area of growth for Microsoft and reflects the company's focus on empowering customers in digital transformation—an especially important priority amid increased reliance on technology due to COVID-19. In fact, a version of the platform the team in question is developing has been used by hospitals to manage real-time inventory as part of critical COVID-19 response. Thus, the Proclamation has not only interrupted domestic job and economic growth in a time of turmoil, but also interfered with Microsoft's efforts to build new technologies that will help address the pandemic.

II. The Proclamation Hampers Microsoft's Operations By Interrupting Key Personnel Relocations.

21. The Proclamation's suspension of L-1 and H-1B visas has prevented other key personnel from transferring to or commencing work in the United States to perform essential leadership roles and technical jobs. This disruption impacts the speed, agility, and efficiency of Microsoft's work across all sectors: Microsoft's core engineering, research, design, and innovation; the stability and reliability of critical technological infrastructure for customers; and the development of essential business strategies.

22. These efficiency and productivity disruptions are significant and irreparable. Products will be delayed and technological advancement will be impeded. The inefficiencies are plain from the experience of several key Microsoft teams.

23. For example, an Indian national currently employed as a Cloud Networking Engineering Manager with Microsoft in India was slated to be transferred to the U.S. on an L-1A visa in spring 2020. He was unable to get a visa before the closure of the U.S. Consulate due to COVID-19. Now he is blocked until 2021 or longer due to the Proclamation.

24. Microsoft had planned to relocate this individual to the United States to lead a team of 12 fulltime staff based out of the company's Redmond headquarters. The team is charged with managing key portions of cloud-based engineering on Microsoft's Azure platform. This team's work supports internal platforms (such as SharePoint, Skype, and Xbox), as well as external clients (including Fortune 500 companies, governments, and healthcare entities that depend on the technology for COVID response). These functions are more important now than ever: COVID-19 has caused an increase in users for applications like Skype and SharePoint—which, in turn, depend on Azure infrastructure—as people increasingly depend on these programs for remote work.

25. Due to the Proclamation, however, the team lead will be unable to transfer to the United States until at least the end of this year, perhaps longer. As a result, this individual must work at a 13-hour time difference from his direct reports, which strains the team and reduces its productivity and effectiveness. That could harm Microsoft's ability to serve its clients in this critical time.

26. Another individual, also an Indian national employed as a Software Engineering Manager, has worked for Microsoft in India since 2004. He was also scheduled to transfer to the U.S. on an L-1A visa in spring 2020. He is now unable to obtain a visa under the Proclamation. Microsoft had planned for this manager to lead a team at its U.S. headquarters of 7 fulltime employees, also involved in Azure cloud management. This group manages the underlying infrastructure to ensure functionality of real-time message-routing on Microsoft platforms, including Teams, Microsoft's unified communications and collaboration platform. The service is critical to enable efficient and reliable remote collaboration—which is particularly important to accommodate during COVID-19—for internal Microsoft clients and users, as well as the company's customers (primarily other businesses).

27. Due to the Proclamation, this team lead is indefinitely unable to join his direct reports in the U.S., as Microsoft had planned. The 13-hour time difference that separates the team means that interaction is limited to only a few hours per day. In turn, this causes projects to be delayed; the team lead cannot review work immediately or communicate easily with his reports.

This team lead also has a customer-facing role, so he must stay awake overnight (Indian Standard Time) in order to contact U.S.-based customers. He is exhausted and concerned that the arrangement is not sustainable for him or those he manages. If this situation persists, productivity and service levels will suffer, affecting the company's competitiveness.

28. To offer another example, a Business Program Manager currently in India, also an Indian national who has been employed by the company since 2006, manages 18 global business programs in the Indian market. He was supposed to transfer to the U.S. on an L-1 visa in spring 2020 to manage a $1.2 billion business portfolio that works with more than 4,000 businesses across the United States. Due to COVID-19, he was unable to get a visa appointment at the U.S. Consulate before the consular post closed. Now, he is subject to the Proclamation and thus unable to enter the United States indefinitely. The time difference between India and Microsoft's Washington headquarters has made it difficult for him to lead his new team's efforts, adversely affecting its productivity. Microsoft remains concerned about this individual's ability to fully transition to the U.S.-based role for which he is uniquely suited.

29. The Proclamation's ban on H-1B visas has led to similar disruptions to Microsoft's operations. For example, on June 10, 2020, Microsoft hired an exceptionally skilled Indian national who was supposed to move to the U.S. to become a Senior Program Manager, focused on research and development related to Azure hardware. Because of this individual's specialized expertise, he holds an already-approved Microsoft H-1B petition. But the Proclamation now bars his planned relocation.

30. This individual focuses on new technologies that will accelerate data analytics for hyper-scale mission-critical workloads. Given the sensitivity of the technology on which Microsoft hired him to work, the entire team—with the exception of this one talented new recruit—is located in the United States.

31. Now stuck abroad indefinitely, the employee coordinates the work of 15 U.S.-based engineers. With the time difference, he is only able to connect and collaborate with his team—and perform key customer-facing work—about half the day. And that arrangement is only feasible because he currently works until 3 A.M. (Indian Standard Time) to try to mitigate the time-zone

difference. The Proclamation has delayed—and continues to delay—scheduling for the groundbreaking new product. One of the planned product launches has already been pushed back because of these disruptions.

III. The Proclamation Has Stranded Abroad Microsoft's Existing U.S.-Based Employees, Causing Hardship and Frustrating Productivity.

32. The Proclamation's ban on H-1B visas has also impacted U.S.-based Microsoft employees who happened to be abroad when the Proclamation was announced.

33. For example, an Indian national employed via an H-1B visa as a Principal Architect (a high-level software engineer) works on critical infrastructure projects, integrating external customer data to the internal Microsoft system to facilitate access to up-to-date data. This employee has lived in the United States since 2009, and his technical expertise prompted Microsoft to hire him in 2015 to join a team at the company's Redmond headquarters.

34. This employee and his wife have two children, a three-year-old and a six-month-old, both of whom are U.S. citizens. The family traveled to India on March 1, 2020, to visit relatives and hold cultural and religious ceremonies for their newborn child. They planned to get their visas stamped while in India. Then COVID-19 hit; consulates closed, and their appointments were cancelled. Now, the Proclamation indefinitely bars the family's return to their home in the United States.

35. Due to the Proclamation, this employee is currently working all night and sleeping during the day so that he can be on Redmond time, like his team, and complete his work. He is exhausted and wonders how long he can continue at this pace.

36. His family faces additional challenges: The older child has epilepsy, and the child's health has declined because the family cannot find a neurologist to treat him in India. Under the Proclamation's indefinite ban, the family worries about the child's condition worsening without follow-up care in Washington. This stress, as well as the broader uncertainty about whether and when his family will be able to go home, understandably affects the employee's ability to focus on and complete his work. Under the Proclamation, the situation will continue without an end in sight.

IV. The Proclamation Continues to Frustrate Microsoft's Business Planning.

37. As just described, the Proclamation's disruptions to the work and lives of Microsoft employees is significant and ongoing.

38. Microsoft, like other corporations, has been able to shift successfully to a work-from-home model during COVID-19. But remote work has not obviated the need for personnel transfers under L-1 visas or the issuance of H-1B visas. Time-zone differences and personal strain on employees cause substantial stress and uncertainty and pose significant, ongoing barriers to effective and efficient work. This, in turn, compromises Microsoft's service levels and productivity, as discussed above.

39. What is more, there is no guarantee that the Proclamation will terminate at the end of 2020. As a result, Microsoft's development and planning for projects in key sectors are impaired.

40. The Proclamation expresses the possibility of a "national interest" exception to the suspension of L-1 and H-1B visa issuances. But that discretionary exemption does not resolve the business disruption caused by the Proclamation.

41. It is unclear whether any visas have been issued under this "national interest" exception, what the criteria may be to satisfy it, what materials must be submitted to apply for it, how long a decision might take, and how to appeal any adverse determination. The possibility of applying for a case-by-case exception based on unknown criteria is not sufficient for Microsoft to plan for its business cycles and needs at a time when the economy is already unstable.

42. The Proclamation has frustrated and continues to frustrate Microsoft's ability to make and execute business plans necessary to weather the current economic uncertainty, causing concrete harm to Microsoft's business. This will not only harm Microsoft's competitiveness, but also perversely deter the company from planning U.S.-based growth.

I declare under penalty of perjury and under the laws of the United States that the foregoing is true and correct.

Executed at Redmond, Washington

July 31, 2020

IN THE UNITED STATES DISTRICT COURT

IN AND FOR THE NORTHERN DISTRICT OF CALIFORNIA

NATIONAL ASSOCIATION OF MANUFACTURERS, CHAMBER OF COMMERCE OF THE UNITED STATES OF AMERICA, NATIONAL RETAIL FEDERATION, TECHNET, and INTRAX, INC.,

Plaintiffs,

v.

UNITED STATES DEPARTMENT OF HOMELAND SECURITY, UNITED STATES DEPARTMENT OF STATE; CHAD F. WOLF, in his official capacity as Acting Secretary of Homeland Security; and, MICHAEL R. POMPEO, in his official capacity as Secretary of State,

Defendants.

Case No. 4:20-cv-4887-JSW

DECLARATION OF C. SCOTT CORLEY IN SUPPORT OF PLAINTIFFS' MOTION FOR A PRELIMINARY INJUNCTION

I, C. Scott Corley, declare as follows:

1. I am the Executive Director of the Compete America Coalition, a coalition of companies and associations that focuses on the need for the United States to obtain and retain high-skilled domestic and international talent in order for American employers to continue to innovate and create jobs in the United States. Compete America members have collaborated for over 20 years to work with successive administrations and Congress to promote the global

mobility of talent, protect the integrity of the employment-based high-skilled immigration system, and enhance the education and training of domestic talent. The facts set forth in this declaration are based on my personal knowledge and, if called to testify to their truth, I could and would competently do so.

2. In mid-May 2020, while President Trump was considering whether the April 22 Presidential Proclamation should be amended to include a nonimmigrant visa ban, Compete America prepared a letter and Appendix presenting data points and information on high-skilled nonimmigrants. The letter, for consideration by the Trump administration, was drafted to explain why foreign professionals coming to the United States on nonimmigrant visas are key to industries currently keeping our economy operating and keeping an increasing number (according to the Bureau of Labor Statistics) of Americans employed, and why these sectors and their employees, including nonimmigrant visa holders, will be absolutely critical to President Trump's plan for economic recovery for the remainder of calendar year 2020. Compete America member associations then asked other employers and industry associations and other peer groups across the country to consider co-signing the letter.

3. The final letter and Appendix with sourced facts is attached hereto as Exhibit 1. The letter was co-signed by 324 employers and trade, industry, and higher education associations and groups across the US economy focused on the high-skilled workforce and described how highly skilled foreign professionals play an essential role in American prosperity, our success as a nation of innovators, and US worker employment and opportunity. We urged the President to avoid outcomes, even for temporary periods, that restrict employment-authorization terms, conditions, or processing of nonimmigrants.

4. The view of the 324 signatories was that presidential decisions restricting nonimmigrant visa usage "are likely to result in unintended consequences and may cause substantial economic uncertainty if we have to recalibrate our personnel based on country of birth." For example, many US firms across sectors base R&D in the US but conduct those efforts without regard to national borders, with American staff collaborating with testing or engineering centers around the world. Often final product testing or production rollout in the U.S.

necessitates teams of high-skilled professionals, including individuals who must seek nonimmigrant visa issuance, gathering at various US facilities at specified times. Delays in product development, manufacturing, and other endeavors is inevitable and unavoidable when staffing is driven by nationality, sometimes at great cost.

5. On May 21, 2020, I sent the final letter with appendix (attached hereto as Exhibit 1) to a number of White House staff and politically-appointed staff and officials explaining that artificial constraints to the high-skilled workforce are of great concern to the public.

I declare under penalty of perjury that the foregoing is true and correct.

Dated: July 29, 2020
Washington, DC

C. SCOTT CORLEY

Corley Declaration

Exhibit 1

May 21, 2020

The Honorable Donald J. Trump
President of the United States of America
The White House
Washington, DC 20500

The Honorable Secretary Michael Pompeo
Department of State
2201 C Street, NW
Washington, DC 20520

The Honorable Secretary Eugene Scalia
Department of Labor
200 Constitution Avenue, NW
Washington, DC 20210

The Honorable Acting Secretary Chad Wolf
Department of Homeland Security
Washington, DC 20528

Dear Mr. President and Honorable Secretaries,

The undersigned organizations, speaking for a variety of sectors and geographies across the American economy, and small, medium, and large employers, are writing about the importance of the high-skilled workforce to America's economic recovery. In particular, the undersigned represent employers that rely on a highly skilled, college-educated, science and engineering workforce, including nonimmigrant professionals, to innovate, produce, research, develop, and lead. At this critical juncture in our nation's history, the ability to continue to do so is in the national interest.

We urge you to avoid outcomes, even for temporary periods, that restrict employment-authorization terms, conditions, or processing of L-1, H-1B, F-1, or H-4 nonimmigrants. Constraints on our human capital are likely to result in unintended consequences and may cause substantial economic uncertainty if we have to recalibrate our personnel based on country of birth.

We join you in your continued commitment to protect the health and economic well-being of Americans, and hope our attached Appendix is helpful as you consider weighty judgments on how to navigate this important moment.

Respectfully submitted,

324 employers and trade, industry, and higher education associations and groups across the American economy focused on the high-skilled workforce (signatory list follows Appendix)

APPENDIX

Importance to the nation of the STEM workforce and avoiding artificial constraints to this workforce

IMPORTANCE OF THE COLLEGE-EDUCATED STEM WORKFORCE, INCLUDING NONIMMIGRANTS

STEM Jobs. It has been well-understood in the post-World War II era that the STEM workforce is of particular interest to all developed economies because of its central role in fostering innovation, economic competitiveness, and national security. The centrality of the STEM workforce across the American economy is evidenced by the fact that in the 21st century Americans with university STEM degrees are called upon to use their quantitative skills in finance, public administration, professional services, manufacturing, information, education, health care, transportation, and retail, in addition to high-tech, as the Census Bureau has explained. However, over the years, computer-related professional job openings have outstripped the availability of qualified Americans to fill those positions. For this reason, the Department of Homeland Security reports that 66% of all H-1B approvals are in computer-related occupations and, correspondingly, the Department of Labor reports that 60% of Permanent Labor Certifications approved to sponsor new green card holders are in the computer and mathematical occupations, with most such labor certifications filed on behalf of H-1B visa holders. Importantly, when Department of Labor wage data on H-1B workers is compiled, as the Cato Institute did for a May 2020 article, "the unequivocal takeaway from the data is that H-1B employers are, on average, paying a premium for many of their foreign workers." Today, the unemployment rate in computer occupations remains low, at about 2.8% through April 2020, according to a May 2020 analysis of government occupational level data.

Innovation. Foreign-born STEM professionals have had a positive impact on the American economy. As described in a July 2019 economic study on the impact of highly-skilled STEM immigration on the U.S. economy, the foreign-born share of STEM professionals in the United States increased from about 16% to 24% over the period 2000 to 2015 creating an estimated benefit of $103 billion for American workers almost all "attributed to the generation of ideas associated with high-skilled STEM immigration which promotes the development of new technologies that increase the productivity and wages of U.S.-born workers." An economic report on global talent and U.S. immigration policy published in April 2020 highlights that when looking at the net global migration of inventors from 2000 to 2010 China and the United States are at opposite ends of the spectrum, where China receives virtually no immigrant inventors and instead possesses the largest number of natives moving to other countries to become inventors elsewhere. The United States dwarfs all other 26 advanced economies in the world in welcoming new inventors, with about ten times that of Germany, the next highest country. Indeed, economists from George Borjas in June 1986 (National Bureau of Economic Research) to those at the Census Bureau and George Mason University in February 2019 (IZA - Institute for Labor Economics) to William Kerr in April 2020 (Harvard Business School) have consistently found that for immigrants coming to America their propensity toward innovation, as well as entrepreneurship, is higher than for U.S.-born workers. We want to continue to harness that innovation and entrepreneurship for America and Americans, and we're sure the administration wants the same.

Nonimmigrants. Among the nonimmigrant classifications that play a role in providing access to this STEM workforce for American employers, three classifications have been most critical and have been tools in our toolbox for ***decades***: the L-1, H-1B and F-1 nonimmigrant classifications.

- Created by Congress in 1970, over the last ***50*** years the L-1 visa category has been available to facilitate international transfers of existing employees to the United States within related firms. A cornerstone of business operations for those that do business both in the United States and abroad has been the ability to transfer current staff that are managers, executives, and specialized knowledge personnel across national boundaries in order to harmonize operations, expand markets, service clients, and share knowledge.

- Established in the 1952 rewrite of the nation's immigration laws, for over ***65*** years the H-1 visa classification has existed to allow U.S. employers to hire professionals born outside our country. Since 1990, this category has been subject to numerical limits and a labor condition application, and the category has been designated as the H-1B visa.
- In August 1947 the Department of Justice promulgated a regulation permitting "employment for practical training" for international students, after completion of the student's regular course of study. For over ***70*** years, a program allowing such post-completion employment authorization for international students has continued, now through Department of Homeland Security regulations governing F-1 nonimmigrants.

The stability of America's workforce – including L-1, H-1B, and F-1 nonimmigrants – cannot be more important than at this very moment when the Trump administration and the entire nation look to our companies to reinforce the backbone of the national economy.

IMPORTANCE OF AVOIDING UNNECESSARY CHURN IN THE COLLEGE-EDUCATED STEM WORKFORCE, INCLUDING NONIMMIGRANTS

Churn. Economists define "churn" as hiring for replacement, which means that a prior worker, being replaced, left voluntarily or was terminated. Turnover may come about because employers grow and shrink, but more frequently because of churn. Separations in the employment relationship that occur based solely on changed agency policy choices governing nonimmigrant employment authorization create additional churn and result in inefficiency. Thus, at this critical juncture in our nation's economic life, creating government-mandated churn in our human capital creates significant risks because the ramifications of those decisions will quickly reach into our capacity and productivity.

L-1. Narrowing access to L-1 intracompany transfers is a significant concern as we respond to Covid-19 challenges, because appropriate use of the L-1 classification by employers plays a direct role in supporting job creation and job retention in the United States, as well as expanding U.S. advanced manufacturing, continuing U.S.-centered research and development, increasing exports from the U.S., and encouraging foreign direct investment into the U.S. Multinational companies, of the type that might qualify to use the L-1 category, employ about one-quarter of all U.S. private sector employees. The impact of business disruption to a group of firms that play such an outsized role in the economy is significant.

With regard to U.S.-based R&D, an economist at the Wharton School of the University of Pennsylvania assessed Department of Commerce data in a February 2020 study and found restrictive high-skilled immigration policies encouraged multinational companies to off-shore R&D efforts. As the Wharton economist explains, "From a nationalistic perspective, this is problematic; if skilled foreign-born workers are at a U.S. firm's foreign affiliate instead of in the U.S., the innovative spillovers that they generate will go to another country instead." The National Science Foundation's 2020 reports show that the U.S. performs one-quarter of global STEM R&D, the largest percentage for any single nation; that STEM R&D performed in the U.S. increased sharply in 2017, up 10% when compared to 2015 and 34% higher than 2010; that 73% of all development research in the U.S. is performed by private sector businesses; and that U.S. multinational firms are responsible for 80% of such private R&D in the U.S. Changing long-standing immigration policies risks many unintended consequences, including disruption of these positive trends.

H-1B. Temporarily or indefinitely eliminating or reducing the H-1B program or discouraging its use would not create or leave more jobs for U.S. natives *and* would risk reducing growth and productivity. The University of Chicago did a survey in February 2017 through its Initiative on Global Markets (IGM Forum), asking its panel of economists from Yale, MIT, Princeton, Berkeley, Harvard, and Stanford about the following premise: "If the U.S. significantly lowers the number of H-1B visas now, employment for American workers will rise materially over the next four years." None (0) of the economists agreed with the premise, 81% disagreed, 19% were

uncertain. A May 2017 economic study on firm dynamics and immigration found that completely eliminating the H-1B category would ultimately result in a 3.7% decrease in GDP. An August 2018 economic study on the relationship between H-1B visa petitions and the entry of new products and exit of outdated products (product reallocation) concluded that firm-level analysis shows H-1B visa petitions are associated with higher rates of product reallocation. Generating product reallocation is one measure to identify where smaller, incremental innovations are occurring. In a seminal economic evaluation of H-1B visas and productivity in 219 American cities, published in the Journal of Labor Economics in July 2015, economists concluded that their simulations showed an increase of H-1B visa holders in a city explained increased productivity. Specifically, the economists found that "foreign STEM growth explained between one-third and one-half of the average Total Factor Productivity growth during the period" 1990 to 2010. It seems the Trump administration should not initiate a realignment of the H-1B category to respond to a downturn in the economy, especially because history shows us that H-1B demand from employers is tightly connected to market forces.[1]

OPT. As the number of U.S. postsecondary STEM degrees attained by F-1 nonimmigrants has steadily grown, the Optional Practical Training (OPT) program, to include the STEM OPT extension, has correspondingly become a significant pipeline for the U.S. STEM workforce. As explained by CRS in November 2019, from school year 88-89 (the earliest year for which annual data are available) to school year 16-17 (the most recent year for which data are available) there has been a 315% increase in STEM degrees awarded in the U.S. to foreign students, most of which is at the graduate level. When the Business Roundtable of American CEOs (BRT) partnered with the Interindustry Forecasting Project of the University of Maryland (Inforum) to assess the OPT program the resulting December 2018 report showed a negative impact to the U.S. economy should OPT participation be reduced. The BRT-Inforum modeling showed, among other things, a loss of 443,000 jobs over a decade, including 225,000 jobs held by native-born workers. Relatedly, an economist's study in March 2019, analyzing unemployment among STEM workers in 102 metro areas, concluded that unemployment rates are lower in areas with larger numbers of F-1 nonimmigrants doing OPT as a share of workers in STEM occupations. When the Niskanen Center reported on its OPT research in March 2019 its data suggest that 10 additional OPT participants working in a core-based statistical area (CBSAs are aggregated metropolitan areas) leads to 5 additional patents originating in that CBSA. The economic risk of taking steps that might dilute the utility of OPT as a pipeline is further highlighted by a policy brief from October 2018 that illustrated that 22% of America's billion-dollar start-ups had at least one immigrant founder that first came to the U.S. as an international student.

H-4. Lastly, we draw attention to H-4 dependent spouses of the H-1B professionals we are sponsoring for green card status. These H-4 visa holders are permitted to work when they are waiting in long immigrant visa backlogs after the sponsoring employers have completed all legal hurdles to classify the H-1B professional as an immigrant. Economists conducted a cost-benefit analysis in April 2019 on whether H-4 spousal work authorization rules should be rescinded, and found that rescinding the H-4 employment authorization regulation would cost the U.S. economy some $7.5 billion including loss of employment for American workers employed by the 2% of H-4 workers that have started their own businesses and employ 5 workers on average. The same economists found that 66% of employed H-4 visa holders held a job in a core STEM field, another 16% in business, finance, or management, and another 8% were health care professionals or health care support workers.

[1] The ***only*** three fiscal years ***since FY1997*** where cap-subject H-1B petitions did not exceed the numerical limit at some time prior to the end of the fiscal year were FY2000, 2001 and 2002, years for which Congress had temporarily increased the H-1B cap to 195,000 in response to the dotcom explosion. Because the new numbers became available only as the dotcom bubble burst, cap-subject H-1B filings in those three fiscal years were 163,600, 79,100, and 78,000 respectively – with decreasing numbers, well under the cap in each successive year. Similarly, following the 2008 great recession, H-1B filings were significantly down such that the numerical limits were *not* met in April (H-1B cap-subject filings are made in April for the government's fiscal year beginning October 1 of that calendar year). The so-called "regular cap" of 65,000 H-1B petitions was met in December 2009, January 2011, November 2011, and June 2012 for, respectively, FY2010, 2011, 2012, and 2013. When the economy is stronger, numerical H-1B limits are met in April, as in calendar years 2008 and 2009 (for FY2009 and 2010) and calendar years 2014 to the present (for FY2015 to 2021).

SIGNATORIES

1871 – Chicago's Technology & Entrepreneurship Center
ACE Physical Therapy and Sports Medicine Institute, Inc.
Adex Medical Staffing, LLC
Adobe
Advanced Polymer Coatings
airCFO
Akamai Technologies
Altair Global
Amazon.com
American First Finance Inc.
American Immigration Lawyers Association
Applied Value LLC
APPS Solutions inc
Arch Group LLC
Argo AI, LLC
Ariston Tek Inc
Arizona Technology Council (AZTC)
Asana
Aspen Technology, Inc.
Association of American Universities
Association of Public and Land-Grant Universities
Attentive
Aulder Capital
Aurora
Avicenna Medical Systems, Inc.
Avventis Tech Inc
Axess North America
Baslee Engineering Solutions (BES), Inc
Bates White
BBVA Digital Bank - San Francisco Rep Office
Belcher Pharmaceuticals, LLC
Benefit Resource, Inc.
BIO-key International, Inc.
BioBridge Global
Biogen
Biologique Recherche USA
Bloom Energy
Bloomberg
Bluestone Lane
Box, Inc.
Brandinc US, Inc
Briteskies, LLC
BSA | The Software Alliance
Business Roundtable
Cadence Design Systems, Inc.
California Technology Council (CTC)
Carbon Health Technologies, Inc.
Cardone Industries Inc
censhare US Inc.
Ceva Logistics
Chatanooga Technology Council
Chr. Hansen, Inc.
Cisco Systems Inc.
Citadel Drilling
CivilTech Engineering, Inc.
Clockwise Inc
Colorado Technology Association (CTA)
Complete Genomics
Computer Measurement Group (CMG)
Computing Technology Industry Association
Connecticut Technology Council (CTC)
Consonus Health
Consumer Technology Association
Contentsquare
Credit Karma, Inc.
CrowdSmart
Cyclomedia Technology Inc.
Dashlane
Dedrone
Deem, Inc.
Dell Technologies
Dematic
Demon Oilfield Services Corp.
Derakhshan Consulting LLC
DMG MORI USA, Inc.
DoorDash
DotHouse Health
Dr. Schar USA
Dropbox
DRS Engineering Inc.
DTC Global Services LLC
E.W. Howell Co., LLC
E&M Electric and Machinery, Inc.
Enanta Pharmaceuticals Inc
Essence Corp
ETS
Facebook
Far East Metals, Inc.
Fast
FEAM Maintenance/Engineering
Finsight Group Inc
FirstPass Global, Inc
Fitesa Simponville Inc
FlagshipKansas.Tech
Forensic Fluids Laboratories
ForgeRock, Inc.
Fortress Engineering Ltd.
Furniture Design Studios, Inc

Fusion Technologies Inc
FWD.us
g2o, LLC
Game Prophecies, Inc.
Garmin International, Inc.
GCP Tech
Genius Minds LLC
Getaround
GitHub
Glamsquad
Global Business Alliance
Global Engine Maintenance LLC
GN Hearing Care
Golden Technology, Inc
Google, Inc.
Grandison Management
Great Point Partners
Greater Memphis IT Council
Greater Nashville Technology Council
Green Village Concrete INC
GreenShape LLC
greight freight llc
Harco Manufacturing Group, LLC.
HBPO North America, Inc.
Hennepin Healthcare System, Inc.
Hewlett Packard Enterprise
Himax Imaging
Hired
Hirsch Bedner Associates
Horizon Hydraulics
HP Inc.
HUMAC INC.
I&L Investments and Management, Inc.
Idaho Tech Council (ITC)
Illinois Technology Association (ITA)
iLogic inc
Information Technology Industry Council
InfoTech Resources
Insight Venture Management LLC
Instacart
Institute of International Bankers
Integrated Automation Systems, LLC
Intel Corporation
Intuit
IPEX Global Inc
Isthmus Engineering, Inc
Jantzen Brands Corporation
Juniper Networks
Jyve Corporation
KabanaSoft LLC
KC Tech Council
Khan Academy
Kleiner Perkins
Knoxville Technology Council
Kolla Soft Inc
Kong Dragon Capital Investment
Kongsberg Digital
L'Oreal Travel Retail Americas, Inc.
Laguro, Inc.
LANXESS Corporation
Lilu, Inc.
LinkedIn
Louis Dreyfus Company LLC
LUCITO
Lyft
Lynk Inc.
MachiningCloud Inc
Madrona Venture Group
MANN+HUMMEL Purolator Filters LLC
Maryland Tech Council (MTC)
Masimo Corporation
Massachusetts Technology Leadership Council (MassTLC)
Matician Inc
MBLM
McMillen Jacobs Associates
Medialocate, Inc
Medium
Microbiologics
Micron Technology, Inc.
Microsoft Corporation
Mid-America Technology Alliance
Millbrook Revolutionary Engineering Inc
Minnesota High Tech Association (MHTA)
Mokuni LLC
Montana High-Tech Business Alliance
Monzlapur New York
MUEngineers, Inc.
NAFSA: Association of International Educators
NAM Info Inc
Nasdaq
NationsBenefits LLC
NAVAC Inc.
Netgear, Inc.
Nevada Technology Association
New American Economy
New Jersey Tech Council (NJTC)
New Mexico Technology Council (NMTC)
New York Tech Alliance

NH Tech Alliance
North Carolina Technology Association (NC TECH)
Northern Virginia Technology Council
Nova Credit Inc.
Novita Communications
Nuvia, Inc
NXP Semiconductors
Ohio IT Association
Okta
ON Semiconductor
OnSiteIQ Inc
Palm Beach Tech Association
PayPal
PEGRight
Philadelphia Alliance for Capital and Technologies (PACT)
Pirelli Tire LLC
Pittsburgh Technology Council
Postmates
PreciseLED.INC
Pronix
Propeller Health
PVH Corp (Phillips-Van Heusen Corporation)
Qnergy, Inc.
quadric.io Inc
Quallcom, Inc.
R.H. Chen Engineering
Region Technologies Inc
Remedy Analytics, Inc.
Remitly
Ricoh Printing Systems America, Inc.
Roanoke-Blacksburg Technology Council
Roblox Corporation
Rollbar, Inc.
Salesforce
SAMSON Controls, Inc.
SAP
SEBA International LLC
SEDA Environmental
Segment.io, Inc.
Selldorf Architects
Selux Diagnostics
Semex USA, Inc.
Semiconductor Industry Association
Shielding Integrity Services Inc.
Sigma Software LLC
Silicon Valley Bank
Silicon Valley Leadership Group
Simulations Plus, Inc.
SK hynix memory solutions America
Slack Technologies
SLK America, Inc.
Society for Human Resource Management
SolarEdge Technologies
Solution BI US Corp.
Sony Corporation of America
SPACO-Inc
Spectrum Health System
Square
Starburst Accelerator LLC
Sterling Software, Inc.
Stoll America Knitting Machinery, Inc.
Sunsong North America, Inc.
TAG
Tamp Bay Tech
Taro Engineering LLC
TaskRabbit
TEAM Industries Inc.
Tech Association of South Carolina
Tech Birmingham
Tech Collective
Tech Council of Central Pennsylvania
Tech Rochester
Tech San Diego
Tech Titans
Tech:NYC
TechLauderdale
TechNet
TechNexus Venture Collaborative
Technology Association of Georgia (TAG)
Technology Association of Iowa (TAI)
Technology Association of Louisville Kentucky (TALK)
Technology Association of Oregon (TAO)
Technology Council of North Dakota
Technology Councils of America (TECNA)
TechPoint
Tekion
Texas BioMedical Research Institute
Texas Instruments
The Marskell Group, LLC
The Yes Platform, Inc.
TheraCare of New York Inc.
Thumbtack
Tillster, Inc.
Titan Data Group Inc.
Tomorrow Water
Top Notch Logworks Inc.
Tracker Corp
Tri Marine Fish Company, LLC
Trinity Health
Turbo Air, Inc.
Turo
Twitter

U.S. Chamber of Commerce
Utah Technology Council
V Plus O Communications
VEB Solutions, Inc.
Venture Home Solar LLC
VigiLanz Corporation
VMWare
Voss USA Inc.
Waymo
Webber, LLC (a Ferrovial company)
West Coast Consulting
Wi-Tronix, LLC
Wisconsin Technology Council (WTC)
Woodbridge Group
Workday, Inc.
World Fresh Produce Inc.
Worldwide ERC
WorldWide HealthStaff Solutions Ltd.
Xero
YOOBIC Inc.
Zillow
ZOLLER Inc
Zoom Video Communications, Inc.
Zymergen, Inc.

IN THE UNITED STATES DISTRICT COURT

IN AND FOR THE NORTHERN DISTRICT OF CALIFORNIA

NATIONAL ASSOCIATION OF MANUFACTURERS, CHAMBER OF COMMERCE OF THE UNITED STATES OF AMERICA, NATIONAL RETAIL FEDERATION, TECHNET, and INTRAX, INC.,

Plaintiffs,

v.

UNITED STATES DEPARTMENT OF HOMELAND SECURITY, UNITED STATES DEPARTMENT OF STATE; CHAD F. WOLF, in his official capacity as Acting Secretary of Homeland Security; and, MICHAEL R. POMPEO, in his official capacity as Secretary of State,

Defendants.

Case No. 4:20-cv-4887-JSW

DECLARATION OF STEPHANIE HALL IN SUPPORT OF PLAINTIFFS' MOTION FOR A PRELIMINARY INJUNCTION

I, Stephanie Hall, declare as follows:

1. I am the Director of Innovation Policy at Plaintiff National Association of Manufacturers (NAM). I make this declaration based on my own personal knowledge and if called as a witness could and would testify completely thereto.

2. The NAM is a 501(c)(6) nonprofit organization headquartered in Washington, DC. The NAM is the largest manufacturing association in the United States, representing small and large manufacturers in every industrial sector and in all 50 states. Microsoft Corporation is one member of the NAM.

3. Manufacturing employs more than 12 million men and women, contributes roughly $2.17 trillion to the U.S. economy annually, has the largest economic impact of any major sector, and accounts for nearly three-quarters of private-sector research and development in the Nation.

4. For 125 years, the NAM has been the voice of the manufacturing community and the leading advocate for a policy agenda that helps manufacturers compete in the global economy and create jobs across the United States. The NAM fulfills this purpose in part by defending the interests of American manufacturers in court.

5. Part of the NAM's mission is advocating for its members' abilities to access global talent and retain workers who drive innovation in manufacturing. NAM recognizes that immigrants help build America's manufacturing industry and that temporary workers from abroad are essential to the Nation's manufacturing competitiveness.

6. In particular, some members use L-1 visas to relocate key executives or managers to the United States to lead critical initiatives on American soil. Other members facing labor shortages for certain specialized workers, for example, engineers, researchers, or information technology professionals, recruit some workers from abroad who then enter the United States on an H-1B visa to help enhance an American manufacturer's business. Still others sponsor J-1 visa interns and trainees to develop a talent pipeline and provide research assistance for the manufacturers' work in the United States.

7. As Director of Innovation Policy for the NAM, I have worked closely with many NAM member companies to understand how Proclamation 10052 will affect member businesses.

The NAM concluded that the Proclamation will inflict direct and immediate harm on many of the NAM's members of all sizes and across several economic sectors that routinely employ and sponsor individuals who enter the United States on L-1, H-1B, and J-1 visas. Manufacturers have developed multi-year business plans and invested in U.S.-based operations that depend on highly specialized employees entering the country through existing legal nonimmigrant visa programs. In the current economic environment, specific workforce needs persist across our sector, even while we see large unemployment numbers across other sectors. By driving talented individuals away from specialized roles with manufacturers in the United States, the Proclamation will hand other countries a distinct competitive advantage in the global market and restrain American manufacturers' contributions to economic recovery.

8. NAM's members employ millions of individuals in the United States. Since the Proclamation is expressly designed to cause American employers to alter their hiring practices for the remainder of 2020, it will have irreparable implications on NAM's members who have relied on their ability to hire individuals who enter the U.S. on L-1, H-1B, or J-1 visas. The employment decisions that are made for the remainder of 2020 will have long-term, lasting effects. Judicial action later cannot restore companies to the position that they would be in if they could now obtain the talent that they require via these visa programs.

I declare under penalty of perjury that the foregoing is true and correct.

Dated: July 31, 2020
Washington, DC

Stephanie R Hall

STEPHANIE HALL

McDermott Will & Emery LLP
Attorneys At Law
Menlo Park

IN THE UNITED STATES DISTRICT COURT

IN AND FOR THE NORTHERN DISTRICT OF CALIFORNIA

NATIONAL ASSOCIATION OF MANUFACTURERS, CHAMBER OF COMMERCE OF THE UNITED STATES OF AMERICA, NATIONAL RETAIL FEDERATION, TECHNET, and INTRAX, INC.,

Plaintiffs,

v.

UNITED STATES DEPARTMENT OF HOMELAND SECURITY, UNITED STATES DEPARTMENT OF STATE; CHAD F. WOLF, in his official capacity as Acting Secretary of Homeland Security; and, MICHAEL R. POMPEO, in his official capacity as Secretary of State,

Defendants.

Case No. 4:20-cv-4887-JSW

DECLARATION OF MIKE LEMAN IN SUPPORT OF PLAINTIFFS' MOTION FOR A PRELIMINARY INJUNCTION

I, Mike Leman, declare as follows:

1. I am the President and Chief Executive Officer of Singing Hills Landscape, Inc. I make this declaration based on my own personal knowledge and if called as a witness could and would testify completely thereto.

Singing Hill's Business

2. Singing Hills is a member of Plaintiff Chamber of Commerce of the United States

of America.

3. Singing Hills performs essential landscape construction services and landscape maintenance services for commercial, governmental, and residential entities.

4. I founded Singing Hills in 1995 with my wife. When we began the business in 1995, I was the sole employee. Since then, however, we have had substantial opportunities for growth. We now employ approximately 80 people.

5. Of our current 80 employees, approximately 55 are domestic employees and 25 to 30 are hired as seasonal workers on H-2B visas.

6. The H-2B program has played a critical role in our growth from one to 80 employees over our 25 years in business.

7. We hire seasonal employees on H-2B visas for a variety of reasons. Our industry faces a substantial domestic labor shortage. We simply cannot find sufficient numbers of domestic workers who want to fill seasonal laborer roles.

8. Although I am aware that many individuals lost their jobs as a result of the COVID-19 pandemic, I still have not been able to fill many available openings. Of those individuals I have hired following the COVID-19 pandemic, many refused the job after being offered it, and others never showed up to work. About one third of the employees promptly quit. Indeed, the median days worked before quitting has been approximately 9 days. This is all notwithstanding that our starting wage, for an individual with no experience, ranges from $16.21 to $18.00 per hour, with opportunity to earn significant overtime.

9. I did not even file my temporary labor certification with the Department of Labor to secure H-2B workers to start October 1, 2020 until July 2, 2020, well after the COVID-19 pandemic began and I discovered that even in time of substantial job losses, there was still not sufficient domestic labor. During the months of April, May, and June 2020, I advertised heavily for positions prior to filing for the temporary labor certification, and I was unable (and remain unable) to find sufficient workers willing to undertake the jobs I currently have vacant.

10. Hiring H-2B seasonal workers also helps us meet other business objectives. Many of our H-2B workers have worked with us on a seasonal basis for multiple years, and thus have

developed substantial experience working with us. They have thus selected a seasonal landscape role as a long-term career. Most frequently, our domestic seasonal laborers are high school and college students who work with us for one or possibly several seasons but do not intend to pursue landscape as a career. We invest substantial resources in training these students during their time with us but do not reap the benefits if they do not return for subsequent seasons.

11. For our domestic workers who do choose landscape as a career, our use of an H-2B workforce to supplement seasonal labor roles means that those domestic workers can attain full-time employment and move into supervisory and management roles. The H-2B program allows us to employ full-time project managers, designers, division managers, office staff, and irrigation techs.

Consequences of the Proclamation

12. Unless enjoined, the Proclamation will have devastating consequences to Singing Hills. It would result in substantial irreparable harm to our business.

13. Because of the Proclamation, I understand that neither the Department of Homeland Security nor the Department of State are processing petitions for H-2B workers. If these agencies do not process our requests for H-2B workers, the result is that we will not hire the labor force we need. We will not have the labor necessary for our substantial landscaping operations scheduled for fall 2020 nor those for spring 2021.

14. Currently, we are in the process of petitioning for 25 H-2B workers to join us beginning October 1, 2020, to help for the last six weeks of our season. Based on our many years of experience, we know that, if our H-2B petitions are granted, we would find more than sufficient qualified candidates to take these positions, and thus work for us in the United States.

15. Those 25 H-2B workers would support approximately 8 work crews. If we cannot secure the 25 H-2B workers we hope to obtain by October 1, 2020, the immediate result would be the loss of substantial revenue. Once lost, we have no means of regaining this revenue, and this harm cannot be remedied by later action. I have projected that those 8 crews would be able to generate approximately $400,000 in additional sales in the six weeks following October 1, 2020.

16. The inability to secure H-2B workers will harm our customer relationships and

might even result in lost customers. As part of our business, we maintain commercial properties through regular mowing, pruning, and related care. Our commercial customers often have additional enhancement work they want done beyond routine maintenance. Without our H-2B workforce, we have to focus first and foremost on meeting our maintenance contract and are currently unable to fulfill most requests for enhancement work. When a maintenance customer cannot timely get the enhancement work it wants, that customer is reasonably likely to terminate the maintenance contract entirely. If we knew that our seasonal workforce would arrive October 1, we can assure current customers that we will be able to complete the work they desire.

17. The inability to secure H-2B workers also will harm our ability to attract new customers. If we cannot guarantee our H-2B workforce, we will have to turn down a substantial portion of new residential landscape projects and focus our efforts on fulfilling government and commercial contractual obligations. The loss of these one-time opportunities to gain new business for a large residential project irreparably harms our business because of the lost revenue for the design, lost future maintenance revenue, lost goodwill from that customer, and lost future business from referrals.

18. Our inability to secure our H-2B workforce for October 1, 2020, also harms our ability to grow. Right now, we would be purchasing more equipment—and thereby contributing to the economy—but, without our H-2B workforce, we will not have enough laborers to use that equipment. Therefore, we are withholding capital improvement expenses because of the Proclamation.

19. Additionally, if we bring in 25 H-2B workers for an October 1, 2020 start date, and had more certainty of those workers returning next season, we would plan to hire domestic workers for three management positions—a CFO/controller position (earning $100k or more annually), a project manager (earning approximately $70k annually), and a landscape designer (earning approximately $50k annually). This growth of our business would directly help our local economy, employing more domestic workers in well-paying, permanent jobs. The Proclamation, however, is precluding us from making these hires, because without an H-2B labor force joining us on October 1, 2020, for the last six weeks of the 2020 season, we will not have sufficient revenue and growth

to support these new positions.

20. I have also devoted substantial time and attention to dealing with the uncertainty regarding our H-2B workforce and developing contingency plans in the event the Proclamation remains in place. This is time I could have spent focusing on growing my business to the benefit of my customers, my employees, and my community.

I declare under penalty of perjury that the foregoing is true and correct.

Dated: July 28, 2020
Aurora, Colorado

MIKE LEMAN

IN THE UNITED STATES DISTRICT COURT

IN AND FOR THE NORTHERN DISTRICT OF CALIFORNIA

NATIONAL ASSOCIATION OF MANUFACTURERS, CHAMBER OF COMMERCE OF THE UNITED STATES OF AMERICA, NATIONAL RETAIL FEDERATION, TECHNET, and INTRAX, INC.,

Plaintiffs,

v.

UNITED STATES DEPARTMENT OF HOMELAND SECURITY, UNITED STATES DEPARTMENT OF STATE; CHAD F. WOLF, in his official capacity as Acting Secretary of Homeland Security; and, MICHAEL R. POMPEO, in his official capacity as Secretary of State,

Defendants.

Case No. 4:20-cv-4887-JSW

DECLARATION OF TOM O'GORMAN IN SUPPORT OF PLAINTIFFS' MOTION FOR A PRELIMINARY INJUNCTION

McDERMOTT WILL & EMERY LLP
ATTORNEYS AT LAW
MENLO PARK

I, Tom O'Gorman, declare as follows:

1. I am the Chief Executive Officer of Gentle Giant Moving Company. I make this declaration based on my own personal knowledge.

2. Gentle Giant is a member of Plaintiff Chamber of Commerce of the United States of America.

3. Gentle Giant is an award-winning national moving company that offers a full range of packing and moving services for residential and commercial moving, both locally and long distance.

4. Larry O'Toole, an Irish immigrant, founded Gentle Giant in 1980 and set out to build a leading team of movers. Having grown to twenty locations across the country, Gentle Giant still continues Larry's tradition today, priding itself on delivering consistently high-quality moving services for customers.

5. In the moving industry, the busy season is in the summer when more people are buying and selling homes and, thus, moving. Gentle Giant's peak months are the next two: August and September. Because of the moving industry's business cycle, Gentle Giant has to rely on seasonal employees to adequately meet demand.

6. Gentle Giant typically employs 500 people during the summer busy season and approximately 200 people through the slower winter season.

7. The H-2B program has played a critical role in our growth from one to 500 employees over our 40 years in business.

8. We hire seasonal employees on H-2B visas for a variety of reasons. Our industry faces a substantial domestic labor shortage. We simply cannot find sufficient numbers of domestic workers who want to fill seasonal laborer roles. We routinely advertise available positions, but we are consistently unable to hire enough workers.

9. Additionally, many of our H-2B workers have worked with us seasonally for many years. Their substantial experience in the moving industry ensures that we can hire even more seasonal employees who do not yet have experience in the moving industry while ensuring continued quality and safety on each moving crew. The domestic seasonal laborers that we

typically do hire—college students—lack the experience that many years in the moving industry brings.

10. In February 2020, Gentle Giant received approval for 90 H-2B workers to work with us this busy season. Only 7 of those approved H-2B workers have been able to enter the United States. We thus still have approval to bring to the United States 83 H-2B workers, and we would do so immediately but for the Proclamation.

11. Some of our 7 workers arrived after the onset of the COVID-19 pandemic, and we would be able to bring over many workers immediately if the Proclamation were lifted. The Proclamation is thus the only factor precluding us from hiring the workers that we need.

12. Although I am aware that unemployment levels are high as a result of the COVID-19 pandemic, I still have not been able to fill many available openings. It is particularly challenging to find domestic workers with substantial experience in the moving industry. The domestic laborers that we have hired to help during the peak season are mostly college students and will be leaving us soon to return to school, further causing labor shortages in addition to those caused by missing H-2B workers.

13. Gentle Giant also hires approximately 50 J-1 cultural exchange visa holders to work with us as trainees during the summer busy season. The J-1 trainees help supplement our work force of seasonal labors who do not have moving industry experience. They regularly help out on crews right along with their domestic peers and with our H-2B work force. We did not have any J-1 employees this busy season.

14. Unless enjoined, the Proclamation will have devastating consequences to Gentle Giant. It would result in substantial irreparable harm to our business.

15. As noted, we currently have approval for 83 H-2B workers, none of whom will be able to join us for our busy season if the Proclamation stays in place. If the Proclamation were enjoined, we would have plenty of people who would be ready to immediately board flights to the United States to work for us for the remainder of the season.

16. By our current best estimate, these 83 H-2B workers would support an additional $8 to $10 million in business through the summer and early fall. If we cannot get these workers to

the United States, we will lose this revenue, and there will be no way for us to regain it. That lost revenue is irreplaceable.

17. Having these 83 H-2B workers join our team, many of whom have moving-industry experience, would allow us to hire even more domestic seasonal laborers who do not have moving-industry experience. Hiring these 83 H-2B workers also ensures we can support our 200 domestic employees' full-time roles, particularly employees in administrative roles.

18. The inability to secure H-2B workers has also required us to take other protective measures, which we will have to keep in place if we cannot keep the H-2B workers into the U.S. because of the Proclamation. We have had to reduce pay for domestic workers, to freeze non-essential expenditures, and to impose strict cost measures. We have a fleet of brand new trucks sitting useless because we do not have the experienced work force necessary to support use of those trucks.

19. We have had to turn away a substantial volume of business because we do not have the labor force to support it. In our high-end moving business, it is essential that we have sufficient skilled workers to ensure that a job will be handled the right way. Customers moving millions of dollars' worth of belonging expect the best. Because we have not had sufficient experienced H-2B workers, we have had to pass on jobs we otherwise could have taken because of concern that we would not be able to achieve our high quality and safety standards.

20. If the Proclamation were immediately enjoined, we would have H-2B laborers who would be ready to board a plane and to come help us through our busy season. We could thus mitigate many of these otherwise irreparable harms that we have suffered and will continue to suffer if the Proclamation remains in effect.

I declare under penalty of perjury that the foregoing is true and correct.

Dated: July 31, 2020
Somerville, Massachusetts

Tom O'Gorman

TOM O'GORMAN

IN THE UNITED STATES DISTRICT COURT

IN AND FOR THE NORTHERN DISTRICT OF CALIFORNIA

NATIONAL ASSOCIATION OF MANUFACTURERS, CHAMBER OF COMMERCE OF THE UNITED STATES OF AMERICA, NATIONAL RETAIL FEDERATION, TECHNET, and INTRAX, INC.,

Plaintiffs,

v.

UNITED STATES DEPARTMENT OF HOMELAND SECURITY, UNITED STATES DEPARTMENT OF STATE; CHAD F. WOLF, in his official capacity as Acting Secretary of Homeland Security; and, MICHAEL R. POMPEO, in his official capacity as Secretary of State,

Defendants.

Case No. 4:20-cv-4887-JSW

DECLARATION OF MARCIE SCHNEIDER IN SUPPORT OF PLAINTIFFS' MOTION FOR A PRELIMINARY INJUNCTION

I, Marcie Schneider, declare as follows:

1. I am the President of International Training & Exchange Inc, d/b/a Intrax.

2. Intrax is a plaintiff in this action, and it is also a member of Plaintiff Chamber of Commerce of the United States of America. I make this declaration based on my own personal knowledge and if called as a witness could and would testify completely to these statements.

3. Intrax maintains its headquarters in San Francisco, California.

4. Intrax has been offering J-1 cultural exchange programs for 40 years, and it has successfully recruited and supported nearly 1 million participants over those decades.

5. Intrax works with our own offices in Germany, Chile, South Korea, and Japan, as well as with well-trained partners in about 60 countries to recruit and carefully screen participants, and place them with domestic companies and camps (or in the case of the au pair program, with U.S. host families). Intrax supports the host families, host companies, program participants, and au pairs from recruitment throughout the entire duration of their stay. Intrax oversees the support, education, and cultural exchange activities for all of our participants during their entire program. Intrax prioritizes the health, safety, and wellbeing of our participants, while also complying with every Department of State regulation and requirement.

6. Intrax operates six State Department-regulated J-1 cultural exchange visitor programs, five of which—summer work travel, au pair, intern, trainee, and camp counselor—are shut down by Presidential Proclamation 10052 (the Proclamation). If not for the Proclamation, Intrax would currently be operating those programs. That is, the Proclamation is the direct and immediate cause of Intrax's inability to operate these five programs.

7. The Proclamation has had enormous effects on Intrax. Since it went into effect, Intrax has been unable to bring to the United States more than 8,200 participants on its programs who had been scheduled to arrive between June 24, 2020 (the day the Proclamation became effective), and now.

8. While COVID-19 has reduced the ability of some individuals to travel, Intrax is a global company that sponsors tens of thousands of global participants annually. There are many countries who have participants that may travel and adhere to the CDC and WHO safety guidelines.

Thus the Proclamation is the sole reason that thousands of participants in cultural exchange programs sponsored by Intrax cannot enter the country. For example, Intrax would have had many individuals enter the United States on J-1 visas from countries such as Japan, South Korea, Russia, and Mexico, where no COVID-related travel restriction is applicable.

9. In part due to the seasonal nature of many of these programs, if the Proclamation remains in force until December 31, only about 25% of the exchange visitors that normally participate in Intrax's affected programs will be able to enter the United States in 2020. That is devastating for the participants, the host families, and employers—as well as for Intrax as a company.

10. The primary purpose of Intrax's programs is to provide the benefits of cultural exchange and global understanding to the United States. These programs build bridges between nations even in challenging times like the current COVID pandemic. Participating exchange visitors on Intrax programs are exposed to the best of American culture and take home a positive perception of the United States that contributes to American standing around the world. Host communities, local universities, sponsoring institutions and individuals also benefit from the diverse international perspectives brought by the exchange visitors.

11. The benefits that cultural exchange brings to America's image around the world cannot be overstated. The experiences that the participants have had on these programs directly supports the foreign policy goals of the United States. For example, one in three world leaders participated on a J-1 cultural exchange program at a time earlier in life. 97% of participants report a more positive view of the United States after participating on a cultural exchange program. The Proclamation halts these essential policy objectives.

12. Cultural exchange programs support American jobs, while advancing our national security interests. By further restricting J-1 programs that have already been significantly affected by the pandemic, the Administration will increase the economic pain in American communities and among hard-working families. Intrax believes that is a fundamental mistake. Instead, we should continue to use cultural exchange programs as intended: to support the unique economic and diplomatic needs of the United States.

13. The Proclamation suspends Intrax's summer work travel program, which places exchange visitors in short-term, seasonal positions, often in remote areas that do not have sufficient local populations to fill the needed jobs. The classic example is ski resorts, which rely heavily on the work travel program. Many of these businesses, who work directly with Intrax, are unable to operate at full capacity without J-1 exchange visitors to fill seasonal positions. If the Proclamation remains in place until December 31 as planned, the winter 2020 season—which includes placements at ski resorts—will not take place at all, given the necessary lead time for recruiting and obtaining the necessary paperwork and approvals. This will mean in many cases that resorts will be unable to operate at full capacity which will slow the economic recovery of the U.S.

14. The Proclamation is imminently harming Intrax, as well as the employers with which it works. For example, ski area businesses need to have staff recruited by August 2020 with visas issued by the end of November for mid-December arrivals. Intrax would currently be working to recruit and arrange individuals to participate in work-travel programs with these employers, but the Proclamation forbids that from occurring. And the State Department's ban on visa issuance also precludes Intrax from arranging for J-1 work travel individuals to arrive in January 2021.

15. Similarly, seasonal employers with which Intrax works will plan their summer 2021 staffing beginning in October 2020. They must finalize budgets, and decide how much they will invest in the upcoming season. If the Proclamation remains in place until December 31, it will fundamentally alter recruitment for the 2021 summer season as businesses with which Intrax works will not be able to plan for the summer 2021 season in reliance on the benefits provided by J-1 work-travel participants. Intrax's business partners are thus scaling down the size of their operations for 2021, because of a lack of J-1 participants. These diminished business operations will only depress economic recovery. If the Proclamation were to remain in force throughout 2020, not only would it foreclose the work-travel program in 2020, but it would be cause a massive disruption to the summer work travel program in 2021 for Intrax, the employers with whom Intrax works, and for the summer work travel program as a whole.

16. Intrax works with many companies that employ J-1 cultural exchange participants on summer work travel. Many of our host companies are located in remote parts of the U.S such as

the Wisconsin Dells, various National Parks, Branson, Missouri and many other locations. These businesses cannot fill their summer positions with enough domestic staff. Because our work-travel participants were barred from entering, these small businesses have had to drastically scale back their operations. The net result is not just economic devastation to Intrax, but damage to the country's economic recovery as a whole, and to say nothing of lost cultural opportunity for the many individuals who seek to participate in these programs.

17. The Proclamation suspends Intrax's camp counselor program, which similarly places exchange visitors in often-remote, seasonal positions at summer camps. Again, Intrax works with camps that face a dire problem: the local populations in these areas are often too small to provide enough counselors for camps to operate at full capacity, and the seasonal nature of the positions makes them unattractive to many domestic workers. Indeed, many camps, including some of Intrax's partners, have closed for this year without the ability to rely on J-1 counselors.

18. The implications go beyond the economic. J-1 counselors also enrich the experience that American children get at camp by exposing them to other cultures and broadening their horizons. This has been a core component of American summer camps for decades. American staff and American campers get the chance to develop close relationships and understanding with camp counselor staff from around the globe.

19. Intrax works with many camps that will soon be preparing for summer 2021. In order to set the scope of their operations in 2021, camps must have staffing in place by around August 2020. If the Proclamation remains in place until December 31, it will substantially reduce—if not eliminate—Intrax's recruitment with those camps for the summer 2021, as camps will be unwilling to dedicate resources into such an uncertain environment with the recruiting of international staff that are currently banned. The result will be further immediate financial harm to Intrax. The camps, meanwhile, will be forced to reduce their operations, in turning losing revenue and depriving American children of valuable experiences, especially as it relates to cross-cultural exchange.

20. The Proclamation suspends Intrax's J-1 Intern and Trainee programs, which place Exchange Visitors with companies interested in incorporating international or multicultural

perspectives into their existing operations. Intrax's partner companies work with J-1 Interns and Trainees specifically to enhance and complement the current U.S. based operations, whether it is for a U.S.-owned company or a U.S. subsidiary of a foreign-owned company. By regulation and program design, these individuals cannot compete for jobs with domestic workers. Participating companies with Intrax sign up specifically because of the unique benefits of hiring an international trainee or intern, and are carefully vetted to ensure that they are not simply using the program to secure labor.

21. Interns and Trainees participate in J-1 programs affiliated with Intrax to gain professional experience, but also to learn more about American culture. The U.S. has long been a top destination for university students and young professionals from around the world and U.S. host companies have benefited from their contributions, both in the short and long term for many decades. This Proclamation dramatically alters this historic legacy and tradition that established and sustained the U.S. as the premier and preferred destination for the best and the brightest future global leaders, stopping these participants from seeking out the U.S. as their premier destination for intern and trainee opportunities.

22. Intrax has been designated for the J-1 Trainee program since 2003, and the Intern program since 2007. Since that time, Intrax has sponsored more than 35,000 Intern and Trainee exchange visitors. These exchange visitors are placed in all 50 states and DC. 40% of Intrax's Intern and Trainees are placed in California. The bulk of the exchange visitors are in the fields of science, technology, engineering and mathematics and another quarter are in the fields of management and business. The Proclamation is severely limiting and primarily impacting J-1 Intern and Trainee programs in STEM and business management related positions.

23. In a normal year prior to 2020, Intrax sponsors approximately 3,200 Interns and Trainees. Even following COVID-19, Intrax was still planning—and had committed—to sponsor approximately 1,500 Interns and Trainees in 2020. With the Proclamation, this number falls precipitously to 775 (almost all of whom arrived in Q1 of 2020) which represents 24% of the total number of Interns and Trainees sponsored by Intrax in a normal year, and about half of what was planned prior to the proclamation.

24. The Proclamation suspends Intrax's live-in au pair program. That program provides exchange visitors the opportunity to live as a complete member of an American family for a year, while host families benefit from having flexible live-in childcare. Working families that rely on childcare from au pairs are distraught about the Proclamation; Intrax has heard from many panicked host families that their ability to work—and thus to contribute to the economic recovery—will have to be put on hold. Many families are desperate for childcare and simply do not know how they can continue working without the program, as it is difficult (if not impossible) to find domestic workers willing to provide the flexibility of live-in childcare services. The cultural exchange part of the experience is also a key reason that a family chooses an au pair program, including with Intrax. An American child will have an invaluable experience by being exposed to a different culture and language. A main tenet of the au pair programs is education and au pairs receive an education stipend from the host family to attend a local college or university and learn firsthand about American culture.

25. As the Wall Street Journal has reported, "the ban adds to a child-care crisis in the U.S. that has left parents, especially mothers, struggling to figure out how to supervise their children and maintain their jobs at the same time."[1] That article quotes a mother whose says "she may have to scale back the hours she puts into her business": "It's so ironic—actually what's in danger here is, I'm desperate to keep my business alive, and now I'm being hampered because my child care is being ripped from me." That experience is typical of what Intrax has heard from many of our host families. Before the Proclamation was put into place, we were still able to provide this needed service to our host families.

26. Had it not been for the Proclamation, we would have placed hundreds of au pairs with families, all of whom were committed to appropriate quarantine measures to ensure safety. Indeed, Intrax had put protocols for safety during COVID into place with the support of our host families. Notwithstanding this, the Proclamation caused these arrivals to cease.

27. By barring cultural exchange visitors for more than half of 2020, and by

[1] Lauren Weber & Michelle Hackman, *Au Pairs Ensnared by Work Visa Ban*, Wall. St. J. (July 7, 2020), https://perma.cc/3Q3B-CLT7.

fundamentally disrupting the program for 2021, the Proclamation defeats the goals of the Fulbright Hays Act, harming foreign policy objectives.

28. Moreover, given the uncertainty surrounding whether the ban will continue into 2021, prospective participants are unwilling to sign up for future exchange programs in the United States. Many participants are already choosing other more welcoming countries for their time abroad. Recruiting is virtually impossible when potential exchange visitors are asked to plan their lives around a program that may or may not continue to be banned by the President.

29. The Proclamation has and will continue to impose severe economic harm on Intrax. We have had to furlough corporate U.S. employees, cancel exchange visitor placements, and refund or credit fees. Recruiting for future placements—which would ordinarily be ongoing now—is virtually impossible, choking off all normal revenue.

30. The revenue we are now missing out on cannot be restored. We do not anticipate receiving any compensation for the broad shutdown of our business caused by the Proclamation.

31. Because five of our programs have been shuttered, substantially reducing its revenue, Intrax has had to furlough or lay off 40-50% of its approximately 300 U.S. staff. Intrax's remaining staff have taken very substantial pay cuts.

32. We are fighting for our survival and have put every possible expenditure on hold. The Proclamation is the most substantial harm that has ever occurred to Intrax, inflicting more damage to our business than the 9/11 terrorism crisis, the COVID-19 pandemic, economic downturns, and wars. This Proclamation is causing the loss of many American jobs and destroying dreams for so many.

33. If the Proclamation is lifted, allowing Intrax to resume its business, it would reverse furlough decisions and restore salaries to its employees. Indeed, if the Proclamation is enjoined, Intrax would immediately resume operation of the five programs that the Proclamation has shuttered. Intrax would begin earning the revenue that, because of the Proclamation, will be forever lost.

34. On July 22, 2020, the State Department published its interpretation of the Proclamation's national-interest exception, establishing categories of noncitizens whose entry may

be considered exempt from the Proclamation's entry ban.[2] None of the stated categories have had or will make a meaningful difference to Intrax's business. The exceptions stated in the State Department interpretation apply to a miniscule number of the individuals that Intrax had planned to have enter the United States on J-1 visas in the second and third quarters of 2020. Five of Intrax's key programs remain completely shuttered notwithstanding the State Department's interpretation of the national-interest exception. Intrax thus continues to face devastating financial harm to its business notwithstanding the national-interest waivers.

35. Apart from the Proclamation, the State Department has paused the substantial majority of the processing and issuance of J-1 visas. For example, I am aware of one Tweet from an official State Department account that the State Department is not currently "issuing H-1B, H-2B, L, or certain J visas, and their derivatives through December 31, 2020, unless an exception applies."[3]

36. The State Department's failure to process J-1 visas at U.S. consulates is causing direct harm to Intrax, apart from the Proclamation. The Proclamation states that it is set to expire on December 31, 2020. Intrax would like to schedule for J-1 cultural exchange visitors to enter the United States immediately after, beginning on January 1, 2021. But, because for the most part the State Department has stopped processing and issuing J-1 visas, Intrax cannot even arrange for participants in its programs to enter the United States immediately after the entry bar is lifted.

37. Rather, the State Department has taken the position that it will not issue visas until after the Proclamation lifts. Because the process for issuing visas is lengthy, this will create massive delays for visa processing. For example, the State Department would usually process J-1 visas in May, June, and July for individuals participating in Intern and Trainee programs beginning in September. Visas are usually processed several months before an individual is scheduled to travel to the United States for a cultural exchange program.

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[2] *See* U.S. Dep't of State, Bureau of Consular Affairs, *National Interest Exceptions to Presidential Proclamations (10014 & 10052) Suspending the Entry of Immigrants and Nonimmigrants Presenting a Risk to the United States Labor Market During the Economic Recovery Following the 2019 Novel Coronavirus Outbreak* (July 22, 2020).

[3] @Travelgov Tweet, published June 25, 2020, perma.cc/TE9S-G2C8.

38. That is, by not processing visas now, the State Department is ensuring that there will be an enormous backlog of applications pending. Given resource limitations, it will take many months, if not a year or more, for the State Department to clear this backlog if it resumes visa operations in January 2021. The result will be massive delay of individuals obtaining their visas, including J-1 visas which will have a devastating impact on Intrax, on all J sponsor organizations, and on cultural exchange as a whole.

39. But for the delay of visa processing and issuance, Intrax would currently be working with employers of work travel participants who have needs during the winter months. For example, ski resorts often work with cultural exchange participants in the winter. While these individuals would usually enter the United States in November or December, Intrax would currently be working with some of its ski resort partners and other winter resorts for J-1 placements beginning on January 1, 2021, when the Proclamation is purported to end. Intrax would recruit individuals for these positions, and their processing and issuance of visas would proceed. However, because the State Department has almost entirely stopped processing J-1 visas, Intrax cannot even arrange for work travel participants to enter the United States on January 1, 2021. That harm is caused immediately by the State Department's decision not to process visas. If the State Department began processing visas, we would immediately recruit J-1 participants to enter on January 1, 2021. That would earn revenue for Intrax, and it would allow us to return some employees to work from furlough. Thus, the State Department's decision to suspend the processing of J-1 visas is causing Intrax substantial lost revenue, and that revenue cannot be recouped. Once time elapses, that opportunity for revenue is forever gone.

40. This delay in obtaining J-1 visas will lead to fewer individuals entering the United States with Intrax programs. This will cause a direct and irreversible loss of revenue to Intrax.

41. Additionally, individuals outside the United States may choose from among many countries across the world to pursue cultural exchange opportunities. Both the Proclamation, and additionally the visa delay caused by the State Department action, will cause many individuals to decline a cultural exchange program in the United States and instead pursue a program in another country abroad. Once the individual commits to other programs, that individual will be forever lost

as a participant in a U.S. J-1 program. For Intrax, that individual will represent irreparable loss of revenue for the company. For our country the loss is even more profound and immeasurable.

42. In fact, I am aware that many of the talented young people who would have participated in a cultural exchange program via Intrax are now pursuing similar opportunities in countries like Canada and Australia. The loss to Intrax—and the Nation as a whole—by individuals choosing to pursue cultural exchange experiences elsewhere is irreparable.

43. If the Proclamation's entry ban ends on December 31, 2020, Intrax will suffer severe and irreversible economic harm, but will likely be able to continue operating in some form. If the ban extends into 2021, Intrax likely will not survive.

I declare under penalty of perjury that the foregoing is true and correct.

Marcie Schneider

Dated: July 30, 2020
San Francisco, California

MARCIE SCHNEIDER