How Do Restrictions on High-Skilled Immigration Affect Offshoring? Evidence from the H-1B Program

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Abstract

The decision to encourage or restrict high-skilled immigration has long been controversial. Advocates argue that high-skilled immigration is critical for firm competitiveness and innovation; critics argue that skilled immigrants displace native workers and drive down wages. The debate, however, has largely overlooked the secondary consequences of restrictions on high-skilled hiring of immigrants: multinational firms faced with decreased access to visas for skilled workers have an offshoring option, namely, hiring the foreign labor they need at their foreign affiliates. This paper documents the impact of restrictive high-skilled immigration policies on the globalization of high-skilled activity by US MNCs. I use a unique matched firm-level dataset of H-1B visas and multinational firm activity and two different identification strategies to examine three key questions about that impact. First, do restrictions on H-1B visas result in increased foreign affiliate activity? Second, how does any impact differ across firms and countries? Finally, do these restrictions also affect the location of innovative activity? Both strategies yield the same result: that restrictions on H-1B immigration caused increases in foreign affiliate employment at both the intensive (US multinationals employed more people at their foreign affiliates) and the extensive (US multinationals opened more foreign affiliate) margins. The effects are concentrated among highly H-1B-dependent firms and R&D-intensive firms operating in offshorable services sectors and the expansion of activity was concentrated in Canada, India, and China. Restrictions also caused increases in foreign affiliate patenting, suggesting that there was also a change in the location of innovative activity.

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1. Introduction

The question of the impact of immigration on the host country has long been controversial, but it has risen to the forefront of political debates in recent years. Unexpected political shifts such as the Brexit vote and the election of President Trump have been attributed to voter concern about the impact of immigration. While the debate surrounding low-skilled immigration has captured headlines in the US, high-skilled legal immigration – and particularly the H-1B visa program – has also been contentious. Critics of the H-1B program argue that skilled immigrants displace native-born workers and drive down their wages.[1] Indeed, H-1B rejection rates have more than tripled since President Trump signed the Buy American and Hire American Executive Order[2] in early 2017.[3] However, business leaders have decried both these recent measures and long-standing restrictions on high-skilled immigration, arguing that the shortage of workers with specialized skills has negatively affected the competitiveness and innovation of high-tech firms and of the US economy.[4]

Policy debates like these have spawned an extensive academic literature evaluating the claims of each side. The debate, however, has largely overlooked the secondary consequences of restrictions on high-skilled hiring of immigrants: multinational firms faced with decreased access to visas for skilled workers have an offshoring option, namely, hiring the foreign labor they need at their foreign affiliates. Despite the implications of such an option, to the best of my knowledge, no paper has examined whether the offshoring of jobs and innovative activities is a consequence of restricting skilled immigration flows. If US multinationals use this option in response to restrictive H-1B policies – as their public statements suggest[5] - then such restrictive migration policies are unlikely to have the desired effects of increasing employment and earnings of high-skilled natives, but rather have the effect of offshoring high-skilled jobs.

This project directly examines the impact of restrictive high-skilled immigration policies on the globalization of high-skilled activity by US multinational companies (MNCs). I use a unique dataset that combines firm level data on

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[1] Richard Trumpka, the President of the AFL-CIO wrote that: "Clearly, high tech is not looking to bring in H-1B visa holders for a few years at a time because there is a shortage of tech workers. They want a massive expansion of H-1B visa holders because they can pay them less. This is not about innovation and job creation. It is about dollars and cents." https://www.usatoday.com/story/opinion/2013/05/28/h1b-visa-high-tech-workers-afl-cio-editorials-debates/2367769/ Critics like the AFL-CIO often cite the work of Hira (2010) and Matloff (2003).

[2] The Buy American and Hire American Executive Order directed four federal agencies – the departments of State, Labor, Justice and Homeland Security – to crack down on fraud and abuse of the H-1B and other work visa programs. In response, USCIS has increased H-1B inspections and commenced site visits of businesses employing foreign workers holding "specialized knowledge". USCIS also has significantly increased challenges and requests for more evidence.

[3] U.S. Customs and Immigration. Non-Immigrant Worker RFE Data. https://www.uscis.gov/sites/default/files/USCIS/Resources/Reports%20and%20Studies/Immigration%20Forms%20Data/BAHA/non-immigrant-worker-rfe-h-1b-quarterly-data-fy2015-fy2019-q1.pdf

[4] In Congressional testimony in 2008, Bill Gates warned that unless the U.S. expanded its H-1B program, it would be "at risk of losing its position of technological leadership".
Eric Schmidt, speaking at MIT's Computer Science and Artificial Lab, said that limits on the H-1B visa program "make it more difficult for U.S. companies to remain competitive." https://www.cnbc.com/2017/05/04/googles-eric-schmidt-h1b-limit-is-stupidest-us-policy.html

[5] Carbonite: "if [we] can't get them admitted to the United States, [we'll] staff up at Carbonite offices in Canada and Europe" https://www.bostonglobe.com/business/2017/04/02/tech-industry-talent-shortage-claims-under-new-scrutiny/EsxYnPpoKBNv1iTjRl6lLL/story.html
Amazon: "we are currently assessing alternatives that could include placement in countries other than the United States" https://www.geekwire.com/2017/trumps-immigration-crackdown-may-force-amazon-microsoft-shift-workers-canada/

H-1B visas and multinational firm activity to examine three key questions about that impact. First, do restrictions on H-1B visas result in increased high-skilled foreign affiliate employment? Second, how does any impact differ across firms, industries, and countries? Finally, do these restrictions also affect the location of innovative activity?

The data used in this paper are constructed by combining four different datasets: (1) the Bureau of Economic Analysis (BEA) annual surveys on US Direct Investment Abroad database, which contains detailed microdata on the financial and operating characteristics of both the US parent companies and their foreign affiliates, (2) H-1B visa microdata, (3) Labor Condition Application (LCA) data[6], and (4) US Patent and Trademark Office (USPTO) patent data. These data allow me to measure exactly how constrained each firm was as the cap grew more restrictive over time by comparing – at the firm-level – LCA requests (demand) and issued H-1B visas (realized supply), and how their foreign affiliate employment responded to these constraints. I analyze the impact of restrictions on H-1B visas on foreign affiliate activity using two identification strategies. The first exploits the 2004 drop in the H-1B visa cap, while the second exploits randomized variations in firm-level excess demand from the H-1B visa lotteries in high demand years. Both strategies yield the same result: that restrictions on H-1B immigration caused increases in foreign affiliate activity at both the intensive margin (US multinationals employed more people at their existing foreign affiliates) and the extensive margin (US multinationals opened more foreign affiliates). In particular, I find that – on average – about 0.3 jobs were offshored for every unfilled H-1B position. The effects are concentrated among highly H-1B-dependent firms and R&D-intensive firms operating in offshorable services sectors. The expansion of foreign affiliate employment has been largely concentrated in three countries: China, India, and Canada. Restrictions also caused increases in foreign patenting, suggesting that there was also a change in the location of innovative activity.

Two aspects of this paper are novel. First, this paper provides the first empirical evidence to support the hypothesis that restrictions on high-skilled immigration cause the offshoring of skilled jobs. While high-profile cases – like Microsoft's decision to open an R&D foreign affiliate in Vancouver[7] – have suggested that restricting skilled immigration flows could lead to the offshoring of jobs and innovative activities, this paper presents the first empirical work both proposing this hypothesis and examining whether this claim is indeed true. Second, it is the first paper to use a matched firm-level dataset of H-1B visas and multinational firm activity.

The results have important implications for understanding how multinational firms respond to artificial constraints on resources and how they globally re-distribute those resources. The findings of the paper also have important policy implications; the offshoring of jobs and innovative activities appear to be an unforeseen consequence of restricting skilled immigration flows. Even if H-1B immigrants displace some native workers, any 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.

[6] Labor Condition Applications are the first step towards H-1B visas for skilled foreign-born workers in the U.S.
[7] "Microsoft opens Canada center in response to US immigration problems." http://workpermit.com/news/microsoft-opens-canada-center-response-us-immigration-problems-20070710

2. The Effects of a Negative Foreign Labor Supply Shock on Offshoring: Literature Review

Highly-skilled workers are crucial and relatively scarce inputs into firms' productive and innovative processes. An increasingly high proportion of these workers – and particularly STEM workers – in the US were born abroad and immigrated to the US (Bound et al. 2014). This phenomenon has spawned an extensive literature on skilled immigration and a heated policy debate on the appropriate admissions levels of skilled immigrants. The literature has largely focused on the impact of high skilled immigration along three dimensions – (i) the impact on innovation, (ii) the impact on native workers' outcomes, and (iii) the impact on the source country (brain drain). [8] The policy debate has largely centered around these same three issues.

In this extensive immigration literature, there is surprisingly little focus on the role of the firm, as was noted in Kerr, Kerr, and Lincoln (2015).[9] The lacuna is particularly surprising in the U.S. literature, since applications for skilled immigration visas like H-1B and L1 visas are made by sponsoring firms. Fortunately, in recent years, a series of careful empirical papers have begun to address this gap. Ashraf and Ray (2017) and Wu (2017) consider the impact of high skilled immigration on firm innovation. Doran et al. (2016), Kerr, et al. (2015), and Mayda et al. (2017) examine the impact on firm structure and employment. Ashraf and Ray (2017), Ghosh et al. (2015), and Xu (2016) examine the impact on other firm outcomes.

However, while these papers have significantly contributed to our understanding of the impact of high-skilled immigration on firm outcomes, they have largely overlooked the multinational nature of many of these firms in their analysis. Multinationals (MNCs) are the leading employers of skilled immigrants, engage in the vast majority of formal innovative activities, and – unlike other firms[10] - have the option of responding to skilled immigration restrictions by offshoring their high-skilled activities. Branstetter, Glennon, and Jensen (2018) argue that skilled labor shortages in the past – a result of a large IT- and software-biased shift in innovation – did drive US MNCs abroad, and particularly drove them to locations with large quantities of STEM workers who possessed IT and software skills. High-skilled immigration provides another way of addressing this shortage, but an increasingly restrictive cap on H-1B admissions that began in 2004 reduced the ability of US firms to use this approach to meet their human capital needs. This line of thinking suggests that, to some degree, immigration and offshoring are substitutes.

[8] Studies of the impact on innovation and entrepreneurship include Chellaraj, Maskus, and Mattoo (2008), Wadhwa et al. (2007), Akcigit, Grigsby, and Nicholas (2017), Burchardi et al. (2019), Doran and Yoon (2019), Ganguli (2015) Agrawal et al. (2018), Borjas and Doran (2015b), Ghosh et al. (2015), Hunt (2011), Hunt and Gauthier-Loiselle (2010), Kerr and Lincoln (2010), Moser et al. (2014), Oettl and Agrawal (2008), and Wu (2017). Docquier and Rapoport (2012) provide an extensive review on the brain drain literature. Studies of the impact on native wages and jobs include Bound, Khanna, and Morales (2017), Turner (2017), Borjas (2005, 2003), Card (2009, 2001), Choudhury and Kim (2018), Doran et al. (2016), R. B. Freeman (2006), Friedberg 2001, Hayes and Lofstrom (2011), Hunt (2011), Kerr, William R Kerr, et al. (2015), Lowell (2001), Matloff (2003), Mayda et al. (2017), Mithas and Lucas (2010), Ottaviano, Peri, and Wright (2012), Peri et al. (2015), Salzman and Lowell (2007), and Tambe and Hitt (2009).

[9] Kerr, Kerr, and Lincoln (2015) provide a vivid example to support this, noting that in the 51 pages of Borjas (1994)'s classic survey of the economics of immigration literature, the word "firm" does not appear once.

[10] Unless they choose to internationalize.

Some recent papers in the international trade literature (Olney and Pozzoli 2018; Ottaviano, Peri, and Wright 2018; Ottaviano, Peri, and Greg C. Wright 2013) have indeed found that immigration and offshoring are substitutes at the multilateral level. These papers, however, largely consider the offshoring of manufacturing and immigration of all types of workers, as opposed to focusing on high-skilled immigration and high-skilled offshoring activity. Global production networks and global R&D networks are fundamentally different in how they operate however; while production has become highly dispersed around the world, most formal research and development and other high-skilled activities remain highly concentrated in a few firms' headquarters in only a few countries. This is at least in part due to substantial frictions in international collaboration (Argote, Mcevily, and Reagans 2003; Audretsch 1998; Patel and Pavitt 1991) that often require researchers to work in physical proximity; tacit knowledge is best transferred in person (Polanyi 1958, 1966; Singh 2008; Szulanski 1996; Teece 1977). In keeping with this, the globalization of R&D literature has long recognized that a central driver of globalized R&D is a host country's supply of human capital (Hall 2010; Serapio and Dalton 1999; Siedschlag et al. 2013; Thursby and Thursby 2006), while this is much less important for the offshoring of manufacturing. Hence, the degree to which offshoring and immigration are substitutes could look quite different for high-skilled tasks than for production activities.

There is one avenue through which offshoring and immigration could be complementary rather than substitutable, and this is at the bilateral level; hiring an immigrant of a given ethnicity can actually increase a firm's offshoring in that immigrant's country of origin through ethnic ties. Firms may utilize the expertise and networks of an immigrant when offshoring in that immigrant's country of origin (Arora and Gambardella 2005; Choudhury 2016; Choudhury and Kim 2018; Foley and Kerr 2013; Gould 1994; Hernandez 2014; Iriyama, Li, and Madhavan 2010; Kerr 2008; MacGarvie 2005; Saxenian 2006). They argue that ethnic ties facilitate the disintegration of innovative activity across borders and allow multinationals to more easily form new affiliates abroad. This hypothesis implies that a reduction in immigration from a given country could reduce offshoring, since it would make it more difficult for firms to set up new foreign affiliates there without the diaspora networks. [11] This argument is not necessarily incompatible with substitution at the multilateral level; Olney and Pozzoli (2018) find both that immigration substitutes for offshoring at the multilateral level and that it complements offshoring at the bilateral level. In other words, they find that while bilateral offshoring increases with immigration from the host country, it decreases with immigration from other countries.

In short, the sign and magnitude of the effects, if any, of high-skilled immigration restrictions on multinational foreign affiliate activity are still an open question.

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3. Overview of the H-1B Program

Firms have multiple ways in which they can hire foreign high-skilled workers: the H-1B, L-1, O, OPT, and TN visas are just a few examples.[12] The first is the most widely used and is the focus of this paper. The H-1B visa is a nonimmigrant[13] visa that enables firms to hire foreign workers in the US for a three-year period, renewable once for a total of six years. They make up about 50% of temporary work visas, and are used to employ foreign workers in "specialty occupations"[14] which typically means the individual must have at least a Bachelor's degree. Firm interviews conducted with the author suggest that U.S. firms typically use H-1B visas to hire international students at domestic universities.

There are five aspects of the H-1B program that are important in the context of this paper.

First, H-1B visas are tied to the firm, so it is possible to directly infer firm hiring responses to quantity constraints. Firms – not foreign workers – determine demand for H-1B visas. Legal and application fees are substantial; depending on the size of the company, the H-1B filing fee alone in 2017 was between $1,710-$6,460, not including the attorney fee.

Second, the H-1B application process is a two-stage process. This feature allows examination of both latent demand and realized supply. In the first stage, firms must file a Labor Condition Application (LCA) with the Department of Labor's Employment and Training Administration (DOLETA). This first stage measures demand. There is no limit – beyond cost – on the number of LCAs that a firm can file, so demand is measured independent of whether an H-1B is ultimately issued or not. In the second stage, after the LCA is approved, the firm must file an I-129 petition with USCIS, which makes the ultimate determination about the visa application. Constraints imposed by the H-1B cap are imposed in the second stage, where the final decision is made, so this stage measures realized supply. The two-stage structure of the H-1B application process allows me to measure exactly how constrained each firm was as the cap grew more restrictive over time by comparing – at the firm-level – LCA requests (demand) and issued H-1B visas (realized supply).

The next two features provide sources of identification from an econometric point of view.

Third, variations in the cap on H-1B visa supply provide a source of exogenous variation. The number of new H-1B visas that can be issued to private sector businesses has been subject to a cap since their inception in the

[12] I provide some discussion of other high-skilled visa alternatives in the appendix.
[13] They are called "nonimmigrant" visas because they allow those with H-1Bs to stay in the US only temporarily. However, they are also "dual intent" visas, which means that workers can reside in the US with a nonimmigrant status while simultaneously applying for permanent residency.
[14] According to USCIS, "to qualify as a specialty occupation, the position must meet one of the following requirements: (1) a bachelor's or higher degree or its equivalent is normally the minimum entry requirement for the position; (2) the degree requirement is common to the industry in parallel positions among similar organizations or, in the alternative, the position is so complex or unique that it can be performed only by an individual with a degree; (3) the employer normally requires a degree or its equivalent for the position; or (4) the nature of the specific duties is so specialized and complex that the knowledge required to perform the duties is usually associated with attainment of a bachelor's or higher degree."

Immigration Act of 1990. This cap is set by Congress and the President. Figure 1 plots the cap on the number of H-1B visas by fiscal year. The cap only applies to new H-1B visas issued to private sector businesses; there is no cap for the following categories: (1) those for non-profit firms, universities, and research labs, (2) those that are an extension of an existing H-1B visa, (3) those that have an existing H-1B visa and are changing jobs during the period of the existing visa, and (4) citizens of countries with whom the United States has a relevant free trade agreement.

There are three discrete phases of interest in terms of hiring constraints over time. The first phase is one in which the hiring constraint was not binding: throughout most of the 1990s, the cap was set at 65,000 visas and applications rarely outstripped supply[15]. Phase 2 began in 1998-2000, when the cap was increased to 195,000 visas by the American Competitiveness and Workforce Improvement Act of 1998 and the American Competitiveness in the Twenty-First Century Act of 2000 (AC21). During this period, the cap limits were never reached. Phase 3 occurred when trends in increasing visa availability reversed in 2004 and the cap reverted to the initial level of 65,000 visas, although 20,000 additional visas were granted to applicants with a graduate degree in 2006 (to a total of 85,000). Since then, the cap has not changed, and it has been (increasingly) binding in every year since 2004. Due to data constraints, this paper focuses on Phase 2 and 3.

The fourth relevant characteristic of the H-1B program from an econometric point of view is the random variation that is introduced by the process by which H-1B visas are distributed. H-1B petitions are distributed in a first-come-first-served fashion or by lottery in especially high demand years. The process is illustrated in Figure 2. On the first business day of each April, USCIS begins accepting H-1B applications from firms seeking permits that will count towards the following fiscal year. Since the H-1B visa program operates on a first-come, first-served basis, petitions are accepted until the cap hits, at which point no more petitions are processed. The end of the application period is demarcated by the "final receipt date", which is the date on which they receive enough applications to fill the remaining available permits under the cap. Any cap-subject petitions submitted after the final receipt date were automatically rejected. This date is announced by USCIS in a press release every year, and it varies every year, as shown in Table 1. On the date(s) that the available permits are exhausted, a computer-generated random selection process selects the petitions that will be processed. Firms have no way of knowing in advance what date the cap would be reached. The dates of the lottery are not announced in advance and are in fact unknown in advance; they are determined by the number of applications received on different dates. These dates are only made known to firms after the cap is reached. In April 2007 and 2008, USCIS received so many petitions within the first week that all cap-subject petitions were distributed by lottery for fiscal years 2008 and 2009. The lottery generated a random negative shock in the supply of foreign-born skilled workers to firms; the second empirical approach exploits the lottery-generated randomized variation from the H-1B visa lotteries in those two years, which allows for a causal interpretation of the effect of constrained foreign-born skilled worker supply on the offshoring of skilled jobs.

[15] Fiscal years 1997 and 1998 were the lone instances when the cap was reached.

The final relevant characteristic is significant for measuring demand. The timing of petitions can be used to reveal whether an application is for a cap-subject H-1B visa. As described above, the prerequisite to filing an H-1B petition with USCIS is obtaining an approved LCA from the Department of Labor. An LCA cannot be filed more than six months prior to the start of employment. In order to apply for a visa for the following fiscal year (beginning in October), one would expect that firm to file an LCA no earlier than April. Furthermore, an LCA is only valid for three years; the earlier the application submitted, the fewer months a foreign-born worker would be eligible to work. In short, without any restrictions on H-1B supply, one would expect all firms to apply for LCAs no earlier than April, and probably much later.

However, the rising demand for H-1B visas and the first-come, first-served nature of the distribution process changed firm behavior. Firms that needed cap-subject H-1B visas wanted to submit their petitions as early as possible (i.e. April) to ensure the submission would be before the final receipt date, which also meant the LCA application had to be submitted prior to April. Figure 3 illustrates the change in the timing of LCA applications; as demand for cap-dependent H-1B visas increased, LCA applications were filed earlier. This feature is relevant for determining which LCA applications were for cap-dependent H-1B petitions.

4. Data

I use a combination of four sources of data to generate a unique dataset that permits the analysis of the link between MNC hiring decisions, their US multinational innovative activity both domestically and abroad, and how they respond to high-skilled immigration constraints. The first dataset provides information about multinational activity, including employment and R&D expenditures. The second and third are particularly useful because they provide information about both the demand and the realized supply for foreign workers, because they consist of both H-1B visas issued to foreign-born workers at US firms, as well as those requested by US firms. The fourth dataset provides information about the innovative activity of the firms, as measured by patents.

4.1 Multinational activity data

The data that I use to examine multinational activity are firm-level data from the Bureau of Economic Analysis's (BEA) annual surveys on U.S. Direct Investment Abroad. BEA is under a congressional mandate[16] to track investment into and out of the United States, and as such, their data comprise the most comprehensive available data on US multinational activity abroad. Of particular importance is that the data includes foreign affiliate employment, which is the primary variable of interest for this paper. The data are confidential, and only accessible at a restricted site at the Bureau of Economic Analysis in Washington, DC.

[16] By the International Investment and Trade in Services Survey Act. The data are collected for the purpose of producing publicly available aggregate statistics on the activities of multinational enterprises.

I constructed a panel dataset of this activity from 1994 through 2014. [17] Each firm may report on a consolidated basis for multiple affiliates in the same country under certain conditions. [18] Therefore, rather than conducting analysis at the affiliate level, I aggregate all foreign affiliate activity up to the host country level for a given parent firm for a given year. The panel contains 2,263 firms with multinational activity.

4.2 H-1B Data

The second step of the data construction is to measure the firm-level hiring patterns of foreign-born workers. The source of the information is worker-level application records from the U.S. Department of Labor (DOL) and worker-level approved H-1B petition data from the U.S. Customs and Immigration Services.

Measures of firm-level demand for H-1B visas come from the DOL Labor Condition Application (LCA) data. Before a firm can file a petition with US Customs and Immigration Services (USCIS), they must file an LCA with the DOL.[19] There is no limit (other than financial constraints) on the number of LCAs that a firm can file. The primary purpose of the LCA is for employers to attest to the employment details of H-1B applicants and affirm that the worker will be employed in accordance with U.S. law. [20] This data set comprises 6.4 million records between 2001 and 2016, which I aggregate by employer-year and then link to the BEA data.

The LCA data do not contain information on which applications are for H-1B visas that would be cap-subject. This does not matter for the first empirical strategy, but for the second strategy, in order to measure excess demand due to H-1B cap constraints, I infer whether a given LCA application is for a cap-subject H-1B visa by looking at the date of the LCA application. I assume that any LCA filed between January and April with a work start date 5-6 months in the future represents demand for a cap-subject H-1B visa for the following fiscal year. Any LCA filed according to a different timeline thus represents demand for non-cap-subject H-1B visas.

Measures of realized H-1B labor supply come from I-129 H-1B visa applications, obtained by FOIA request. These data are used in the second identification strategy. The original dataset contains I-129 petitions from fiscal years 2004-2014[21], consisting of about 3.3 million petitions, with information on the final decision regarding each petition, the type of visa being requested, the beneficiary's country of birth, the employer name and location, the job

[17] The most extensive data are collected in benchmark years: 1994, 1999, 2004, 2009, AND 2014. The reporting requirement threshold varies by year, size of the affiliate, and the parent's ownership stake. BEA estimates values of some variables of some affiliates in non-benchmark years in order to estimate a consistent universe across years. I only use the reported data in this paper.
[18] These conditions are that the affiliates operate in the same country and same industry classification or are integral parts of the same business operation.
[19] These applications have been made publicly available by the DOL since 2001, and contain information on the employer's name and address, the occupation code of and the wage offered to the worker, and the geographic location of employment for the position to be filled by the visa recipient.
[20] There are four main labor conditions that they are required to meet: (1) recipients of the visa must receive the same or better wages and benefits as other similar company employees and as similar employees in the geographic area, (2) working conditions must be similar for all employees, (3) there must not be a "strike, lockout, or work stoppage" at the employment location when the LCA is signed and submitted, (4) any employee bargaining representatives must be notified of every application submitted.
[21] Not all cap-subject petitions that were rejected by USCIS are included.

code, compensation, and other administrative details. An I129 form is needed for many types of visas, but for the purpose of this paper, the most relevant is the H-1B visa.

Not all H-1B visas were affected by the cap. To identify the visas that were constrained, I first remove (1) those for non-profit firms, universities, and research labs, (2) those that are an extension of an existing H-1B visa, (3) those that have an existing H-1B visa and are changing jobs during the period of the existing visa, and (4) citizens of five countries that were effectively exempt from H-1B limits due to bilateral trade agreements (Australia, Canada, Chile, Mexico, and Singapore). Second, I remove petitions that were submitted after April (the month of the lottery); the cap was reached in April. Finally, I focus on petitions submitted for fiscal years 2008 and 2009 – the two years of the lottery. The remaining petitions comprise the realized H-1B labor supply among cap-dependent petitions. Excess demand for foreign labor due to H-1B restrictions can thus be measured by subtracting realized cap-dependent H-1B petitions from cap-dependent LCA applications.

An examination of the heterogeneity of H-1B petition filings by firm, industry, and country provides some intuition regarding which types of firms might be most impacted by H-1B restrictions, and where the expansion of foreign affiliate activity might be expected to take place. Figures 6 and 7 show the country and industry breakdowns of H-1B petition filings in 2017 and illustrate that the median H-1B visa petition is for an Indian worker in a computer-related occupation. Computer-related occupations accounted for 69% of H-1B petition filings in 2017, and 85% of H-1B petition filings were for workers from India or China. These results suggest that the firms most impacted by constraints on H-1B visas would be firms dependent on computer-related workers. They also suggest that I might expect to see large increases in foreign affiliate employment in India and China. Finally, Figure 7 shows the top 30 H-1B petition filing firms in FY 2016 and illustrates that there is also significant skewness in H-1B visas across firms; this suggests that a non-linear approach may be appropriate. Note that these are not all US multinational companies; the sample of firms in my analysis is somewhat different. Specifically, my data include US multinational firms only. They do not include US domestic firms, foreign multinational firms, or the Indian outsourcing firms who are the largest H-1B applicants in the US. The importance of this distinction is illustrated in Figure 8; based on median compensation alone, Indian outsourcing companies hire a very different set of workers than US multinational firms.

4.3 Patent Data

The final source of data can be used to measure the potential impact of visa restrictions on innovation. The data are constructed from US Patent and Trademark Office (USPTO) patent data and includes all utility[22] granted patent applications through 2017. Following the literature, I consider the patent inventors' country of residence as the country where an innovation takes place, and I consider a patent as having originated from a foreign country if the

[22] There are three types of patents: utility patents, design patents, and plant patents. Utility patents cover inventions that have a useful and specific function and make up the majority of all patents. Language referring to a patent typically refers to utility patents. Design patents protect aesthetic appearance, while plant patents are for the discovery or invention of plants that are asexually reproduced.

majority of its inventors list their address as from that country.[23] I use this dataset to help understand how restrictions on high-skilled immigration flows have affected both the levels of and location of multinational innovative activity.

4.4 Final Dataset

The final dataset is at the firm-country-year level and contains 2,263 multinationals. Of the 2,263 multinationals, 28% filed at least one LCA in 2001, 29% applied for at least one USPTO patent, and 15% both had at least one LCA application in 2001 and had at least one USPTO patent at some point. Summary statistics are shown in Table 2.

5. Empirical Approach and Results

This section describes my estimation framework; I use two identification strategies. The first exploits the 2004 drop in the H-1B visa cap, while the second exploits randomized variation from the H-1B visa lotteries in high demand years. The results yield the same qualitative result and strongly support the hypothesis that restrictions on high skilled immigration cause increased foreign affiliate employment. Although the specifications below primarily use foreign affiliate employment as the dependent variable, I also examine the effects on foreign affiliate patenting.

5.1 Identification Strategy 1: Exploiting the 2004 policy change

The identification in this strategy is based on a plausibly exogenous shock to high-skilled immigration supply: the sharp reduction in the annual H-1B cap in fiscal year 2004, shown in Figure 1. As described in the "Overview of the H-1B and L-1 Visa Programs" section, the cap was not binding in the years leading up to the reduction (1998-2004) but has been binding in every year since 2004.

My empirical specification can be interpreted as a difference-in-difference estimator – similar to that used in Ashraf and Ray (2017), Ghosh et al. (2015), Kerr and Lincoln (2010), and Xu (2016) – where the treatment and control groups are categories of firms with different levels of H-1B dependency in 2001 (when the cap was not binding) and the treatment is the reduction in the annual H-1B cap in 2004. In other words, the difference-in-differences approach relies on pre-existing variation in demand for foreign-born skilled workers to identify how exogenous constraints in supply affected foreign affiliate employment. Accordingly, the regression compares the change in foreign affiliate employment before and after the policy change across multinationals, within the same industry and country, that were more dependent on H-1B visas prior to the policy change (the "treatment" group) and less dependent firms prior to the policy change (the "control" group). Figure 4 provides a graphical version of the strategy, and shows that while foreign affiliate employment growth for non-H-1B dependent firms remained

[23] My results are robust to multiple measurement methods: using the first inventor on a patent to identify location, to excluding all patents with a US inventor on them, and to identifying a patent as belonging to a given country if any inventor's address is there.

fairly flat after the policy change, extremely H-1B dependent firms experienced rapid growth in foreign affiliate employment after the policy change. Furthermore, the trajectory of foreign affiliate employment growth of both types of firms remained parallel and quite flat prior to the policy change. The regression results confirm the associations in the raw data presented in Figure 4.

In the baseline specifications, H-1B dependency is defined as the total LCA applications for a given multinational divided by that multinational's US employment in 2001, as in Kerr and Lincoln (2010) and Xu (2016). The dependency measure is calculated in a pre-policy year to help address the problem of reverse causality. The dependency measure is my preferred metric because it measures demand for H-1B visas, and it is measured independent of whether an H-1B visa is ultimately issued or not. Furthermore, because of the high cost of application, the dependency measure can be seen as reflecting real measured demand. Finally, the dependency measure closely mirrors DOL's own measure of H-1B dependency, namely: "The determination as to whether an employer is H-1B dependent is a function of the number of H-1B nonimmigrants employed as a proportion of the total number of full-time equivalent employees employed in the United States."[24]

The regression specification is as follows:

$$\Delta\, ln\left(FA\_emp_{ic,t-2001}\right) = \alpha_j + \alpha_c + \beta_1 \left(\frac{LCAapps}{US\_emp}\right)_i^{2001} + \Delta\epsilon_{ic,t-2001}$$

where *i* indexes the firm, *j* indexes the industry, *c* indexes the country, and *t* is a post-policy year. *FA_emp* is foreign affiliate employment in country *c* by firm *i*, *LCAapps* is the measure of demand (the number of LCA applications) by firm *i* in pre-policy year 2001, *US_emp* is a multinational's employment in the US in pre-policy year 2001, and α_j and α_c capture industry (NAICS 4-digit level) and country time trends respectively. All standard errors are clustered at the firm level. The dependent variable is the logged differenced foreign affiliate employment of firm *i* in country *c*, between year *t* and a pre-policy year (2001). The measure of foreign affiliate employment is not the ideal measure; I am interested in the substitution of high-skilled immigrants for high-skilled foreign affiliate employment. However, the BEA data does not allow for this breakdown. This suggests that, if anything, the regression estimates are smaller than the true effects. I expect β_1 to be positive in post-policy change years (2005-2014) and null in pre-policy change years (2002-2004). After the 2004 reduction in the H-1B cap, firms that were more dependent on H-1B visas should be more affected by the policy change and therefore more likely to expand their foreign affiliate activity. Before the 2004 cap change, any pre-existing variation in demand for foreign-born skilled workers, as measured by H-1B dependency, should not be correlated with foreign affiliate employment growth.

The results are shown in Table 3, where each column represents a long difference between 2001 and a later year. The results provide evidence that there were no existing pre-trends in the differences in foreign affiliate

[24] Labor Condition Application for Nonimmigrant Workers. ETA Form 9045CP – General Instructions fot he 9035 and 9035E, U.S. Department of Labor. https://icert.doleta.gov/library/ETA_Form_9035CP_2009_Revised_03.18.09.pdf

employment growth that correspond with the measure of H-1B dependency; β_1 is not statistically significant until 2005, the first year after the policy change. The results also show that firms that were one percentage point more H-1B dependent than average saw a 3-8% larger increase in foreign affiliate employment than average, as a result of increased immigration restrictions resulting from the 2004 cap drop. Since the average foreign affiliate in 2001 had 1,151 employees, the estimated effect at the mean is thus an increase of 35-90 employees at every foreign affiliate. Of course, since the measure of foreign affiliate employment is not the ideal measure, and I am interested in the substitution of high-skilled immigrants for high-skilled foreign affiliate employment[25], the regression estimates are likely smaller than the true effects.

There are two empirical issues that arise in this estimation strategy that need to be considered.

First, the approach requires that pre-treatment trends in foreign affiliate employment (and other outcomes of interest) were the same for the treatment and control groups (the parallel trends assumption). If one looks simply at how the level of foreign affiliate activity differed between our treatment and control groups, it is apparent that firms that filed more LCAs in 2001 were not identical to firms with fewer LCAs. For example, firms that filed large numbers of LCAs tend to do more R&D abroad but have fewer employees abroad. However, the difference in levels is not in of itself problematic for my specification; the threat to identification would be if my measure of H-1B dependency were correlated with pre-treatment changes in foreign affiliate employment.

To test for this possibility – whether the growth in foreign affiliate employment was different across the two groups – I regress the logged change in foreign affiliate employment in a pre-treatment period (1994-1999) on the same 2001 measure of H-1B dependency, with both industry and country fixed effects as before. Table 4 shows no evidence of a systematic relationship between H-1B dependency and changes in foreign affiliate employment prior to the policy change.

A separate test controls for the 1994-1999 pre-trend in the baseline specification. These results are shown in column two of Table 5, with the baseline results shown in column 1 for the purpose of comparison. The coefficient of interest gets slightly smaller, but remains positive and statistically significant, and hence lessening any concerns about endogeneity.

The second is that results may be driven by systematic growth rate differences across firms of different size, internationalization, or innovativeness to begin with. If, for instance high-patenting firms naturally expand their activity abroad more quickly than non-patenting firms, even within the same industry, then my results could reflect that correlation rather than the effect of the policy change. I therefore tested whether the coefficient of interest changes when including controls for the size or type of firm in terms of their 2001 employment quantile, in terms of their 2001 sales quantile, in terms of their 2001 R&D spending quantile, in terms of their 2001 total patenting quantile, and in terms of the number of foreign affiliates quantile in 2001. These controls are included as group fixed effects. The identification in these regressions, once various controls are added, is now based on the comparison of

[25] The BEA data does not provide that level of detail.

trajectories within the same industry and the same category of employment size or sales size or R&D size or patenting amount or degree of internationalization, depending on the control. Column 3 of Table 5 represents the results of a specification that contains indicators for each firm's 2001 patenting quantile; the other results can be requested separately but show the same result, which is that the main results remain qualitatively unaffected.

Exploring Firm and Country Heterogeneity

This section examines what types of firms responded most to restrictions on high-skilled immigration flows. Multinational firms differ in their strategic needs and capabilities; these sources of firm heterogeneity will affect how different firms respond to legal restrictions on migration. I examine four sources of firm heterogeneity: R&D intensity, software-orientation, offshorability, and H-1B dependency. I also explore the sensitivity to the model specification. Finally, I examine host country heterogeneity: particularly focusing on differences between countries which possess the necessary raw human capital (such as India) versus countries where it is easy to make use of foreign affiliates with easy access to foreign born workers (such as Canada[26]).

I begin by examining firm's R&D intensity, since I expect that the firms most responsive to restrictions on high skilled immigration would be firms that conduct high-skilled activity and are reliant on high-skilled human capital to do so[27]. Column 4 of Table 5 shows the results of the same baseline regression run on firms that were in the top 20% of R&D-intensive firms in 2001. I find that the coefficient is larger than on the entire firm sample suggesting that the results are driven by the firms conducting high-skilled activity, as expected.

I follow this by examining the importance of the H-1B program for firms that hire computer-related occupations, since Figure 6 showed that computer-related occupations account for the vast majority of H-1B petition filings. Specifically, I look at firms that patented extensively in software, where software patents are defined in the same way as Arora, Branstetter, and Drev (2013) and Branstetter, Drev, and Kwon (2018).[28] As expected, the coefficient of interest is larger than on the entire firm sample.

I also examine in more detail those industries where offshoring is a viable substitute for immigration. As expected, if I restrict the sample to firms that operate within the most offshorable services sectors, [29] the results are even more striking; the coefficient nearly doubles.

[26] Much has been made anecdotally of Canada as a destination for firms struggling with immigration constraints in the United States. See, for example, the Envoy 2019 Immigration Trends Report, where 38% of surveyed firms were thinking about expanding to Canada because their immigration policy is more favorable, and 21% already had at least one office there.
[27] Where R&D intensity is measured as the ratio of R&D spending to sales.
[28] Branstetter, Drev, and Kwon (2018). This methodology uses a set of keywords (e.g. "computer program" or "software") associated with software-based technologies as defined by Bessen and Hunt (2007) to define one set of patents as software, and uses a narrow set of IPC categories as defined in Graham and Mowery (2003) to define another set. The final population of software patents is defined as the union of these two sets of patents. I define the software intensity of a firm as the software stock of all USPTO citation-weighted patents applied for by that firm (in any location) by 2001. Here, I restrict to the top quartile of software-patenting firms.
[29] As defined in (Jensen and Kletzer 2010). It includes industries such as software publishing and scientific research and development services.

Of course, the relationship between growth in multinational foreign affiliate employment and the share of H-1B workers might be nonlinear, as suggested by the skewness in applications shown in Figure 7. I use a non-parametric approach to examine this possibility: I divide multinationals into groups according to their H-1B dependence in 2001. I create 7 categories of multinationals, where the base category is all multinationals with zero LCA applications, and the remainder are divided into five quantiles, with the top category divided into two groups. Again, I expect positive coefficients with especially large coefficients on high-dependency multinationals, and Column 5 of Table 5 shows exactly that pattern. In particular, I find large, positive, and statistically significant coefficients for the top bracket (with an LCA application-US employment ratio of at least 0.0158 in 2001). In other brackets, there is no statistical significance. These estimates suggest that the positive effect of H-1B restrictions on foreign affiliate employment is being driven by the heaviest users of H-1B visas.

I also explore country heterogeneity. The largest countries of origin for H-1B visa holders are China and India – as shown in Figure 5 – while many of the prominent examples of companies opening foreign affiliates abroad in response to H-1B restrictions are concentrated in Canada[30]. Canada is a special case for US firms; cities like Vancouver and Toronto are geographically close to Silicon Valley and other multinational headquarters, but Canada has much less restrictive high-skilled immigration policies than the US. These characteristics mean that the fixed costs of offshoring are relatively low. These facts suggest that the expansion of foreign affiliate activity could operate through two channels: (1) a direct channel, whereby multinationals expand foreign affiliate activity in countries where the raw human capital they need is located (e.g. India or China), or (2) an indirect channel, whereby multinationals expand foreign affiliate activity in countries like Canada where it is easy to open foreign affiliates housing immigrants from other countries. Canada is also a special case due to geographic proximity. To test the relative effects, I construct two samples, one of foreign affiliates in China and India (the "raw human capital" countries), and one of foreign affiliates in Canada. This approach is an imperfect way of measuring direct and indirect flows, but it does provide some sense of the possible operational channels. The effects are statistically significant, positive, and larger than the base sample for both subsets but they are stronger for the "raw human capital" countries sample, suggesting that the expansion of foreign affiliate activity operates more through the direct channel, but that both channels are relevant.

An Alternate Specification

An alternative to a series of cross-section long differenced regression specifications is a more traditional differences-in-differences regression approach on the full 1994-2014 panel dataset, as follows:

$$\ln(FAemp_{ict}) = \alpha_c + \alpha_i + \alpha_t + \beta_1 H1BDep_i * policy_t + \epsilon_{ict}$$

As before i indexes the firm, c indexes the country, and t indexes the year. FAemp as before is foreign affiliate employment. *Policy* which also is a dummy variable, equal to one if it is 2004 or later, and zero otherwise. This is interacted with H1BDep, which is defined in one of two ways. The first is the same continuous measure as before

[30] http://www.talenteconomy.io/2017/06/19/tighter-immigration-policy-pushes-firms-open-foreign-satellite-offices/

(LCA applications/US employment in 2001), while the second is a new variable equal to one if the firm was in the top group of H-1B dependency[31] in 2001, and zero if the firm had zero LCA applications in 2001. The main advantage of this specification is that we can include firm fixed effects. Column 1 of Table 6 shows the results of the continuous version, while column 2 shows the results of the binary version. Both are statistically and economically significant, and the coefficient in the continuous case is similar to those observed in the long-differenced version. The coefficient in the binary version tells us that the 2004 policy change caused highly H-1B dependent firms to increase their foreign affiliate employment by 27% more than a non-H-1B dependent firm.

Extensive Margin

The results thus far show the effect of immigration restrictions on foreign affiliate employment at the intensive margin; because foreign affiliate employment is logged, this measure only captures the change in employment at foreign affiliates that existed in both 2001 and the later post-policy period. It does not capture the effect of any foreign affiliates that were opened after the policy change in response to the policy. Both effects are of interest here. To measure the extensive margin effect, I use the same long differenced regression specification, but I change the dependent variable to a binary variable equal to one if the firm has a foreign affiliate in a given country by the post-policy year and equal to zero otherwise. I use a linear probability model so that I can include time trends, but the results are robust to a logit model. Column 1 of Table 7 shows that that the 2004 cap decline made a one percentage point more H-1B dependent firm 0.2% more likely to open a new foreign affiliate than the average firm by 2013.

Column 2 shows the same regression specification, but instead examines the likelihood of a multinational initiating R&D activity abroad. Here, the coefficient is slightly larger, as expected, since one would expect skilled immigration restrictions to affect the opening of an R&D lab, but not necessarily to affect the opening of a new manufacturing facility.

The coefficients in Columns 1 and 2 are fairly small, even if they are statistically significant. This is in large part due to the preponderance of zeros in the data; the average US multinational in the BEA data is active in about two countries, while the dataset includes 50 countries. To counteract this noise, Column 3 shows the same regression but for a subset of the 25 countries with the most activity in the data, and with the binary version of the independent variable. As expected, the coefficients become substantially larger. The results show that the 2004 cap decline made highly H-1B dependent firms 6% more likely to start conducting R&D in a new country than a non-H-1B-dependent firm.

In combination, these results show that immigration restrictions had an economically and statistically significant effect on offshoring, both on the intensive and extensive margins. But the effect is not spread throughout all firms; the firms that responded most strongly were firms that (1) were R&D-intensive, (2) operated in industries where services could be easily offshored, and (3) depended heavily on H-1B visas prior to the restrictions taking place. The

[31] Measured in the same way as in the earlier non-linear specification.

effect is also not geographically spread out; Canada, China, and India have seen the largest expansion in US multinational foreign affiliate employment.

Additional Robustness Checks

I implement several additional robustness checks. First, I use 2002 as the base year instead of 2001. Second, instead of normalizing the number of LCA applications by US employment as the H-1B dependency measure, I use the number of LCA applications. Third, I run regressions excluding India, and excluding Canada, to ensure that the results are not being driven by just one country. The results are robust to all of these robustness checks.

The Effect on the Location of Innovation

While the primary focus of this paper is to measure the impact of restricting high-skilled immigration flows on foreign affiliate employment, I also examine the effect on the location of innovation, using the same identification strategy outlined above. This is particularly important for understanding the policy relevance of the finding that skilled immigration restrictions led to the offshoring of jobs; if the jobs being offshored were high-skilled R&D jobs, then the knowledge spillovers from corporate R&D also shifted location, and we should be able to observe whether there was an actual change in the location of innovation by observing firm patenting. If on the other hand, firms simply restructured their R&D activities and shifted some jobs abroad while keeping the most R&D-intensive jobs in the US, then one would not see any observable change in the location of firm patenting, and hence would be less concerned about the change in the geographic location of spillovers.

To examine the effect of visa restrictions on the location of innovation, I use two different dependent variables: (1) foreign affiliate R&D spending, and (2) patent counts from foreign affiliate locations. In the second instance, this is measured using the inventor addresses listed on the patent. As with foreign affiliate employment, I expect the effect to be positive for either of these dependent variables; innovation should follow the human capital critical to its processes. The earlier results above showed that there was a shift in the location of innovation on the extensive margin side; US multinationals began conducting R&D at more foreign affiliates in response to the H-1B restrictions. The intensive margin results are mixed. In terms of foreign affiliate R&D, there is no statistically significant effect for most years. However, the results on patent counts show a positive and statistically significant effect when I run the following specification:

$$PatCount_{ict} = \alpha_c + \alpha_i + \alpha_t + \beta_1 H1BDep_j * policy_t + \epsilon_{ict}$$

This is the same H-1B dependency measure as used in all the prior regressions up to this point. $PatCount_{ict}$ is the count of patents originating from country c in time t by firm i. I designate a patent as originating from a country based on inventor addresses; if the majority of inventors list the address of a given country, then the patent was invented there. Table 8 shows the results. The first column shows a fixed effects negative binomial model; the sparsity of patent counts and their long right tail makes negative binomial more appropriate than OLS in some cases. The second column shows a standard OLS model with patent counts as the dependent variable. And the third

column provides an inverse hyperbolic sine transformation of patent count data[32] to combat the sparseness and skewness of patent data. All three variants find the same result, that increased H-1B restrictions caused an increase in foreign affiliate innovative activity, suggesting a shift in the location of innovation. The results translate into about 370 more patents originating from foreign affiliates as a result of the policy change, just for highly H-1B dependent firms.

Effect on the Share of Activity Abroad

The analysis above aimed to establish that the level of foreign affiliate employment and the level of foreign affiliate patenting increased in response to skilled immigration restrictions. However, it did not establish whether the share of foreign affiliate employment and the share of foreign affiliate patenting increased. In other words, did US multinational firms simply increase their foreign affiliate activity while also increasing their domestic activity, or was there a shift in the location of their employees and innovative activity? An increase in the share of activity abroad in response to restrictions on skilled immigration would provide even stronger evidence in support of a substitution effect.

I use a panel difference-in-differences regression approach similar to those used in the analysis above to address this question:

$$Share_{ict} = \alpha_c + \alpha_i + \alpha_t + \beta_1 H1BDep_j * policy_t + \epsilon_{ict}$$

where $Share_{ict}$ is either the share of firm *i*'s employment in country *c* in time t relative to firm i's total employment, or firm *i*'s patenting in country *c* and time *t* as a share of firm *i*'s total patenting. The H-1B dependency measure is the same measure as used in all prior regressions up to this point and can be shown in either continuous or binary form. Table 9 shows the results when the dependent variable is the share of employment, and Table 10 shows the results when the dependent variable is the share of patenting. Both tables show the same qualitative result: that while on average there is no clear evidence of any shift in the share of employment and patenting, when the sample is constrained to those countries where the expansion of activity as a direct response to skilled immigration restrictions was concentrated, there was a clear shift towards those countries. US multinationals appear to have increased the share – not just the levels – of their total employment and patenting to three main countries: Canada, India, and China.

Estimation Issues

The main threat to identification comes from any shocks correlated with both the timing of the H-1B policy and its effects across firms. In particular, the tech bubble in the late 1990s and early 2000s may have been correlated with increases in the cap. After the bubble burst, the H-1B visa cap was higher than average and the economy experienced a downturn. To the extent that the recession particularly affected H-1B dependent firms, the estimates

[32] The natural log transformation commonly applied to highly skewed variables is not appropriate for patent counts, because there are large quantities of zeros and ln(0) is undefined. In contrast, the inverse hyperbolic sine (IHS) transformation deals with the skewness without dropping observations. The inverse hyperbolic sine transformation is defined as: log(yi+(yi2+1)1/2. Except for very small values of y, it can be interpreted in the same way as a standard logarithmic dependent variable.

could be biased. The direction, however, is unclear. They may have been more likely to increase foreign affiliate activity to escape the recession in the US, which would lead to upward bias, or they may have been more likely to shrink their firms, which would lead to a downward bias. However, the robustness of the results to the inclusion of industry time trends in all regressions suggests that this is not problematic; any unobserved demand shocks for highly skilled workers would need to vary across firms within the same industry for there to be any bias.

A separate concern surrounds the parallel trends assumption and any anticipation of the cap decline; namely, did firms behave differently leading up to the policy change in anticipation of soon experiencing immigration constraints, and did these behavioral differences correlate with my constructed measures of H-1B dependency? Figure 4 does not show any clear change in trends prior to 2004, and more rigorous tests, shown in Tables 3-5, further support the case that firms did not change behavior in advance. There is also qualitative evidence to suggest that firms did not change behavior in advance; an immigration lawyer told the author in discussion surrounding this policy change that: "my clients weren't expecting it…and keep in mind that at that time, the cap wasn't being met…[the firms thought that even if] the cap is not increased…who cares, we don't meet it anyway."

Both concerns are further ameliorated by the results of a second identification strategy, which does not suffer from the same sources of potential bias and yet produces consistent results.

5.2 Identification Strategy 2: Utilizing the Random Lottery Feature of the H-1B Application Process

The difference-in-differences approach relies on pre-existing variation in demand for foreign-born skilled workers to identify how constraints in supply – induced by a change in the cap – affected foreign affiliate employment. It is unable, however, to measure the precise constraints firms faced as the cap grew more restrictive. I therefore also take another approach that does measure exactly how constrained each firm was as the cap grew more restrictive over time by comparing – at the firm-level – LCA requests (demand) and issued H-1B visas (realized supply). A feature of the H-1B allocation system – the lottery – allows for a causal interpretation of the effect of constrained foreign-born skilled worker supply on the offshoring of skilled jobs.

The identification in this strategy exploits random variation in the allocation of H-1B workers across U.S. multinational firms resulting from the H-1B lotteries of 2007 and 2008. In both of those years, the number of cap-dependent H-1B visa petitions submitted within the first month of the filing period far exceeded the annual limit of available permits in those years, as shown in Table 1. In those years, all petitions received by the final receipt date (April 3 and April 8 respectively) were put through a computer-generated random selection process that selected which petitions would be processed. This produced a random shock to the supply of H-1B workers; some firms were successful in the lottery, while others were not. My approach exploits this random H-1B variation.

The dependent variable in this approach is the same as the differences-in-differences approach: the change in foreign affiliate employment. However, instead of regressing the change in foreign affiliate employment on a measure of the firm's pre-policy-change H-1B dependency, I regress it on a measure of excess demand for foreign

labor that is driven by exogenous supply shocks. Following Peri, Shih, and Sparber (2015a), I calculate excess demand as the difference between the firm-level demand for new H-1B workers (LCA applications that were filed early) and the firm-level capped supply of H-1B workers (the lottery allocation of permits). I scale this absolute measure of excess demand by the firm's US-based employment in 2007; an equivalent number of H-1B permits denied to two firms will represent a much larger shock for firms with few workers in the US as opposed to for firms with many workers in the US.

There are two mechanisms at work in this approach, both generating variation in normalized excess demand across firms. The first is the same mechanism at work in the differences-in-differences approach: firms that are more H-1B-dependent will feel the effects of H-1B supply constraints more acutely than those that do not hire many H-1B workers. The second is the unexpected supply shock coming from the lottery.

I regress the change in foreign affiliate employment growth between a pre-lottery year (2005) and a post-lottery year (2010-2014) on the firm-level excess demand in the two lottery years combined (2007 and 2008), as shown in the following regression specification:

$$\Delta \ln\left(FA\_emp_{ic,t-2005}\right) = \alpha_j + \alpha_c + \beta_1\left(\frac{ExcessDemand_i^{2007+2008}}{US\_emp_i^{2007}}\right) + \beta_2 LCA_i^{07+08} + \Delta\epsilon_{ic,t-2005}$$

where as before, *i* indexes the firm, *j* indexes the industry, *c* indexes the country, and *t* is a post-lottery year. *FA_emp* is foreign affiliate employment in country *c* by firm *i*, *ExcessDemand* is the measure of excess demand (the number of LCA applications minus the number of H-1B permits received) by firm *i* in lottery years 2007 and 2008 combined, *US_emp* is a multinational's employment in the US in 2007, LCA_i^{07+08}controls for the number of LCA applications a given firm submitted, and α_j and α_c capture industry (NAICS 4-digit level) and country time trends respectively. The dependent variable is the logged differenced foreign affiliate employment of firm *i* in country *c*, between a post-lottery year (*t*) and a pre-lottery year (2005). I expect $\beta_1$to be positive; firms that lost a larger share of their H-1B petitions should be more likely to expand their foreign affiliate activity. All standard errors are clustered at the firm level.

Table 11 shows that β_1 is indeed significantly positive. The columns display foreign affiliate employment growth one, two, three, four, and five years after the lottery and illustrate that there was a persistent positive effect. The results show that a random negative shock to H-1B supply equal to one percentage point of initial employment caused an increase in the foreign affiliate growth rate of between 12 and 16%. This positive effect is consistent with the results from the differences-in-differences approach[33], and provides further support for the hypothesis that restrictions on high skilled immigration cause increased offshoring of high-skilled jobs.

[33] The coefficients are not directly comparable. The two approaches have different samples (the first is much bigger since it includes multinationals that have never applied for an H-1B while the second only includes the subset of multinationals applying for LCAs in one of those two years). Furthermore, the key regressor is measured differently.

Translating these coefficients into the number of jobs offshored, I find that about 0.3 foreign affiliate jobs were created for every unfilled H-1B position. To calculate this number, I divided excess demand among US multinationals during the two relevant lottery years by the predicted change in foreign affiliate employment. To estimate the predicted change in foreign affiliate employment, I multiplied each firm's normalized excess demand by the coefficients identified in Table 11. I then multiplied this value by logged foreign affiliate employment in 2005 and took the exponential to calculate the predicted change in foreign affiliate employment for each firm. I did this for each firm and then summed across firms. Table 12 displays these figures for US multinationals in aggregate. Column 1 shows excess demand. Column 2 shows the predicted increase in foreign affiliate employment. The final column displays the number of offshored jobs lost per unfilled H-1B position. This estimate of substitution is likely an underestimate for three reasons. First, it relies on calculations on the intensive margin and does not consider increased foreign affiliate employment on the extensive margin. Second, as already discussed, the measure of foreign affiliate employment is not the ideal measure; I am interested in the substitution of high-skilled immigrants for high-skilled foreign affiliate employment. Third, there are likely at least some firms that did not submit their petition(s) in time to be considered for the lottery, which means that their behavior is not captured in the analysis.

One might be concerned that some firms anticipated the lottery and increased their submitted applications to improve their chances of winning the lottery. The two lottery years in the empirical analysis were selected precisely to address this concern; these were the first two years in which a lottery was held to distribute all H-1B visas. To further address this concern, Table 13 duplicates the same analysis, but with only the 2007 lottery, and finds the same qualitative result: that a random negative shock to H-1B supply caused an increase in the foreign affiliate growth rate.

6. Discussion

This paper explores the effect of high-skilled immigration restrictions on increases in foreign affiliate jobs. I utilize a unique firm-level panel dataset that links firm-level H-1B visa data and firm-level data on the financial and operating characteristics of US multinational firms and their foreign affiliates. I utilize two identification strategies, the first of which exploits the 2004 drop in the H-1B visa cap, while the second exploits randomized variation in firm-level excess demand from the H-1B visa lotteries in high demand years.

Both strategies yield the same result: that foreign affiliate employment increased as a direct response to increasingly stringent restrictions on H-1B visas. This effect is driven on the extensive and intensive side; firms were more likely to open new foreign affiliates abroad in response, and employment increased at existing foreign affiliates. The effect is strongest among R&D-intensive firms in industries where services could more easily be offshored. The effect was somewhat geographically concentrated: foreign affiliate employment increased both in countries like India and China with large quantities of high-skilled human capital and in countries like Canada with

more relaxed high-skilled immigration policies and closer geographic proximity. These empirical results also are supported by interviews with US multinational firms and an immigration lawyer.[34]

This is the first paper to empirically explore how decreased access to visas for skilled workers could lead multinational firms to offshore more jobs. The results have important implications for understanding how multinational firms respond to artificial constraints on resources and how they globally re-distribute those resources. The findings of the paper also have important policy implications; the offshoring of jobs and innovative activities appear to be an unforeseen consequence of restricting skilled immigration flows. Even if H-1B immigrants displace some native workers – and there is evidence that even large inflows of immigrant workers cause very little impact on local employment rates and wages (Card 2012)[35] – any 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.

The results also suggest that in addition to affecting the location of skilled employment, restrictive immigration policies affect the location of innovation, and therefore also the associated positive externalities. Skilled immigrants have been shown to have outsized impacts on innovation in the home country through spillovers (e.g. Hunt et al. 2017; Moser, Voena, and Waldinger 2014). While immigration has a positive impact on innovation and growth, its spatial diffusion disappears with distance (Burchardi et al. 2019) since innovative spillovers are geographically localized (Jaffe 1986; Jaffe, Trajtenberg, and Henderson 1993; Marshall 1920). From a nationalistic perspective, this is problematic; if skilled foreign-born workers are at a US firm's foreign affiliate instead of in the US, the innovative spillovers that they generate will go to another country instead. Furthermore, the finding that immigrants often are not equally innovative outside the United States (Kahn and Macgarvie 2016) has even wider welfare implications. In short, restrictive H-1B policies could not only be exporting more jobs and businesses to countries like Canada, but they also could be making the U.S.'s innovative capacity fall behind.

[34] Quotes from these interviews can be found in the Appendix.
[35] Although a recent paper by Doran et al. (2016) puts this finding into doubt: they find that H-1Bs substantially crowd out firms' employment of other workers.

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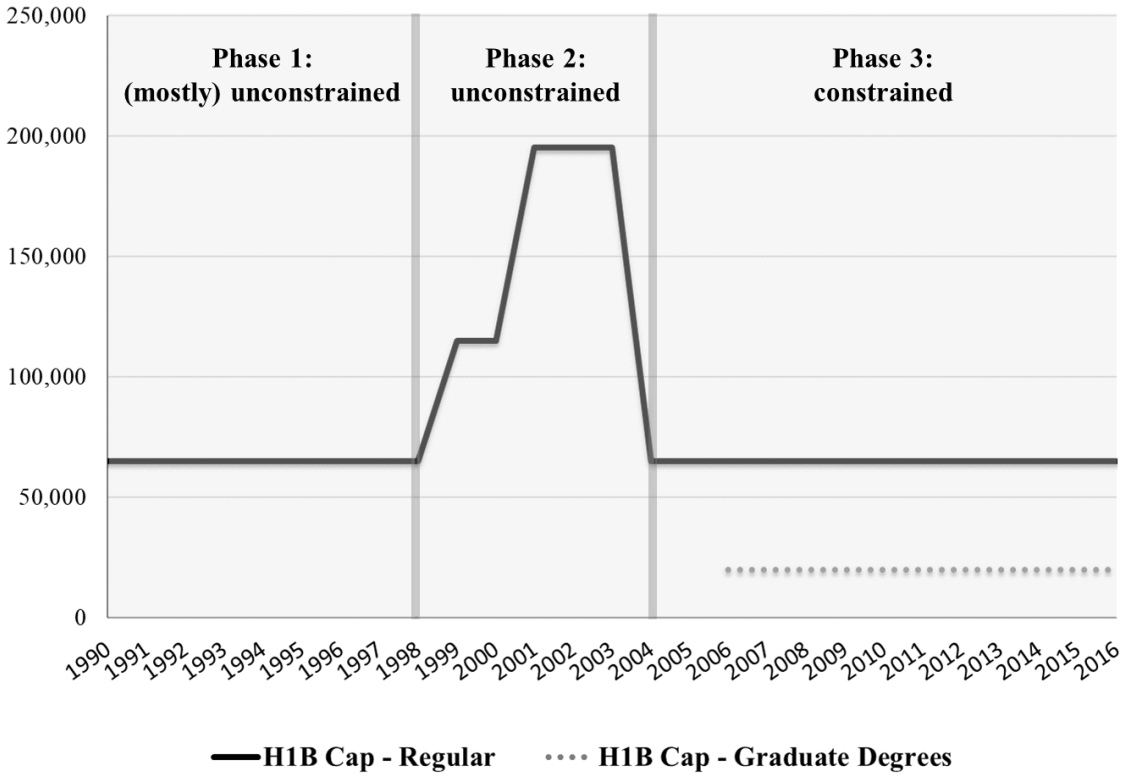
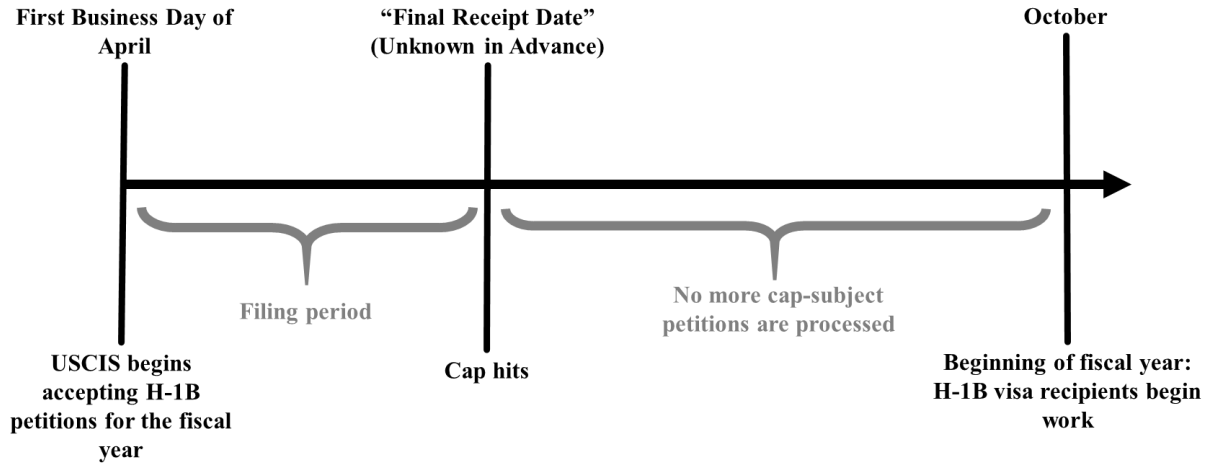
Figure 1: H-1B Cap Change Over Time



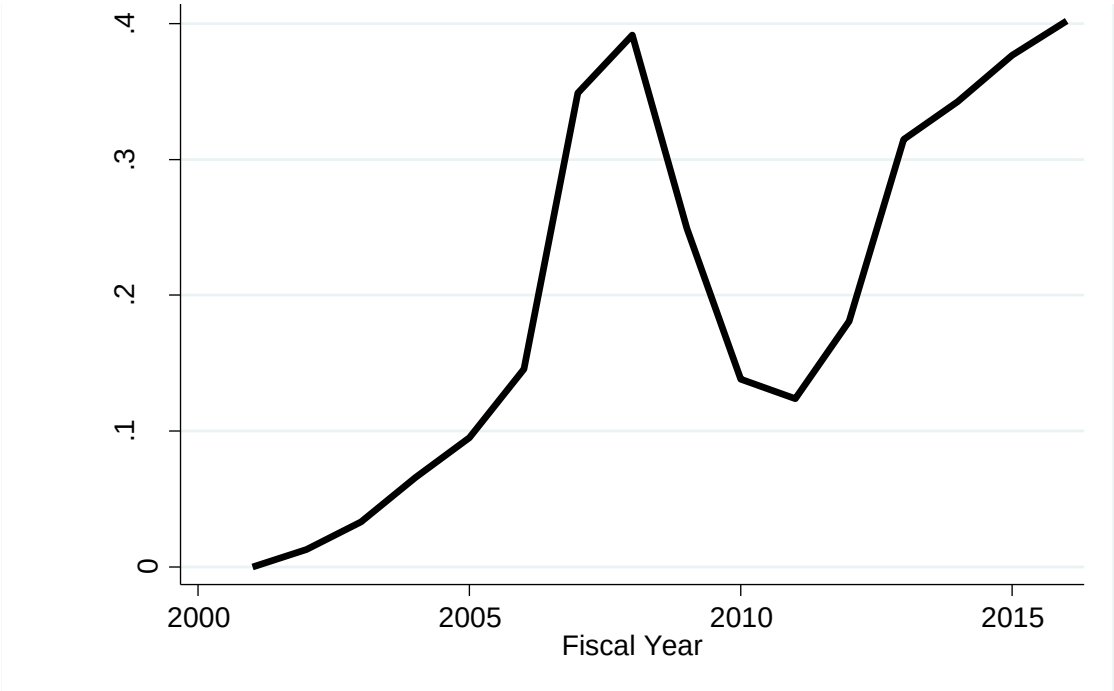
Notes: This figure plots the cap on the number of H-1B visas by fiscal year. Since the Immigration Act of 1990, there has been an annual cap on the number of new H-1B visas that can be issued to private sector businesses. This cap is set by Congress and the President. Throughout most of the 1990s, the cap was set at 65,000 visas and applications rarely outstripped supply. It was increased to 195,000 visas by the American Competitiveness and Workforce Improvement Act of 1998 and the American Competitiveness in the Twenty-First Century Act of 2000 (AC21). During this period, the cap limits were never reached. The AC21 stipulated that this reversion would happen in the absence of any additional legislation, but, despite a trend towards less restrictive labor labs, no legislation was enacted, and the cap level reverted back to 65,000. It was raised by 20,000 in 2006, but those additional 20,000 could only be used for applicants with a graduate degree. Although in the early 2000s, the cap was not binding, since the cap changed in 2004, it has been binding in every year. The identification in this paper exploits the sharp reduction in the annual H-1B cap in fiscal year 2004.

Figure 2: H-1B Visa Submission Timeline



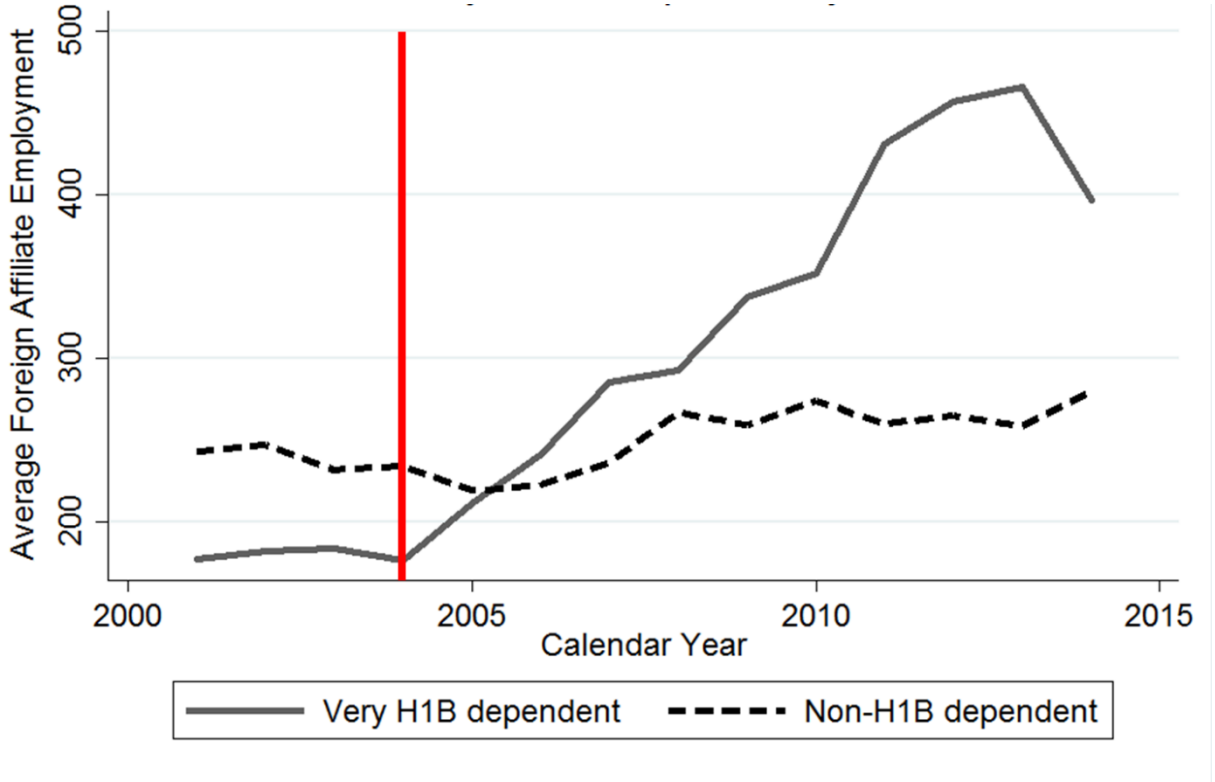
Notes: On the first business day of each April, USCIS begins accepting H-1B petitions from firms seeking permits that will count towards the following fiscal year. Petitions are accepted on a first-come, first-served basis until the cap hits, at which point no more petitions are processed. The end of the application period is demarcated by the "final receipt date", which is the date on which they receive enough applications to fill the remaining available permits under the cap. Any cap-subject petitions submitted after the final receipt date are automatically rejected.

Figure 3: In High-Demand Years, LCA Applications Were Filed Earlier



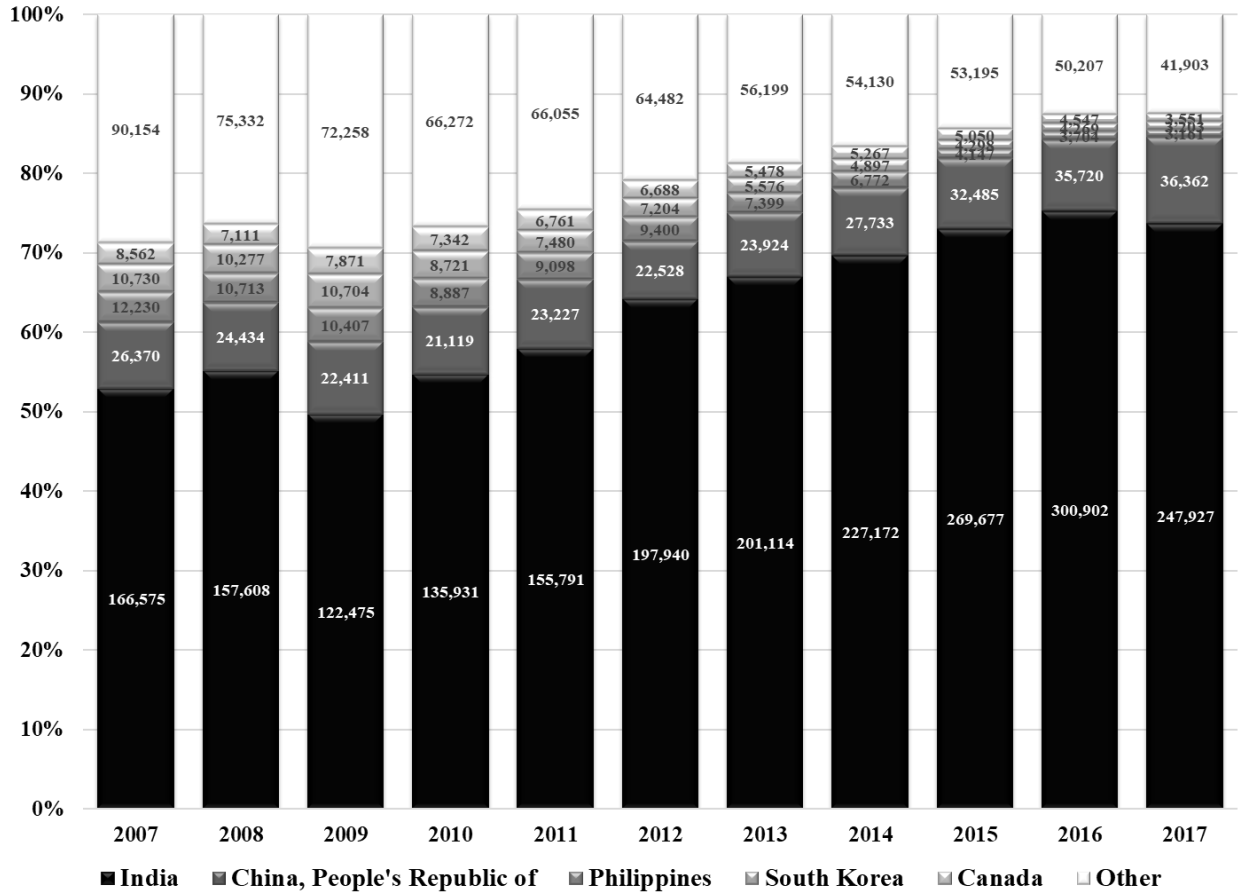
Notes: The prerequisite to filing an H-1B petition with USCIS is obtaining an approved Labor Condition Application (LCA) from the Department of Labor; the LCA is used in this paper as the primary measure of demand. LCA application data does not include information about whether a given LCA is for a cap-subject H-1B visa, but the timing of petitions can be used to reveal whether an LCA application is for a cap-subject H-1B visa. An LCA cannot be filed more than six months prior to the start of employment. In order to apply for a visa for the following fiscal year (beginning in October), one would expect that firm to file an LCA no earlier than April. Furthermore, an LCA is only valid for three years; the earlier the application submitted, the fewer months a foreign-born worker would be eligible to work. In short, without any restrictions on H-1B supply, one would expect all firms to apply for LCAs no earlier than April, and probably much later. However, the rising demand for H-1B visas and the first-come, first-served nature of the distribution process changed firm behavior. Firms that needed cap-subject H-1B visas wanted to submit their petitions as early as possible (i.e. April) to ensure the submission would be before the final receipt date, which also meant the LCA application had to be submitted prior to April. This figure illustrates the change in the timing of LCA applications; as demand for cap-dependent H-1B visas increased, LCA applications were filed earlier. I infer that LCA applications submitted in the first quarter of the calendar year are for cap-dependent H-1B petitions.

Figure 4: Growth in Average Foreign Affiliate Employment by H-1B Dependency



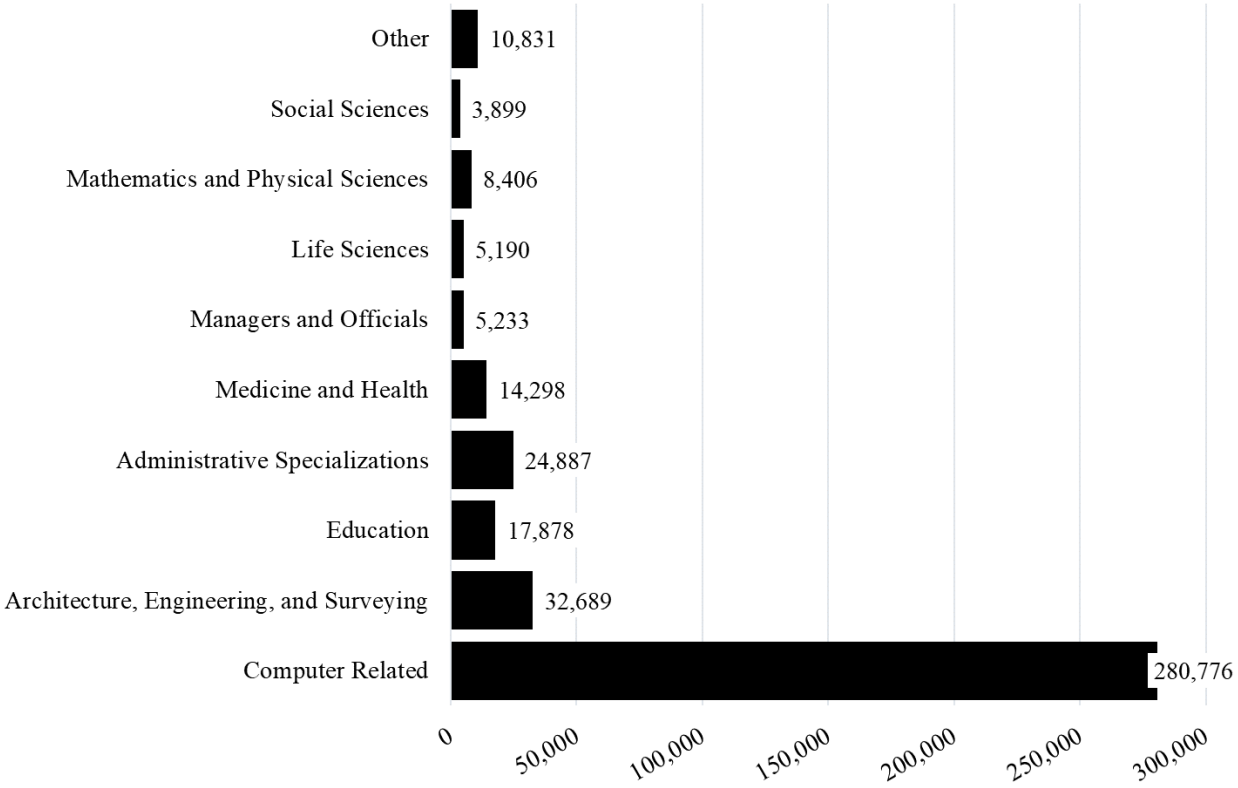
Notes: This figure plots foreign affiliate employment growth for non-H-1B dependent firms relative to very H-1B dependent firms. Non-H-1B-dependent firms had zero LCA applications in 2001, while very H-1B dependent firms were in the top category of H-1B dependency in 2001. H-1B dependency is defined as the total number of H-1B positions requested in LCA applications for a given multinational divided by that multinational's US employment in 2001. Categories of H-1B dependency are measured throughout the paper by dividing non-zero LCA applications into five quantiles, with the top category divided into two groups. The red line demarcates the year of the 2004 policy change. The figure shows that while foreign affiliate employment growth for non-H-1B dependent firms remained fairly flat after the policy change, very H-1B dependent firms experienced rapid growth in foreign affiliate employment after the policy change. Furthermore, the trajectory of foreign affiliate employment growth of both types of firms remained parallel and quite flat prior to the policy change, in keeping with the parallel trends assumption. The regression results confirm the associations in the raw data.

Figure 5: H-1B Petitions Filed in FY2007-2017, by Beneficiary Country of Birth



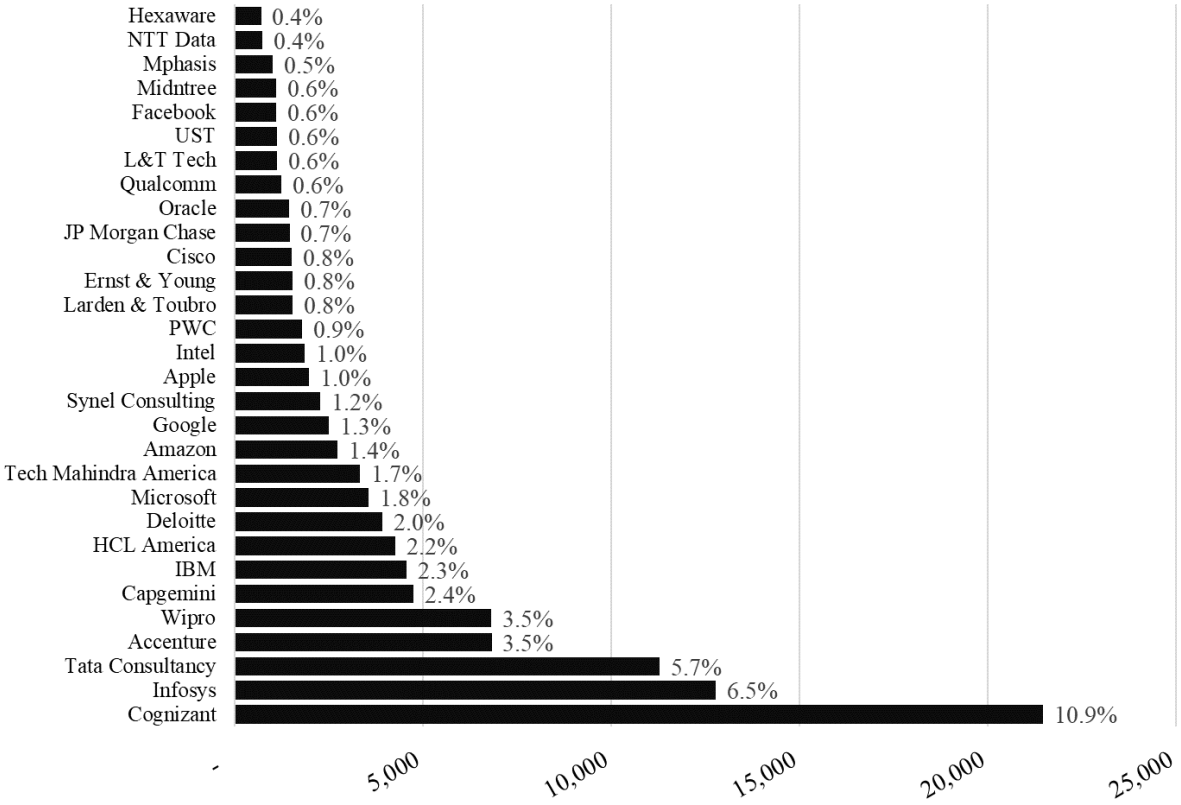
Notes: This figure shows the country breakdowns of H-1B petition filings between FY 2007 and 2017. It illustrates that the distribution of countries of origin is increasingly skewed; by 2017, 85% of H-1B petition filings were for workers from India or China. Note that these are petitions filed not petitions approved. Petition counts include both cap-subject and cap-exempt, initial and continuing employment. The data are publicly available from USCIS.

Figure 6: H-1B Petitions Filed in FY 2017, by Beneficiary Occupation Category



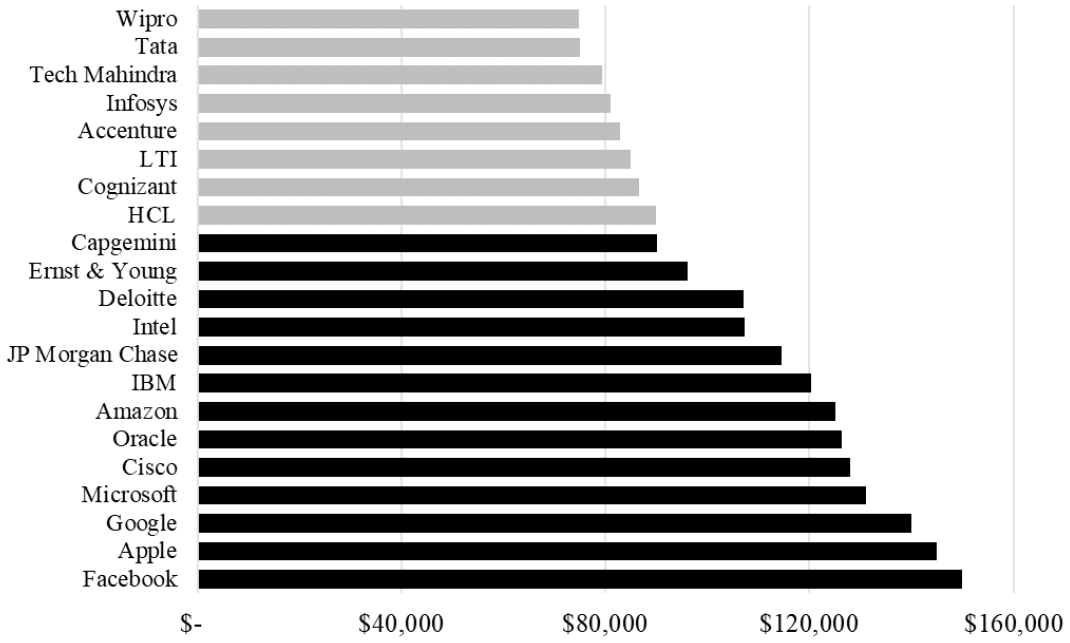
Notes: This figure shows the industry breakdowns of H-1B petition filings in 2017. It illustrates that the distribution of occupations is highly skewed; computer-related occupations accounted for 69% of H-1B petition filings in 2017. Note that these are petitions filed not petitions approved. Petition counts include both cap-subject and cap-exempt, initial and continuing employment. The data are publicly available from USCIS.

Figure 7: Total Number of H-1B Approved Petitions in FY 2016, for the Top 30 Firms



Notes: This figure shows the number of approved H-1B petitions for the top 30 firms in fiscal year 2016. All data are based on approved petitions during the fiscal year. Total number of beneficiaries includes initial, renewal, cap-subject, and cap-exempt petitions. This figure is constructed from publicly available data, which means that these may be underestimates in some cases; while some company names may appear multiple times, USCIS does not combine companies even where the names are the same because in all cases the employer tax identification numbers are different. In the confidential data used in the paper, this is not the case. The figure illustrates that there is also significant skewness in H-1B visas across firms. Note that these are not all multinationals and therefore are not equivalent to the BEA sample of firms used in this paper's data; the sample of firms in my analysis is somewhat different.

Figure 8: Median Salary of H-1B Visa Holders at Top 20 H-1B Hiring Firms in 2018



Notes: This figure shows the median salary of H-1B visa holders hired by the top 20 H-1B hiring firms in 2018. The light grey bars show Indian outsourcing companies, while the black bars show American firms. The companies shown in black bars are closer to the sample of firms used in this paper.

Table 1: Final Receipt Dates of the Cap-Subject H-1B Petition Filing Period in Each Fiscal Year

Fiscal Year	Final Receipt Date	Days in Filing Period	Number of Lottery-Subject H-1B Petitions Received During the Filing Period
2004	February 17, 2004	323	
2005	October 1, 2004	184	
2006	August 10, 2005	132	
2007	May 26, 2006	56	
2008*	April 3, 2007	3	150,000
2009*	April 7, 2008	7	163,000
2010	December 21, 2009	265	
2011	January 26, 2011	301	
2012	November 22, 2011	236	
2013	June 11, 2012	72	
2014*	April 7,2013	7	124,000
2015*	April 7, 2014	7	172,500
2016*	April 7, 2015	7	233,000
2017*	April 7, 2016	7	236,000
2018*	April 7, 2017	5	199,000
2019*	April 6, 2018	5	190,098

Notes: On the first business day of each April, USCIS begins accepting H-1B applications from firms seeking permits that will count towards the following fiscal year. Since the H-1B visa program operates on a first-come, first-serve basis, petitions are accepted until the cap hits, at which point no more petitions are processed. The end of the application period is demarcated by the "final receipt date", which is the date on which they receive enough applications to fill the remaining available permits under the cap. Any cap-subject petitions submitted after the final receipt date were automatically rejected. This date is announced by USCIS in a press release every year, and it varies every year, as shown in the table above. In some years, USCIS received so many petitions within the first week that all cap-subject petitions were distributed by lottery. These years are demarcated with a star (*), and the fourth column shows the total number of petitions on which the lottery was run. For the purposes of this paper, the most relevant are fiscal years 2008 and 2009.

Table 2: Summary Statistics

Summary Statistics of MNCs in 2001

	N	Mean	Std. Dev	10^{th} percentile	90^{th} percentile
Reporter employment	2263	7785.2	29915.7		
Ratio of LCA Applications to US Employment in percentage point units	2263	0.176	0.812	0	0.2835
Number of countries active in	2263	2.831	5.646		
Number of LCA applications	2263	11.87	79.85		

Summary Statistics of MNCs in 2013

	N	Mean	Std. Dev
Reporter employment	2263	6300.6	35868.7
Number of countries active in	2263	2.422	5.992

Summary Statistics of Existing Foreign Affiliates in 2001

	N	Mean	Std. Dev
FA Employment	6407	1151.0	3964.3
FA R&D Expenditure	6407	2765.6	26276.7

Summary Statistics of Still-Existing Foreign Affiliates in 2013

	N	Mean	Std. Dev
FA Employment	5482	1559.4	8307.1
FA R&D Expenditure	5482	5741.0	37289.6

Table 3: Effect on Growth in Foreign Affiliate Employment for All Firms, 2001 Base Year

	(1) 2002	(2) 2003	(3) 2004	(4) 2005	(5) 2006	(6) 2007	(7) 2008	(8) 2009	(9) 2010	(10) 2011	(11) 2012	(12) 2013	(13) 2014
Ratio of LCAs to US-based Employment in 2001 in percentage point units	0.0113	0.0084	0.0140	0.0316*	0.0397**	0.0498*	0.0451**	0.0443*	0.0330*	0.0578***	0.0650***	0.0722***	0.0628
	(0.0103)	(0.0120)	(0.0148)	(0.0178)	(0.0186)	(0.0262)	(0.0201)	(0.0235)	(0.0195)	(0.0222)	(0.0252)	(0.0248)	(0.0434)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5619	5277	4657	4418	4343	4122	3798	4160	3687	3449	3237	3130	3277
R^2	0.052	0.062	0.086	0.085	0.091	0.134	0.143	0.147	0.162	0.181	0.196	0.208	0.198
Adjusted R^2	0.018	0.026	0.046	0.043	0.050	0.092	0.100	0.107	0.119	0.138	0.151	0.162	0.155
F	1.198	0.492	0.895	3.164	4.527	3.606	5.040	3.554	2.852	6.754	6.682	8.481	2.096

Standard errors in parentheses
Standard errors clustered at the firm level
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Each column represents a long difference in logged foreign affiliate employment between 2001 and a later year. We would expect null results in 2002-2003 (pre-policy change), and positive results in 2005-2014 (post-policy change), and this is exactly what we see. The key independent variable is my measure of H-1B dependency, defined as the total number of LCA applications for a given multinational divided by that multinational's US employment in 2001. The fixed effects account for industry (NAICS 4-digit level) and country time trends. The results show that firms that were one percentage point more H-1B dependent than average saw a 3-8% larger increase in foreign affiliate employment than average, as a result of increased immigration restrictions resulting from the 2004 cap drop.

Table 4: Placebo Test, Effect on Growth in Foreign Affiliate Employment for All Firms, 1994-1999

	(1) Change in ln(FA emp), 1994-1999
Ratio of LCA Applications to US Employment in 2001 in percentage point units	0.0373 (0.0289)
Industry FE	Yes
Country FE	Yes
Observations	5656
R^2	0.103
Adjusted R^2	0.072
F	1.670

Standard errors in parentheses
Standard errors clustered at the firm level
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The dependent variable is the logged change in foreign affiliate employment in a pre-treatment period (1994-1999). The key independent variable is my measure of H-1B dependency, defined as the total number of LCA applications for a given multinational divided by that multinational's US employment in 2001. The fixed effects account for industry (NAICS 4-digit level) and country time trends. The estimation strategy requires that pre-treatment trends in foreign affiliate employment were the same for the treatment and control groups (the parallel trends assumption). The threat to identification would be if my measure of H-1B dependency were correlated with pre-treatment changes in the outcomes of interest. This table shows the results of regressing the logged change in foreign affiliate employment in a pre-treatment period (1994-1999) on the same 2001 measure of H-1B dependency, with both industry and country fixed effects as before. The table shows no evidence of a systematic relationship between H-1B dependency and changes in foreign affiliate employment prior to the policy change.

Table 5: Effect on Growth in Foreign Affiliate Employment for All Firms, 2001-2013

	(1) Baseline	(2) Controlling for Pre-trend	(3) Base year patent control	(4) Most R&D-Intensive	(5) Nonlinear Specification
Ratio of LCA Applications to US Employment in 2001 in percentage point units	0.0722***	0.0684**	0.0893***	0.126**	
	(0.0248)	(0.0283)	(0.0282)	(0.0551)	
Change in ln(FA emp), 1994-1999		-0.0818**			
		(0.0326)			
2nd Quantile of Patenters in 2001 = 1			-0.0922		
			(0.120)		
3rd Quantile of Patenters in 2001 = 1			-0.0714		
			(0.126)		
4th Quantile of Patenters in 2001 = 1			-0.135		
			(0.108)		
5th Quantile of Patenters in 2001 = 1			-0.282**		
			(0.112)		
2nd Quantile of H-1B Dependency in 2001 = 1					0.0509
					(0.108)
3rd Quantile of H-1B Dependency in 2001 = 1					-0.00229
					(0.118)
4th Quantile of H-1B Dependency in 2001 = 1					-0.0518
					(0.0990)
5th Quantile of H-1B Dependency in 2001 = 1					-0.0792
					(0.135)
6th Quantile of H-1B Dependency in 2001 = 1					-0.129
					(0.154)
Top Quantile of H-1B Dependency in 2001					0.462**
					(0.209)
Industry FE	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes
Observations	3130	1913	3130	488	3130
R^2	0.208	0.247	0.211	0.261	0.209
Adjusted R^2	0.162	0.187	0.165	0.151	0.163
F	8.481	6.108	2.636	5.250	1.550

Standard errors in parentheses
Standard errors clustered at the firm level
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The dependent variable in every column is the long difference in logged foreign affiliate employment between 2001 and 2013. The key independent variable in columns 1-4 is my measure of H-1B dependency, defined as the total number of LCA applications for a given multinational divided by that multinational's US employment in 2001. The first column is the duplicate of Table 2, column 8, and serves as a reference baseline. The second column includes a control for the 1994-1999 pre-trend as a robustness check. Reassuringly, the coefficient of interest gets slightly smaller, but remains positive and statistically significant, further reassuring endogeneity concerns. Column three address the concern that results may be driven by systematic growth rate differences across firms of different size, internationalization, or innovativeness to begin with. If, for instance high-patenting

firms naturally expand their activity abroad more quickly than non-patenting firms, even within the same industry, then my results could reflect that correlation rather than the effect of the policy change. I therefore tested whether the coefficient of interest changes when including controls for the size or type of firm in terms of their 2001 employment quantile, in terms of their 2001 sales quantile, in terms of their 2001 R&D spending quantile, in terms of their 2001 total patenting quantile, and in terms of the number of foreign affiliates quantile in 2001. These controls are included as group fixed effects. The identification in these regressions, once various controls are added, is now based on the comparison of trajectories within the same industry and same category – based on employment size or sales size or R&D size or patenting amount or degree of internationalization, depending on the control. Column 3 results of a specification that contains indicators for each firm's 2001 patenting quantile; the other results can be requested separately but show the same result, which is that the main results remain qualitatively unaffected. Column 4 shows the results of the same baseline regression run on firms that were in the top 20% of R&D-intensive firms in 2001. I find that the coefficients are larger than on the entire firm sample suggesting that the results are driven by the firms conducting high-skilled activity, as expected. Finally, column 5 shows a non-linear approach, whereby I divide multinationals into groups according to their H-1B dependence in 2001. I build 7 categories of multinationals, where the base category is all multinationals with zero LCA applications, and the remainder are divided into five quantiles, with the top category divided into two groups. The table shows large, positive, and statistically significant coefficients for the top bracket (with a LCA application-US employment ratio of at least 0.0158 in 2001). In other brackets, there is no statistical significance. These estimates suggest that the positive effect of H-1B restrictions on foreign affiliate employment is being driven by the heaviest users of H-1B visas.

Table 6: Effect on Foreign Affiliate Employment for All Firms, 1994-2014

	(1) ln(FA emp)	(2) ln(FA emp)
Continuous Treatment	0.0625***	
	(0.0183)	
Binary Treatment		0.274***
		(0.0906)
Country FE	Yes	Yes
Firm FE	Yes	Yes
Year FE	Yes	Yes
Observations	137459	57984
R^2	0.429	0.429
Adjusted R^2	0.420	0.413
F	11.68	9.140

Standard errors in parentheses
Standard errors clustered at the firm level
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Unlike the previous tables, this table reflects a differences-in-differences approach that utilizes the panel dataset all at once, rather than a series of long-differenced cross-sectional regressions. The timeframe is 1994-2014 and the dependent variable is ln(foreign affiliate employment). I control for country, firm, and year fixed effects in both columns. Both columns utilize an independent variable constructed as the interaction between a dummy variable equal to one in 2004-onwards and zero before, and a measure of H-1B dependency. In the continuous case, H-1B dependency is measured as the total number of LCA applications for a given multinational divided by that multinational's US employment in 2001. In the binary case, it is a new variable equal to one if the firm was in the top group of H-1B dependency in 2001, and zero if the firm had zero LCA applications in 2001. Column 1 shows the results of the continuous version, while column 2 shows the results of the binary version. Both are statistically and economically significant, and the coefficient in the continuous case is similar to those observed in the long-differenced version. The coefficient in the binary version tells us that the 2004 policy change caused highly H-1B dependent firms to increase their foreign affiliate employment by 27% more than a non-H-1B dependent firm.

Table 7: Effect on the Extensive Margin

	(1) DV: New FA by 2013	(2) DV: New R&D by 2013	(3) DV: New R&D by 2013 Subsample of 25 countries
Ratio of LCA Applications to US Employment in 2001 in percentage point units	0.00282*	0.00317*	
	(0.00151)	(0.00172)	
Binary form of H-1B Dependency in 2001			0.0648**
			(0.0259)
Industry FE	Yes	Yes	Yes
Country FE	Yes	Yes	Yes
Observations	108623	108623	8305
R^2	0.032	0.025	0.083
Adjusted R^2	0.029	0.022	0.060
F	3.467	3.411	6.281

Standard errors in parentheses
Standard errors clustered at the firm level
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The dependent variable here is a binary variable equal to one if the firm had opened new operations in a given country by 2013 (that they did not have in 2001) and equal to zero otherwise. I use a linear probability model so that I can include time trends, but the results are robust to a logit model. The independent variable in the first two columns is my measure of H-1B dependency, defined as the total number of LCA applications for a given multinational divided by that multinational's US employment in 2001. In the third column, the independent variable is the binary version of H-1B dependency in 2001, comparing the top quantile to the bottom quantile. Column 1 shows that that the 2004 cap decline made a one percentage point more H-1B dependent firm 0.2% more likely to open a foreign affiliate than the average firm by 2013. Column 2 shows the same regression specification, but with a look at the start of R&D. Here, the coefficient is even higher, suggesting that immigration restrictions caused US multinationals to both start conducting R&D in more existing foreign affiliates, but also to open more R&D-performing foreign affiliates. The effect is slightly larger on existing foreign affiliates starting to conduct R&D than on new R&D-performing foreign affiliates, but it is positive and statistically significant in both cases. Column 3 shows that the effect is even larger among highly H-1B dependent firms in a subset of 25 countries. The sample of countries in Columns 1 and 2 is fifty.

Table 8: Effect on Foreign Affiliate Patenting for All Firms, 1994-2014

	(1) Negative Binomial	(2) OLS	(3) OLS, IHS(Patents)
Continuous Treatment	0.178***	0.253***	0.0451***
	(0.00675)	(0.0872)	(0.0108)
Constant	-0.548***		
	(0.0158)		
Country FE	No	Yes	Yes
Firm FE	No	Yes	Yes
Year FE	No	Yes	Yes
Firm-Country FE	Yes	No	No
Observations	70161	409794	409794
R^2		0.045	0.200
Adjusted R^2		0.039	0.195
F		8.382	17.36

Standard errors in parentheses
Standard errors clustered at the firm level
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The dependent variable in Column 1 is the count of patents originating from country c in time t by firm i. I designate a patent as originating from a country based on inventor addresses; if the majority of inventors list the address of a given country, then the patent was invented there. The first column shows a fixed effects negative binomial model; the sparsity of patent counts and their long right tail makes negative binomial more appropriate than OLS in some cases. The second column shows a standard OLS model with patent counts as the dependent variable. And the third column provides an inverse hyperbolic sine transformation of patent count data to combat the sparseness and skewness of patent data. All three variants find the same result, that increased H-1B restrictions caused an increase in foreign affiliate innovative activity, suggesting a shift in the location of innovation.

Table 9: Effect on Foreign Affiliate Employment Share of Firm Employment, 1994-2014

	(1) Emp Share, All firms & countries	(2) Emp Share, China, Canada, and India	(3) Emp Share, All firms & countries	(4) Emp Share, China, Canada, and India
Continuous Treatment	-0.0000789	0.00487***		
	(0.000270)	(0.00116)		
Binary Treatment			-0.00207	0.0130**
			(0.00167)	(0.00588)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes
Observations	296002	32899	134598	16773
R^2	0.380	0.709	0.420	0.752
Adjusted R^2	0.375	0.695	0.413	0.735
F	0.0855	17.52	1.545	4.906

Standard errors in parentheses
Standard errors clustered at the firm level
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table reflects a differences-in-differences approach that utilizes the panel dataset all at once, rather than a series of long-differenced cross-sectional regressions. The timeframe is 1994-2014 and the dependent variable is the share of firm *i*'s foreign affiliate employment in country *c* in time *t*. I control for country, firm, and year fixed effects in all columns. All columns utilize an independent variable constructed as the interaction between a dummy variable equal to one in 2004-onwards and zero before, and a measure of H-1B dependency. In the continuous case, H-1B dependency is measured as the total number of LCA applications for a given multinational divided by that multinational's US employment in 2001. In the binary case, it is a new variable equal to one if the firm was in the top group of H-1B dependency in 2001, and zero if the firm had zero LCA applications in 2001. Columns 1 and 2 show the results of the continuous version, while columns 3 and 4 show the results of the binary version. The sample in columns 1 and 3 is all firms in all years, while in columns 2 and 4, it is constrained to the three countries most impacted by foreign affiliate expansion in response to skilled immigration restrictions. On average (in the full sample), there is no clear evidence of any shift in the share of employment. However, when the sample is constrained to those countries where the expansion of activity as a direct response to skilled immigration restrictions was concentrated (Canada, India, and China), there was a clear shift of firm employment share towards those countries.

Table 10: Effect on Foreign Affiliate Patenting Share of Firm Patenting, 1994-2014

	(1) Patent Share, All firms & countries	(2) Patent Share, China, Canada, and India	(3) Patent Share, All firms & countries	(4) Patent Share, China, Canada, and India
Continuous Treatment	0.0000322	0.00358***		
	(0.000195)	(0.00116)		
Binary Treatment			0.000753	0.0214***
			(0.00138)	(0.00509)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes
Observations	114823	10416	35333	3399
R^2	0.175	0.625	0.211	0.754
Adjusted R^2	0.171	0.607	0.203	0.735
F	0.0273	9.435	0.299	17.69

Standard errors in parentheses
Standard errors clustered at the firm level
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table reflects a differences-in-differences approach that utilizes the panel dataset all at once, rather than a series of long-differenced cross-sectional regressions. The timeframe is 1994-2014 and the dependent variable is the share of firm *i*'s foreign affiliate patenting in country *c* in time *t*. I control for country, firm, and year fixed effects in all columns. All columns utilize an independent variable constructed as the interaction between a dummy variable equal to one in 2004-onwards and zero before, and a measure of H-1B dependency. In the continuous case, H-1B dependency is measured as the total number of LCA applications for a given multinational divided by that multinational's US employment in 2001. In the binary case, it is a new variable equal to one if the firm was in the top group of H-1B dependency in 2001, and zero if the firm had zero LCA applications in 2001. Columns 1 and 2 show the results of the continuous version, while columns 3 and 4 show the results of the binary version. The sample in columns 1 and 3 is all firms in all years, while in columns 2 and 4, it is constrained to the three countries most impacted by foreign affiliate expansion in response to skilled immigration restrictions. On average (in the full sample), there is no clear evidence of any shift in the share of patenting. However, when the sample is constrained to those countries where the expansion of activity as a direct response to skilled immigration restrictions was concentrated (Canada, India, and China), there was a clear shift of firm patenting share towards those countries.

Table 11: Effect on Growth in Foreign Affiliate Employment for All Firms, 2005 Base Year

	(1) 2010	(2) 2011	(3) 2012	(4) 2013	(5) 2014
Adjusted Excess Demand in 2007-8	0.0484	0.137***	0.121**	0.161**	0.142*
	(0.0334)	(0.0496)	(0.0499)	(0.0681)	(0.0836)
Number of LCAs in 2007-8	-0.0000989	-0.000342**	-0.000205	-0.000358*	-0.000295
	(0.000113)	(0.000139)	(0.000157)	(0.000185)	(0.000216)
Industry FE	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes
Observations	4308	4029	3776	3685	3834
R^2	0.140	0.162	0.172	0.190	0.179
Adjusted R^2	0.101	0.121	0.131	0.149	0.138
F	1.093	3.891	3.192	2.840	1.493

Standard errors in parentheses
Standard errors clustered at the firm level
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Each column represents a long difference in logged foreign affiliate employment between 2005 and a post-lottery year (2010-2014). The key independent variable is my measure of adjusted excess demand, defined as the total number of cap-subject LCA applications minus cap-subject H-1B petitions issued for a given multinational in 2007 and 2008, divided by that multinational's US employment in 2007. This number is multiplied by 100 for purposes of interpretation. The regression also includes a control for the number of LCA applications, since lottery randomization is at the petition, not firm, level. The fixed effects account for industry (NAICS 4-digit level) and country time trends. The results show that a random negative shock to H-1B supply equal to one percentage point of initial employment caused an increase in the foreign affiliate growth rate of between 12 and 16%.

Table 12: Estimating Offshored Jobs per unit of Excess Demand

Total Excess Demand Among US MNCs in April 2007-08	Predicted Change in Foreign Affiliate Employment, 2005-2014	Foreign Affiliate Jobs per Unit of Excess Demand
14,218	4,449	0.31

Notes: This table shows that about 0.3 jobs were offshored for every unfilled H-1B position. To calculate this number, I divided excess demand among US multinationals during the two relevant lottery years by the predicted change in foreign affiliate employment. To estimate the predicted change in foreign affiliate employment, I multiplied each firm's normalized excess demand by the coefficients identified in Table 11. I then multiplied this value by logged foreign affiliate employment in 2005, and then took the exponential to calculate the predicted change in foreign affiliate employment for each firm. I did this for each firm and then summed across cities. The table displays these figures for US multinationals in aggregate. Column 1 shows excess demand. Column 2 shows the predicted increase in foreign affiliate employment. The final column displays the number of offshored jobs lost per unfilled H-1B position. This is likely an underestimate for two reasons. First, it relies on calculations on the intensive margin and does not consider increased offshoring on the extensive margin. Second, as already discussed, the measure of foreign affiliate employment is not the ideal measure; I am interested in the substitution of high-skilled immigrants for high-skilled foreign affiliate employment. This suggests that, if anything, the regression estimates are smaller than the true effects – and so is the estimate of substitution.

Table 13: Effect on Growth in Foreign Affiliate Employment for All Firms, 2005 Base Year

	(1) 2010	(2) 2011	(3) 2012	(4) 2013	(5) 2014
Adjusted Excess Demand in 2007	0.106*	0.205**	0.172*	0.203**	0.119
	(0.0600)	(0.0871)	(0.0962)	(0.103)	(0.0921)
Number of LCAs in 2007	-0.000132	-0.000279**	-0.000140	-0.000241	-0.000143
	(0.000114)	(0.000129)	(0.000156)	(0.000157)	(0.000154)
Industry FE	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes
Observations	4308	4029	3776	3685	3834
R^2	0.140	0.161	0.172	0.189	0.178
Adjusted R^2	0.101	0.121	0.130	0.148	0.137
F	1.548	2.903	1.739	1.939	0.845

Standard errors in parentheses
Standard errors clustered at the firm level
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Each column represents a long difference in logged foreign affiliate employment between 2005 and a post-lottery year (2010-2014). The key independent variable is my measure of adjusted excess demand, defined as the total number of cap-subject LCA applications minus cap-subject H-1B petitions issued for a given multinational in 2007, divided by that multinational's US employment in 2007. This number is multiplied by 100 for purposes of interpretation. The regression also includes a control for the number of LCA applications, since lottery randomization is at the petition, not firm, level. The fixed effects account for industry (NAICS 4-digit level) and country time trends. The results show that a random negative shock to H-1B supply equal to one percentage point of initial employment caused an increase in the foreign affiliate growth rate of between 10 and 20%. The table differs from Table 11 in that it only includes variation from the 2007 lottery, in an effort to address the concern that some firms anticipated the lottery.