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## Looking for the “Best and Brightest”: Hiring difficulties and high-skilled foreign workers

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# Looking for the “Best and Brightest”: Hiring difficulties and high-skilled foreign workers

Morgan Raux\*

## Abstract

This paper shows that, on average, U.S. employers are more likely to seek foreign skilled workers for positions where finding domestic workers takes time. It uses a new dataset matching online job posting duration to administrative data on Labor Condition Applications (LCAs) submitted as the first step in applying for H-1B temporary skilled worker visas. It investigates the mechanisms by exploring the heterogeneity of the results across firms and labor markets. It shows that this relationship is not driven by firms manipulating their job postings’ duration to demonstrate their good faith efforts in their search for domestic workers. On the contrary, evidence suggest that the results are due to the insufficient domestic labor supply in tight occupations.

**Keywords:** H-1B Work Permit, Hiring difficulties, Web Scraping.

**JEL Classification:** J61, J20

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# 1 Introduction

One of the most important topics in the economic literature on migration studies is the complementarity between foreign and domestic workers on labor markets. Key contributions to this literature have exploited shifts in the supply of foreign workers in the U.S. to assess this complementarity. This literature first focused on low skilled workers ([Card, 1990](#)) and then studied this complementarity between high-skilled workers ([Doran et al., 2014](#)). This distinction is key as low-skilled and high-skilled foreign workers come to the U.S. with different visas. In particular, most high-skilled foreign workers need a visa sponsored by their employer. This is why assessing their complementarity with domestic workers requires an understanding of why the employers want to recruit these workers.

In this paper, I document the complementarity between high-skilled foreign and domestic workers by studying firms' recruitment decisions. I focus on the main immigration policy for high-skilled foreign workers in the US: the H-1B visa program. I have collected and assembled a new and original dataset matching online job postings to administrative data on labor condition applications (LCAs) submitted as the first step in applying for H-1B temporary skilled worker visas. I show that employers are more likely to seek H-1B workers when they have trouble finding domestic workers. I then explore the mechanism driving this relationship. I provide evidence suggesting that this phenomenon is due to insufficient domestic labor supply in these occupations.

I develop a simple model that highlights the role of employer search duration on the recruitment of foreign workers. In this model, employers have two options to fill their vacancies. They can either focus their search efforts on domestic workers only. Or they can search among both domestic and foreign workers. Employers start considering foreign workers as soon as their expected present value of searching among domestic workers only drops below their expected present value of searching among both domestic and foreign

workers. This model predicts that employer search duration increases the probability of seeking a foreign worker.

I test the model’s predictions using online job posting and administrative data on H-1B visa applications. I collected the entire universe of job postings advertised on one of the largest U.S. job boards (hereafter “Job Board A”),<sup>1</sup> from November 2018 to July 2019. I collected those data every two weeks to observe when ads disappeared from the website. Computing the difference with the precise posting date allowed me to measure the duration of each job posting. Job posting duration partly reflects employers’ relative difficulty in filling this position. The H-1B visa program requires firms to sponsor their workers’ visas. Employers first engage in the process by submitting a labor condition application (LCA) to the U.S. Department of Labor for each position they want to fill with a foreign worker. I matched online job postings data with administrative data on LCAs sent by employers. I therefore observed, for each vacancy eligible for the H-1B visa program, whether its employer searched for a foreign worker to fill the position.

I first show that employers are more likely to seek H-1B workers when finding domestic workers takes more time. I used a within-firm within-occupation identification strategy to compare multiple recruitment decisions made by a given employer for similar positions as defined by occupation and location. Employers can fill their vacancies by recruiting either domestic or foreign workers. Domestic workers are legally authorized to work in the U.S. This category includes U.S. citizens, U.S. permanent residents and people living and working in the U.S. with a worker visa. Foreign workers need to be sponsored to obtain an H-1B visa. This category includes workers living abroad and foreign students who graduated from a U.S. university. Sponsoring an H-1B visa is costly in time and money. My results show that employers are more likely to seek foreign workers for positions that take longer to be filled. In baseline regressions, one standard deviation increase in job posting duration increases the probability of submitting an LCA by 28 (1.9) percent (percentage points).

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<sup>1</sup>The real name of the job board on which data were collected is anonymized.

I then investigate the mechanism at play by studying the determinants of job posting duration. Employers' search duration for a given position is determined by the relative demand and supply of domestic workers trained for this job. This relationship is a function of three components: (1) the supply of domestic workers, (2) the wages offered for this position, and (3) the potential employers' preference for foreign workers. I explore the role played by each one of these components in the relationship between job posting duration and the probability of submitting an LCA. I find evidence suggesting that the effect is partly explained by the lack of domestic workers for these occupations. On the contrary, I do not find any evidence supporting the role of wages or the role of employers' preferences for foreign workers.

I also explore the heterogeneity of this effect across employers, occupations and industries. This shows that employer search duration affects more hiring decisions in firms that do not rely extensively on the H-1B visa program. Consistently with the literature, it reports a larger effect for science, technology, engineering, and math (STEM) occupations and for tech industries.

Finally, I use these results to assess the efficiency of the H-1B visa program with respect to its objective of compensating for insufficient domestic labor supply. I build on the results presented above to identify positions that are difficult to fill with domestic workers. I match LCAs with additional data on H-1B visas granted to employers. I then quantify the number of difficult-to-fill vacancies that were denied a visa in fiscal year 2019.

This paper makes three contributions. It first contributes to the literature studying the effect of immigration flows on the labor market outcomes of domestic workers. Assessing this effect requires the degree of complementarity between domestic and foreign workers to be identified. In the context of skilled migration, previous research has mostly focused on the U.S. H-1B visa program. Previous studies have used several empirical methods to assess the complementarity between H-1B workers and natives. First, [Peri et al. \(2015\)](#) and [Peri et al. \(2015\)](#) approached this question by analyzing variations across cities. They both concluded

that native and H-1B foreign workers are complementary at the city level. Second, [Kerr and Lincoln \(2010\)](#) and [Mayda et al. \(2018\)](#) both used a cells-based approach. They showed that natives' employment did not vary differently between cells receiving more or less H-1B workers. Finally, a last set of papers have studied this question by focusing on firms. [Kerr et al. \(2015b\)](#) showed that firms play a “central role” in “admissions of skilled immigrants into the U.S.”. On the one hand, [Kerr et al. \(2015a\)](#) and [Mayda et al. \(2020\)](#) focused on quasi-random variations and reported evidence suggesting complementarity between domestic and foreign workers. On the other hand, [Doran et al. \(2014\)](#) studied variations from the H-1B visas lottery and showed that firms receiving additional H-1B workers did not recruit more domestic workers. My paper contributes to this literature in two ways. First, it takes a closer look at the mechanism at play by focusing on firms' recruitment decisions between domestic and foreign workers. It shows that, on average, H-1B workers are recruited in response to insufficient domestic labor supply in these occupations. Thereby, it also contributes to the literature by offering an explanation to reconcile the results obtained at city, cell and firm levels. First, the lack of domestic workers may explain why firms receiving additional H-1B visas do not recruit more domestic workers in similar occupations, as shown by [Doran et al. \(2014\)](#). Similarly, this is also consistent with the null relationship estimated with cell approaches by [Kerr et al. \(2015a\)](#) and [Mayda et al. \(2020\)](#). Finally, it does not contradict the complementarity observed between domestic and foreign workers at firm and city levels.

This paper also relates to the extensive literature showing how technological changes have shifted labor demand in favor of more educated workers in developed economies. The labor market premium to skill started in the US in the 1980's. [Autor and Katz \(1999\)](#), [Goldin and Katz \(2009\)](#) and [Acemoglu and Autor \(2011\)](#) have provided several overviews of this literature. A first strand has focused on the role played by information and communication technologies in labor demand for highly-skilled educated workers ([Michaels et al., 2014](#)). In addition, [Blair and Deming \(2020\)](#) used detailed vacancy data and showed the increasing demand for skills from U.S. employers in the last decade. [Deming and Noray \(2020\)](#) documented

how skills needed in STEM occupations have changed quickly since the Great Recession, providing an explanation for the insufficient labor supply highlighted in the public debate, especially for STEM occupations ([Chambers et al., 1998](#), [Deloitte and the Manufacturing Institute, 2011](#), [Carnevale et al., 2011](#), [Manpower Group, 2018](#)). [Hanson and Slaughter \(2017\)](#) and [Hanson and Liu \(2017\)](#) highlighted the link between this literature and the role of foreign workers. They respectively documented the increasing share of STEM jobs in the US economy and the important role of foreign-born workers in these occupations. My paper contributes to this literature by providing evidence suggesting that the supply of domestic workers is insufficient compared to the increasing demand for skills. It also contributes to understanding the role of foreign labor supply by showing the mechanism by which employers recruit foreign workers to complement domestic labor supply.

Finally, this paper also contributes to the literature studying firms' recruitment processes via vacancy data. This literature started by studying the determinants of vacancy duration ([van Ours and Ridder, 1992](#), [Burdett and Cunningham, 1998](#)). [Davis et al. \(2014\)](#) and [Davis and de la Parra \(2017\)](#) have also explored the heterogeneity in firms' recruitment behaviors through the lens of vacancy duration, using survey and job board data respectively. [Davis et al. \(2013\)](#) broadened the understanding of firms' recruitment behaviors by using data from the Job Openings and Labor Turnover Survey. More recently, [Faberman and Menzio \(2018\)](#) and [Kettelman et al. \(2018\)](#) have expanded this literature by studying the link between vacancy duration and starting wages. My contribution to this literature is twofold. First, it shows that within-firm variations in job posting duration can be used as a proxy for firms' hiring difficulties. Second, it extends the scope of this literature to the context of migrations. It thus complements [Anastasopoulos et al. \(2019\)](#), who first introduced the use of newspaper vacancy data to study labor demand in the context of migrations.

The paper is structured as follows. Section 2 presents the context of firms' recruitment strategies and the H-1B visa program. Section 3 develops a simple model where employers recruit foreign workers when their expected probability of finding a domestic worker becomes

too low. Section 4 describes the matching procedure between online job postings and administrative data on LCAs. It also describes the data used to analyze and measure job posting duration. Section 5 shows that employers are more likely to seek foreign workers when finding domestic workers takes more time. Section 6 investigates the mechanism driving this relationship between job posting duration and the probability of submitting an LCA. Section 7 provides a better understanding of this relationship by studying its heterogeneity. Section 8 considers the policy implications of these results. Section 9 concludes.

## 2 The H-1B visa program: Context

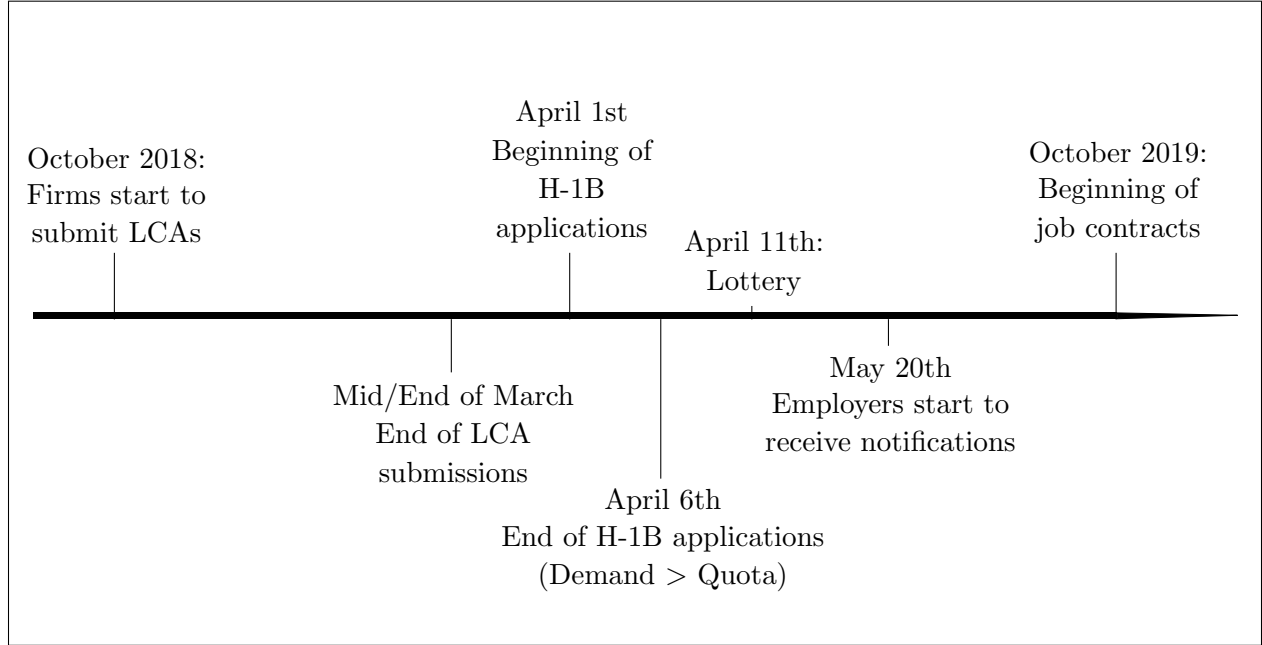
The H-1B visa program is the main alternative to the recruitment of domestic workers. Recruiting a foreign worker under an H-1B visa is costly in both money and time, however, and very uncertain. First, the visas are sponsored by firms. Second, recruiting H-1B workers takes time. Finally, the number of visas awarded is subject to a quota. This section explains why these characteristics must be taken into account when studying employers' recruitment strategies.

H-1B is an employer-driven program that offers one of the main opportunities to recruit foreign workers with at least a bachelor's degree. Contrary to most other types of visas, foreign workers first have to find an American employer willing to hire them. This company then submits a visa application on behalf of the worker. By applying to hire the foreign worker through this procedure, the employer agrees to manage the visa application and cover its cost. This includes both visa fees and attorney's fees, as firms usually employ attorneys to deal with the administrative procedure. The [U.S. General Accounting Office \(2011\)](#) estimated the average cost per visa to be between \$2,320 and \$7,500. If it is obtained, an H-1B visa is valid for three years and can be renewed once.

The H-1B program is subject to a quota. This results in recruitment taking much longer than usual. Figure 1 presents this specific timing. First, U.S. visas are delivered once per fiscal year through a lottery. Employers have to apply in March at the latest, but new



Figure 1: Timeline of the H-1B application process during fiscal year 2019



**Notes:** This graph presents the timeline of the H-1B application process for fiscal year 2019. Fiscal years start and finish in October of each year. The process takes place in fiscal year 2019 in order to obtain visas valid from the beginning of fiscal year 2020 to the end of fiscal year 2022. There are two steps. First, employers submit a labor condition application to the U.S. Department of Labor from October 2018 to March 2019. Second, employers send an I-129 form to U.S. Citizenship and Immigration Services. This second step starts on April 1, 2019.

H-1B holders can only start their employment contract in October. During this period, the visa application process consists of two steps. Employers first submit an LCA to the Department of Labor. They thereby signal their willingness to search among foreign workers. This document allows the administration to check that the job is eligible for the H-1B visa program and that the foreign worker will have the same working conditions as domestic workers. Employers send this first package between October and mid-March, then wait for the approval of the Department of Labor. Then recruiters can formally apply to the U.S. Citizenship and Immigration Administration to obtain an H-1B visa. This second step starts on April 1 and lasts until the quota is reached. Since 2014, firms' applications have exceeded the 85,000 mark during the first week of April every year. To deliver the visas, the administration only selects applications received during this first week and runs a lottery

by the middle of April. Employers receive the result of the lottery between mid-May and mid-June. Finally, winning applicants can start their employment contract by the first of October.

These characteristics of the program have two key implications. First, the number of foreign workers coming to the U.S. depends on demand among firms. Second, H-1B workers are more costly than domestic employees. This suggests that recruiting foreign workers only makes sense when domestic workers are not available, or when foreign workers bring additional benefit to employers. In this paper, I present different pieces of evidence suggesting that employers' demand for foreign workers results partly from the lack of domestic labor supply.

### 3 Theoretical framework

This framework focuses on employers' recruitment decisions. Employers seek to recruit foreign workers when finding domestic workers takes too long. Employers make their decisions by comparing their expected probability of finding a domestic worker to fill the position, and the cost of recruiting a foreign worker.

To fill their vacancies, employers have two options. They can either focus their search efforts on domestic workers only or they can search among both domestic and foreign workers. For the sake of simplicity, I made two assumptions based on the literature. In accordance with [Doran et al. \(2014\)](#), I assumed that both domestic and foreign workers are similarly productive in a given position. In addition, I based myself on [Lofstrom and Hayes \(2011\)](#) to assume that both kinds of workers are paid similar wages.<sup>2</sup> However, recruiting a foreign worker is more expensive as employers must spend additional resources on the visa application process, on top of the usual recruitment costs.

Employers make their decision by comparing the expected present value of seeking a domestic worker only with the expected present value of seeking among both domestic and

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<sup>2</sup>I relaxed these assumptions when testing the model in the empirical analysis. This introduces heterogeneity across employers. My within-firm within-occupation identification takes this dimension into account.

foreign workers. Equation 1 presents the condition under which employers are indifferent between the two options:

$$E[P_d]V + (1 - E[P_d])V_v = E[P_d]V + (1 - E[P_d])[E[P_f](V - C_f) + (1 - E[P_f])(V_v - C_f)]. \quad (1)$$

$E[P_d]$  represents the employer's expected probability of finding a domestic worker to fill the vacancy.  $E[P_f]$  represents the expected probability of finding a foreign worker. This depends on the expected probability of finding the right foreign candidate and the probability of obtaining a visa for this worker.  $C_f$  represents the additional hiring cost associated with the H-1B application process.  $V$  is the value of filling the vacancy.  $V_v$  is the value of an unfilled vacancy.

The main assumption in this framework is that the employer's expected probability of finding a domestic worker to fill the vacancy ( $E[P_d]$ ) decreases with job posting duration. [van Ours and Ridder \(1992\)](#) provided evidence supporting this assumption. According to this paper, the employer's search is likely to be non-sequential, meaning that employers do not immediately accept or reject each application they receive. On the contrary, employers first advertize a vacancy and wait to receive several applications. After receiving a first pool of applications, employers screen all the candidates together. If this first pool includes a suitable domestic candidate, the employer will fill its vacancy with this worker and remove its job posting. Otherwise, the employer will continue their search. As this employer search duration goes on, their expected probability of finding a domestic worker to fill their vacancy ( $E[P_d]$ ) decreases.

Employers start considering foreign workers as soon as their expected present value of searching only among domestic workers drops below their expected present value of searching

among both domestic and foreign workers. From equation 1, this happens when their expected probability of finding a domestic worker drops below the following threshold:

$$E[P_d] < \frac{E[P_f](V - V_v) - C_f}{[E[P_f](V + V_v - 2C_f) + C_f]}. \quad (2)$$

This threshold decreases with the recruitment cost of foreign workers ( $C_f$ ) and increases with the value of filling the vacancy ( $V$ ) and the expected probability of recruiting a foreign worker ( $E[P_f]$ ).<sup>3</sup> The expected probability of finding a domestic worker varies across employers and occupations. So does the right-hand side of equation 2.

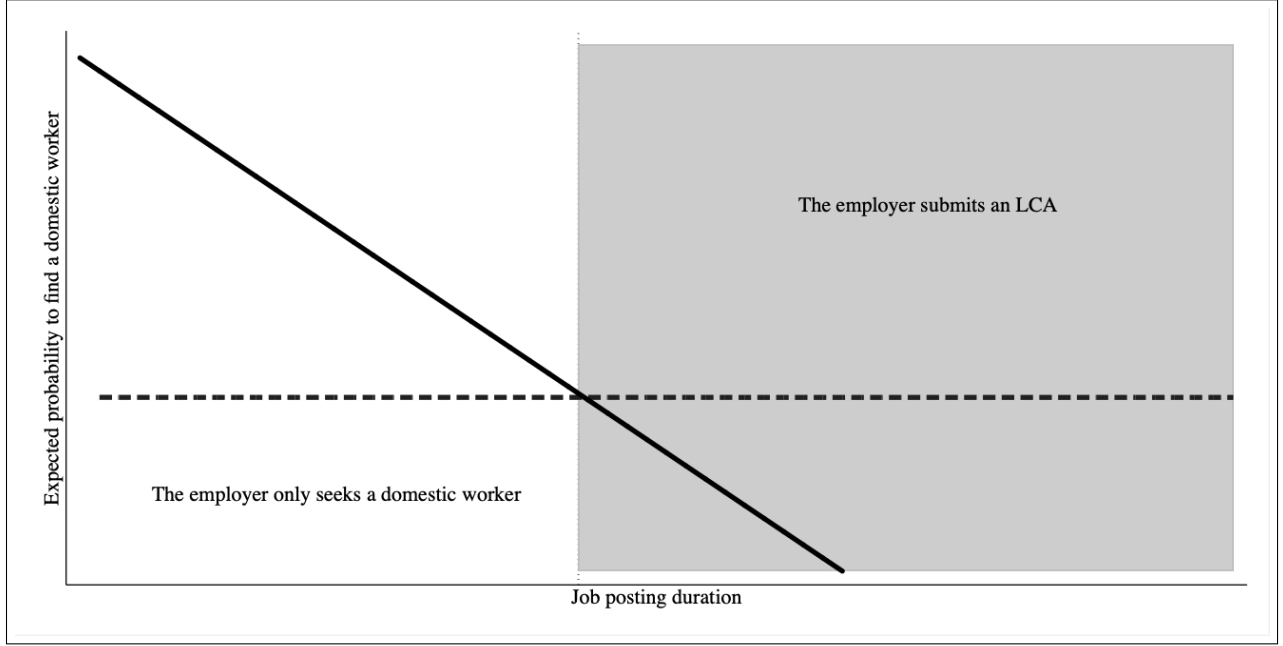
The first step in the process for recruiting a foreign worker with an H-1B visa is to submit an LCA to the U.S. Department of Labor. A direct conclusion from equation 2 is that the probability of submitting an LCA is a decreasing function of the expected probability of finding a domestic worker to fill the vacancy. Therefore, this model predicts that the probability of submitting an LCA increases with the job posting duration. Figure 2 offers a graphical representation of equation 2 and highlights three additional predictions:

1. The steeper the relationship between the expected probability of finding a domestic worker and job posting duration, the closer the relationship between job posting duration and the probability of submitting an LCA.
2. The relationship between job posting duration and the probability of submitting an LCA is closer in occupations in which employers expect difficulties finding a domestic worker.
3. The relationship between job posting duration and the probability of submitting an LCA is closer for employers who expect more difficulties finding a domestic worker.

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<sup>3</sup>The threshold increases with the expected probability of recruiting a foreign worker ( $E[P_f]$ ) as long as the value of filling the vacancy ( $V$ ) exceeds twice the recruitment cost ( $C_f$ ).

Figure 2: Decision to submit an LCA with respect to job posting duration



**Notes:** this figure highlights the relationship between the expected probability of finding a domestic worker ( $E[P_n]$ ) and job posting duration. This relationship is represented with the solid black line. The dashed line represents the right-hand side of equation 1. Employers start considering foreign workers when this probability drops below the dashed line. For simplicity, this graph makes two assumptions. First, it assumes a linear relationship between the expected probability of finding a domestic worker and job posting duration. Second, it assumes that the relationship between the value of filling a vacancy  $V$  and job posting duration is negligible.

## 4 Data

In this paper, I identify positions for which employers seek foreign workers by matching job postings with administrative data on LCA submissions. This original dataset simultaneously observes employers' search durations and recruitment strategy. This section begins by describing the procedure by which I merged both sources at the job level. It then presents the dataset and explores the representativeness of LCAs matched with job postings. Finally, it describes the measure of job posting duration.

## 4.1 Matching procedure

The matching procedure relies on three pieces of information to identify both job postings and LCAs referring to a given position: the location of the job, the name of the company, and the job title. This procedure may be subject to measurement errors when job postings or visa applications are duplicated, but it does represent a second-best option in the absence of a common identifier. This analysis takes advantage of LCAs released by the U.S. Department of Labor. These administrative data detail each position for which an employer initiated a procedure to apply for an H-1B visa from October 2018 to March 2019. It therefore includes these three pieces of information and any job posting advertised online must also specify at least this same information. For this analysis, I collected the entire universe of job postings advertised on one of the largest U.S. job boards, using their Application Programming Interface (API), from November 2018 to the end of June 2019.

For any job advertised on this job board, the matching procedure checked whether there was an associated LCA. The algorithm first focused on the location dimension. Because some ads refer to the city (e.g., New York City) while others refer to their borough (e.g., Manhattan), I first translated the location information into Core Based Statistical Area (CBSA) codes corresponding to commuting zones. For each area, the algorithm then identified a subset of companies included in both online and administrative data. Regarding the firm dimension, both datasets had to be harmonized. As the two sets were collected in different contexts, firms may be referred to by slightly different names between sources (e.g., "Facebook" and "Facebook, Inc."). To fix this issue, I first got rid of the usual suffixes before computing a similarity score between each pair of company names.<sup>4</sup> I only kept pairs whose score exceeded 80% similarity between both strings. I then checked manually whether both names referred to the same employer. For the sake of analysis, any pair of firms for which any doubt remained was categorized as dissimilar. Finally, the algorithm focused on the

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<sup>4</sup>This similarity score was computed using a Jaccard algorithm relying on a bigram method. It was computed with the `matchit` command in Stata 14.

subsample of firms identified as similar across both datasets and looked for identical jobs. Once again, the two documents often referred to the same job with slightly different job titles. Quite often, job postings displayed more precise job titles than LCAs. I identified similar jobs when job titles were the same or when the LCA job title was a subpart of the online job title. At each step, this matching procedure adopted a conservative strategy that mechanically increased the number of false negatives. This tends, if anything, to create a downward bias pulling my estimator toward zero. As my estimate of interest tests whether recruitment duration increases the probability of a job posting being associated with an LCA, my positive estimate can be interpreted, if anything, as a lower bound scenario.<sup>5</sup> Note that the analysis is based on the assumption that the ad duration is uncorrelated with these matching issues.

## 4.2 Sample description

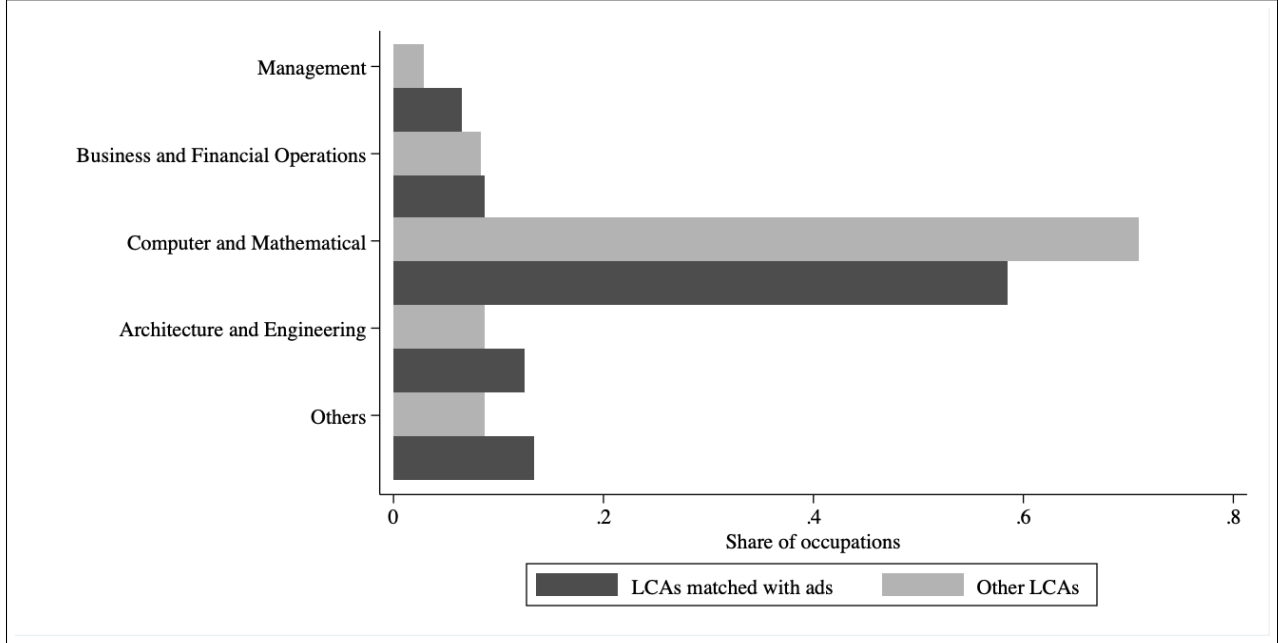
After matching job postings to LCAs, my dataset contained 113,351 job postings collected by the job board on 1,493 employers' career pages. 7,770 of these ads were matched with an LCA. This dataset only includes jobs whose occupations are eligible for the H-1B visa program, as observed in the LCAs. This paper relies on within-firm within-occupation specifications and therefore analyzes the variations driven by the 753 employers who advertised more than one job per occupation. I classified jobs by occupation using the U.S. Department of Labor algorithm. This procedure matches job titles to occupation groups. I took advantage of job categories referenced online by the job board to impute occupations and took account of the limitations of this algorithm, only using information for major and minor groups of occupations as defined by the U.S. Standard Occupation Classification (SOC). Appendix B details this classification.

By applying these data restrictions, this sample represents only 2 percent of the LCAs submitted in fiscal year 2019. However, this sample is fairly representative of all LCAs in terms of occupations. Figure 3 compares the distribution of occupations across LCAs.

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<sup>5</sup>Appendix A describes the relationship between matching issues and estimate biases.

Figure 3: Distribution of occupations across LCAs



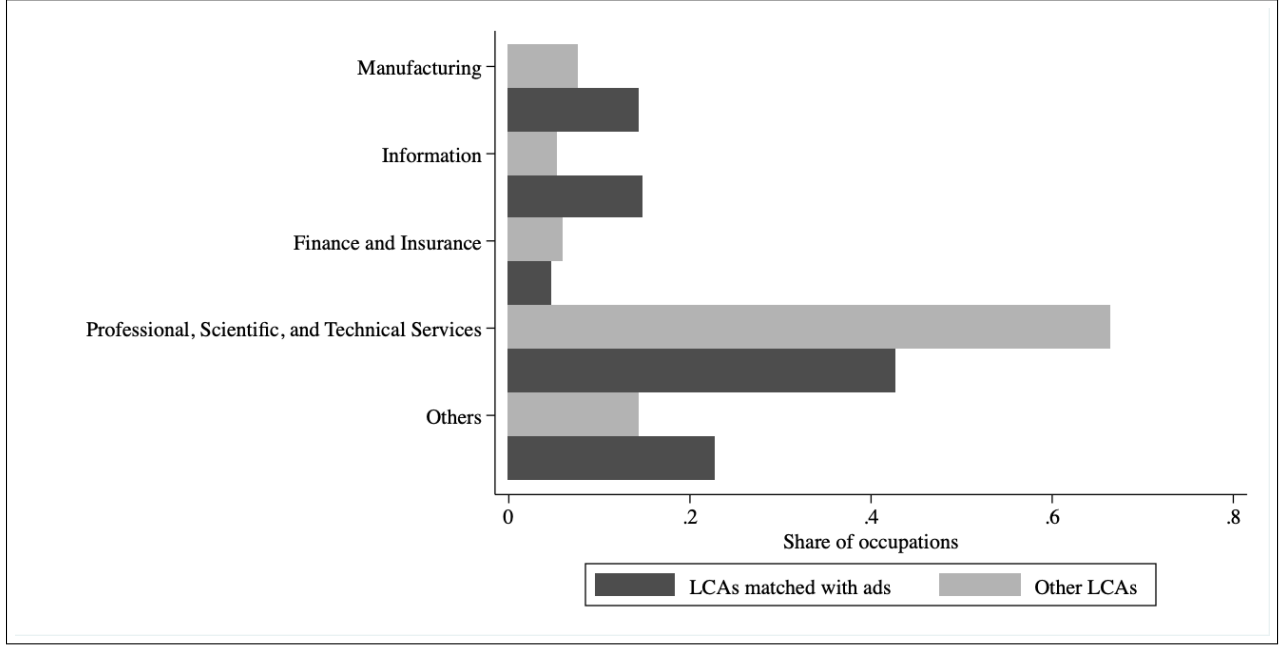
**Notes:** This graph compares the distribution of occupations between two groups of LCAs. Occupations are defined according to the U.S. SOC. The dark grey bars represent LCAs matched with job postings. The lighter grey bars represent the other LCAs. This figure focuses on occupation groups that account for more than 5 percent of all LCAs. **Source:** U.S. Department of Labor.

Dark grey bars represent LCAs matched with job postings. Light grey bars represent the other LCAs. This graph highlights that 70 percent of all LCAs are submitted for computer and mathematical occupations. The rest are distributed across management, business and financial, architecture and engineering, and other occupations. Figure 3 reports small variations across both groups. But overall, both datasets are fairly similar with respect to this dimension.

Distributions by industry diverge more. Figure 4 compares these distributions across both groups of LCAs. This graph shows that 70 percent of LCAs are submitted for positions in the professional, scientific, and technical services. Other LCAs are mostly submitted by companies in manufacturing, information, finance and insurance. Compared to the full set of LCAs, those matched with job postings are more evenly distributed across industries.



Figure 4: Distribution of industries across LCAs



**Notes:** This graph compares the distribution of industries between two groups of LCAs. Industries are defined according to the North American Industry Classification System. The dark grey bars represent LCAs matched with job postings. The grey bars represent other LCAs. This figure focuses on industries that account for more than 5 percent of all LCAs. **Source:** U.S. Department of Labor.

### 4.3 Job posting duration

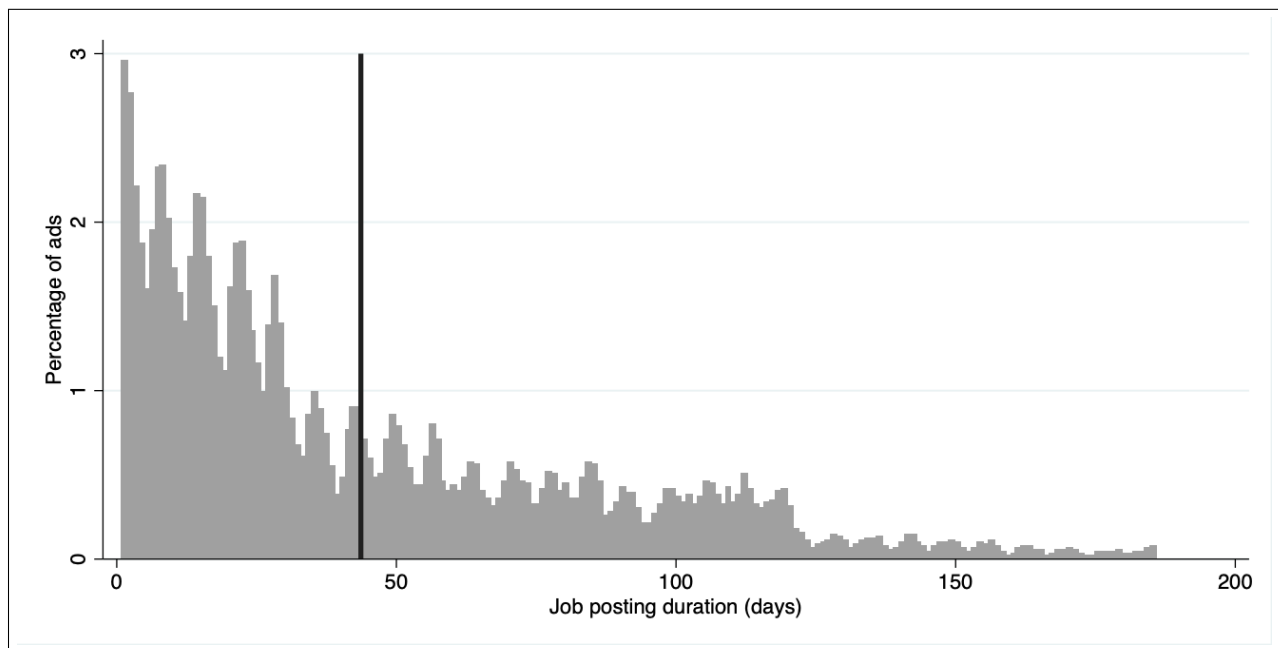
This paper relies on job posting duration to measure the length of recruitment processes. This section first describes the measure of job posting duration. It then presents data characteristics that make this proxy relevant.

I collected job postings data every two weeks from November 2018 to July 2019 using a web-scraping look-alike algorithm to measure job posting durations. Rather than connecting directly to the website, the script makes use of the job board API. This API aims to deliver job posting data continuously to app developers. This allowed me to incorporate a longitudinal feature into my dataset by collecting information successively over time. This data reports the exact posting date of each ad. By collecting data every two weeks, I created a panel where I observed ads that had been removed between two waves. I computed job posting duration as the difference between removal and posting dates. Note that this is subject to a

measurement error of up to two weeks due to the time interval separating two waves of data collection. Figure 5 presents the distribution of this duration measurement. Its values range from one day to six months. The average job posting duration on Job Board A data is 44 days.

I collected data on this job board to ensure that job posting duration was an accurate proxy for the length of recruitment processes. This job board is an aggregator of job ads. Unlike other job boards, it collects job postings directly from the careers pages of the largest companies in the United States. I focused on these specific ads that mirror the information available on firms' careers pages. This specificity eliminates the financial incentive influencing employer behaviors on other job sites. On these platforms, employers usually post their ad for a fixed duration. After the duration is elapsed, they face a second decision: remove their job posting from the website or sign up for another time period. The cost of these

Figure 5: Distribution of job posting duration

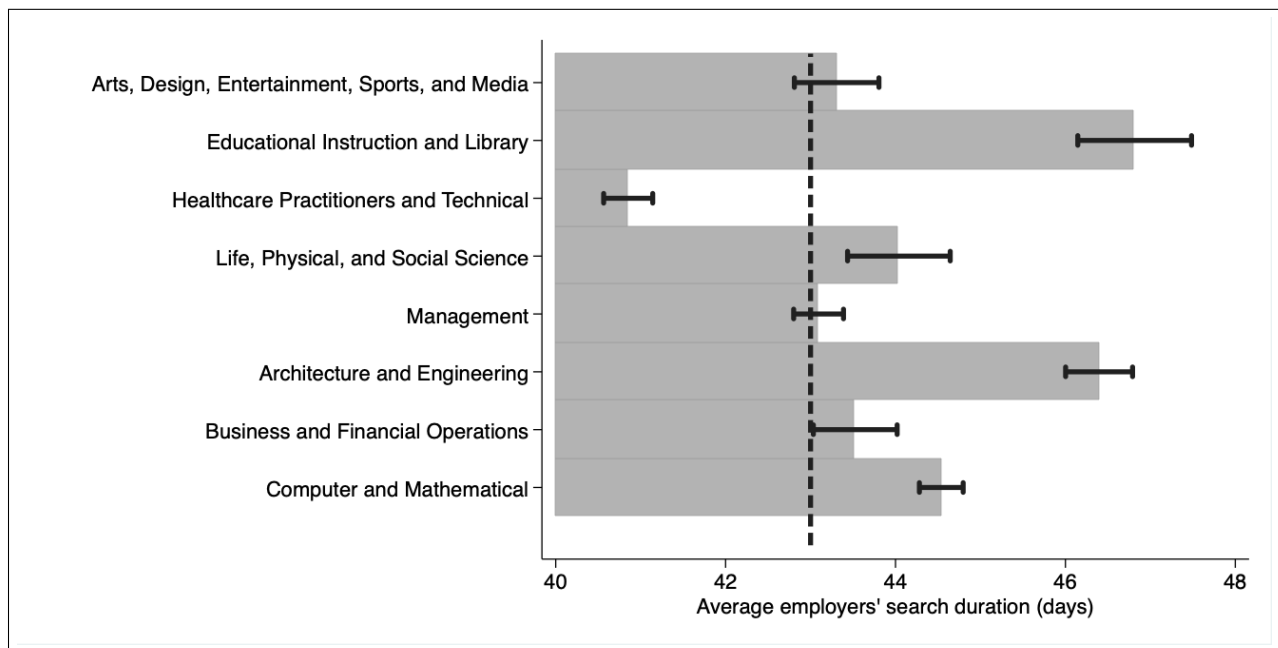


**Notes:** This graph presents the distribution of job posting duration on Job Board A. It relies on job posting data collected from November 2018 to March 2019. The black vertical line represents the average. The distribution ranges from 1 to 186 days with an average of 44 days. Because data are collected every two weeks, the graph is subject to a measurement error of up to two weeks. **Source:** Job Board A.

contracts is likely to influence their strategic decision. On the contrary, the marginal cost of advertising a vacancy on their own careers page is almost null. Therefore, relying on the careers page information to approximate the recruitment duration is more accurate. This could also explain the difference between my measure of average job posting duration and that in [Davis and de la Parra \(2017\)](#). The average duration on Job Board A is five times longer than what they found on Dice.com. Because employers post their ads directly on Dice.com, they face a financial incentive that they do not have on their own careers page. In addition, the average job posting duration on Job Board A is fairly similar to the mean recruitment duration of 34 working days observed by [Davis et al. \(2014\)](#) in Germany.

Note that ads do not last forever on employers' careers pages. Even if the financial incentives to remove vacancies from these pages are almost null, [figure 5](#) also shows that employers voluntarily remove an ad after 44 days, on average. Overall, these lines of evidence

Figure 6: Job posting duration across major groups of occupations.



**Notes:** This graph presents the average job posting duration across major groups of occupations. It focuses on the eight most important groups within the job postings database. The grey bars represent the average duration. The black whiskers depict 95 percent confidence intervals. The vertical black dashed line represents the mean for the whole sample. **Source:** Job Board A.

suggest that job posting duration is an accurate proxy for the length of the recruitment processes.

Interpreting job posting duration as the time needed to fill vacancies, figure 6 compares average job posting durations across the eight largest groups of occupations represented on this job board. It highlights a six-day range from the bottom to the top of the duration distribution. According to this graph, healthcare practitioners and technical occupations are the fastest to fill their vacancies. Educational instruction and library jobs take one additional week on average to find the right candidate. Finally, figure 6 highlights the relative difficulties of filling STEM positions. Among the four groups of occupations with the longest job posting duration, three belong to the STEM category (i.e., computer and mathematical; architecture and engineering; and life, physical, and social sciences occupations).

## 5 Within-firm within-occupation identification strategy

This paper builds on a within-firm within-occupation identification strategy. This specification compares multiple recruitment decisions made by a given employer for similar vacancies that differ by their job posting duration. This section first details the main specification. It then presents the results.

### 5.1 Econometric specification

The within-firm within-occupation specification tests whether employers are more likely to seek foreign workers for positions that are advertised longer. This approach eliminates variations associated with recruitment differences between employers and between occupations. Specifications control for geographic specificities of labor markets as companies are located in several cities. Finally, the analysis takes the job posting date into account to compare vacancies that are as similar as possible. The main specification is the following:

$$\Pr[\text{LCA}_j = 1] = \beta_1 + \beta_2 \text{Duration}_j + \varepsilon_{eo(j)} + \lambda_{l(j)} + \delta_{d(j)} + u_j, \quad (3)$$

where the dependent variable corresponds to the probability of sending an LCA for a given position  $j$ . This specification focuses on the ad duration of position  $j$ , denoted  $\text{Duration}_j$ . Finally,  $\varepsilon_{eo(j)}$  represents the employer-occupation fixed effects,  $\lambda_{l(j)}$  the location fixed effects,  $\delta_{d(j)}$  the polynome controlling for posting date and  $u_j$  the error term. By including this set of controls, the coefficient of interest  $\beta_2$  compares jobs similar in all these dimensions but job posting duration. The coefficient associated with job posting duration ( $\beta_2$ ) tests whether the employers' search duration affects their probability of seeking a foreign worker to fill that given position.

## 5.2 Results

This section supports the main prediction of the model by showing that employers are more likely to seek foreign workers when finding domestic workers takes more time. Table 1 presents the results of the specification presented above. This table progressively increases the number of controls to compare vacancies that are as similar as possible. All specifications take posting dates into account through fixed effects. Therefore, they control for time-specific shocks and reduce noise in the duration measure. Column (2) introduces employer fixed effects. Thereby, it gets rid of variations associated with employers' preference for foreign workers and reduces the estimated relationship between job posting duration and the probability of submitting an LCA. The last two columns refine this estimate by comparing recruitment decisions taking place in similar labor markets. Column (3) narrows the analysis within commuting zones. Column (4) presents the main specification presented above.

Column (4) compares multiple recruitment decisions made by a given employer for similar vacancies that differ by their job posting duration. It shows that on average, a one standard deviation increase in job posting duration increases the probability of submitting an LCA for this given job by 1.88 percentage points. This corresponds to a 28 percent increase in the probability of submitting an LCA. Thereby, it documents the positive relationship between employers' search duration and the decision to seek foreign workers

Table 1: Employers are more likely to seek foreign workers to fill positions advertised longer.

Dependent variable:	Probability to submit an LCA			
	(1)	(2)	(3)	(4)
Job posting duration	0.0305*** (0.0035)	0.0219*** (0.0021)	0.0214*** (0.0021)	0.0188*** (0.0021)
Observations	113,351	113,351	113,351	113,351
Posting date fixed effects	Yes	Yes	Yes	Yes
Firm fixed effects		Yes	Yes	
Commuting zone fixed effects			Yes	Yes
Firm x Occupation fixed effects				Yes

**Notes:** Standard errors in parentheses, \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . This table presents the relationship between the probability to submit a labor condition application for a given job and its job posting duration. It reports average marginal effects from linear probability estimations. The measure of job posting duration is standardized. Standard errors are clustered at the firm level.  
**Source:** Job Board A and U.S. Department of Labor.

### 5.3 Robustness

This section supports the external validity of the results. It takes all the firms observed on Job Board A into account and provides additional evidence of the positive relationship between job posting duration and the probability of submitting an LCA. It thereby addresses one limit of the within-firm within-occupation identification strategy. On the one hand, the within-firm within-occupation approach eliminates all employer-occupation specific variations. On the other hand, however, it restricts the sample to a subset of firms that submitted at least one LCA. Table 2 presents the results for all firms. It no longer controls for employer fixed effects but still shows a positive relationship between job posting duration and the probability of submitting an LCA.

This robustness analysis builds on an extended sample containing 578,351 positions advertised by 4,424 employers. Data restrictions are similar to the main sample. The only difference relates to employers. This robustness sample also keeps employers with no job posting

Table 2: Employers are more likely to seek foreign workers to fill positions advertised longer.

Dependent variable:	Probability to submit an LCA			
	(1)	(2)	(3)	(4)
Job posting duration	0.0010*** (0.0003)	0.0065*** (0.0008)	0.0055*** (0.0006)	0.0050*** (0.0006)
Observations	578,351	578,351	578,351	578,351
Posting date fixed effects		Yes	Yes	Yes
Commuting zone fixed effects			Yes	
Commuting zone $\times$ occupation fixed effects				Yes

**Notes:** Robust standard errors in parentheses, \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . This table presents the relationship between the probability to submit a labor condition application for a given job and its job posting duration. It reports average marginal effects from linear probability estimations. The measure of job posting duration is standardized. Standard errors are clustered at the local labor market level. Local labor markets are defined by commuting zone and major occupation group. **Source:** Job Board A and U.S. Department of Labor.

matched with an LCA. Obviously, this robustness sample includes the whole main sample presented above.

Table 2 shows a positive and significant relationship between job posting duration and the probability of submitting an LCA for all firms. It progressively introduces posting date, commuting zone and commuting zone  $\times$  occupation fixed effects. Standard errors are clustered at the local labor market level where each market is defined by a commuting zone and a major occupation group.

These results support the external validity of table 1. However, magnitudes differ across tables. This can be noted by comparing the second column of table 2 with the first column of table 1 where the results differ only by sample size. One explanation comes from the matching procedure. The robustness sample includes employers with no job posting matched with an LCA. This sample extension therefore mechanically increases, if anything, the number of false negatives (i.e., job postings not matched with an LCA when they should be). Appendix A

shows that an increasing number of false negatives can explain this magnitude difference as it biases the relationship between job posting duration and the probability of submitting an LCA toward zero.

## 6 Mechanism

This section empirically explores the mechanism explaining why employers are more likely to seek foreign workers when finding domestic workers takes more time. Employers' search durations for a given position are determined by the relative demand and supply of domestic workers trained for this job. This relationship is a function of three components: (1) the supply of domestic workers, (2) the wage offered for this position, and (3) the potential employers' preference for foreign workers. I explored the role played by each of these components in the relationship between job posting duration and the probability of submitting an LCA. The first part presents evidence suggesting that the effect is partly explained by the lack of domestic workers for these occupations. In the second and third parts, I do not find any evidence supporting the role of wages nor the role of employers' preferences for foreign workers. These results are consistent with the model presented above.

### 6.1 Lack of domestic labor supply

I first provide evidence suggesting that the relationship between job posting duration and the probability of submitting an LCA is partly driven by the relative lack of domestic supply. Section 4 documents the link between job posting duration and the duration of the hiring process. In this section, I study the relationship between three measures of hiring difficulties and the probability of submitting an LCA. Table 3 reports similar results obtained with job posting duration, average ad duration per labor market, and labor market tightness.

For a given position, job posting duration is determined by two things: (1) relative labor demand and labor supply; and (2) the employer's strategic behavior that has nothing directly to do with relative labor demand and labor supply. I used two other measures of



Table 3: Employers are more likely to seek foreign workers in tight labor markets.

Dependent variable:	Probability to submit an LCA		
	(1)	(2)	(3)
Hiring difficulties proxy:	Job posting duration	Average duration on the labor market	Labor market tightness
	0.0095*** (0.0023)	0.0228*** (0.0050)	0.0295*** (0.0030)
Observations	45,515	45,515	45,515
Standard deviation	1.3287	0.1449	0.0559

**Notes:** Robust standard errors in parentheses, \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . This table presents correlations between the probability to submit a labor condition application and different proxies of hiring difficulties. Job posting duration is the online duration of a given job  $j$ . Average duration on the labor market is the duration of all jobs belonging to the same group of occupations and commuting zone as job  $j$ . Labor market tightness is an index dividing the number of vacancies by the total employment in the same labor market as job  $j$ . Labor market by commuting zone and major group of occupations. This table reports average marginal effects from linear probability estimations. All measures of hiring difficulties are standardized. **Source:** Job Board A and U.S. Department of Labor.

hiring difficulties at the local labor market level, in addition to the job posting duration, to investigate the role played by the lack of domestic workers.

The first was the average duration of the other job postings advertised on the same local labor market. Local labor markets were defined by commuting zone and major group of occupations. The intention in analyzing variations at the local labor market level was to reduce variations associated with firms' strategic behaviors. Average duration was computed separately for each job posting in order to exclude the duration of each given job posting.

The second was local labor market tightness. This is the classic indicator of hiring difficulties in the job search literature (Phelps, 1970, Pissarides, 1974). This index is defined as the ratio of the number of job postings on a specific local labor market to total employment in this same market. Total employment was observed through Occupational Employment

Statistics. The [Open Skills Project](#) provides the total number of job postings per labor market. However, this external data source introduces missing values for some pairs of commuting zone and occupation. This reduced the sample size to 45,515 positions advertised by 1,066 employers. Appendix [C](#) provides more details on the index computation.

Table [3](#) reports positive and significant estimates across all three columns. These correlations suggest that employers are more likely to seek foreign workers when they have trouble finding domestic workers first. This supports the negative relationship between job posting duration and employer’s expected probability of finding a domestic worker to fill its vacancy, as assumed in the model. These estimates are raw correlations. I did not introduce any control. However, the results are consistent with each other. Moreover, the results in columns (2) and (3) are fairly similar, whereas the measures of hiring difficulties are quite different.

## 6.2 Low wage offers

Job posting duration can also be affected by wage offers. Offering a wage below the reservation wage of domestic workers decreases the attractiveness of the position and increases the time needed to fill it. This section investigates whether the relationship between job posting duration and the probability of submitting an LCA is driven by this phenomenon. I replicate the within-firm within-occupation specification and test whether the estimates presented above are driven by employers offering low wages. I do not find any evidence supporting this channel.

I tested the wage channel using LCA information on wage offers made to foreign workers. I used this information because I did not observe any job posting wage offers. However, LCA wage offers allowed me to distinguish two types of employers. These wage offers are regulated by law. According to the U.S. Department of Labor, employers must pay H-1B workers “at least the local prevailing wage.”<sup>6</sup> Prevailing wages are computed by the U.S. Department

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<sup>6</sup>The [Employer Law Guide](#) edited by the U.S. Department of Labor states that the employer must “pay the nonimmigrant workers at least the local prevailing wage or the employer’s actual wage.” [Hira and Gopalaswamy \(2019\)](#) note that “the actual wage requirement has never been enforced” making “prevailing wage [...] the sole binding constraint.” This is why I focused on prevailing wage.

Table 4: The relationship between job posting duration and LCA submission is driven by generous employers.

Dependent variable:	Probability to submit an LCA				
Definitions of Generous employers	(1)	(2)	(3)	(4)	(5)
Job posting duration	0.0224*** (0.0026)	0.0234*** (0.0027)	0.0234*** (0.0029)	0.0217*** (0.0030)	0.0235*** (0.0038)
Job posting duration x not generous employers	-0.0053** (0.0021)	-0.0060*** (0.0020)	-0.0051** (0.0022)	-0.0030 (0.0024)	-0.0051* (0.0029)
Observations	104,582	104,582	104,582	104,582	104,582

**Notes:** \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . Robust standard errors in parentheses. This table compares the relationship between job posting duration and LCA submission across two types of employers. First line estimates present the result for generous employers. Second line estimates present the results for non-generous employers. Column (1) defines as generous those employers who offer a wage premium on top of prevailing wages to foreign workers. Following columns progressively restrict this definition. Column (2) defines as generous those employers offering a wage premium larger than 1 percent of the annual wage on top of prevailing wages. In columns (3) and (4), the wage premium thresholds are respectively set to 5 and 10 percent of the annual wage. Finally, column (5) defines as generous those employers who offer wages larger than the local average wage defined by occupation and measured via the Occupational Employment statistics. All regressions control for posting date, commuting zone, and firm-occupation fixed effects. **Source:** Job Board A and U.S. Department of Labor.

of Labor and depend on geographic location, occupation, and skill level. I distinguished employers making wage offers in line with prevailing wages to foreign workers from those employers making more generous wage offers. I assumed that the employers that offer the lowest wages to foreign workers are also those who offer the lowest wages to domestic workers.

I tested the wage channel by introducing a heterogeneity dimension into the within-firm within-occupation specification. I distinguished the relationship between job posting duration and the probability of submitting an LCA between generous and not-generous employers. This test investigates whether my estimate is driven by not-generous employers. Table 4

considers several definitions of generous employers. Column (1) defines as generous those employers who offer a wage premium on top of prevailing wages to foreign workers. The following columns progressively restrict this definition. Column (2) defines as generous those employers offering a wage premium of more than 1 percent of the annual wage on top of prevailing wages. In columns (3) and (4), the wage premium thresholds are respectively set to 5 and 10 percent of the annual wage. Finally, column (5) defines as generous those employers who offer wages exceeding the local average wage defined by occupation and measured via the Occupational Employment statistics. By restricting the definition of generous employers, table 4 progressively reduces the number of employers in this category.

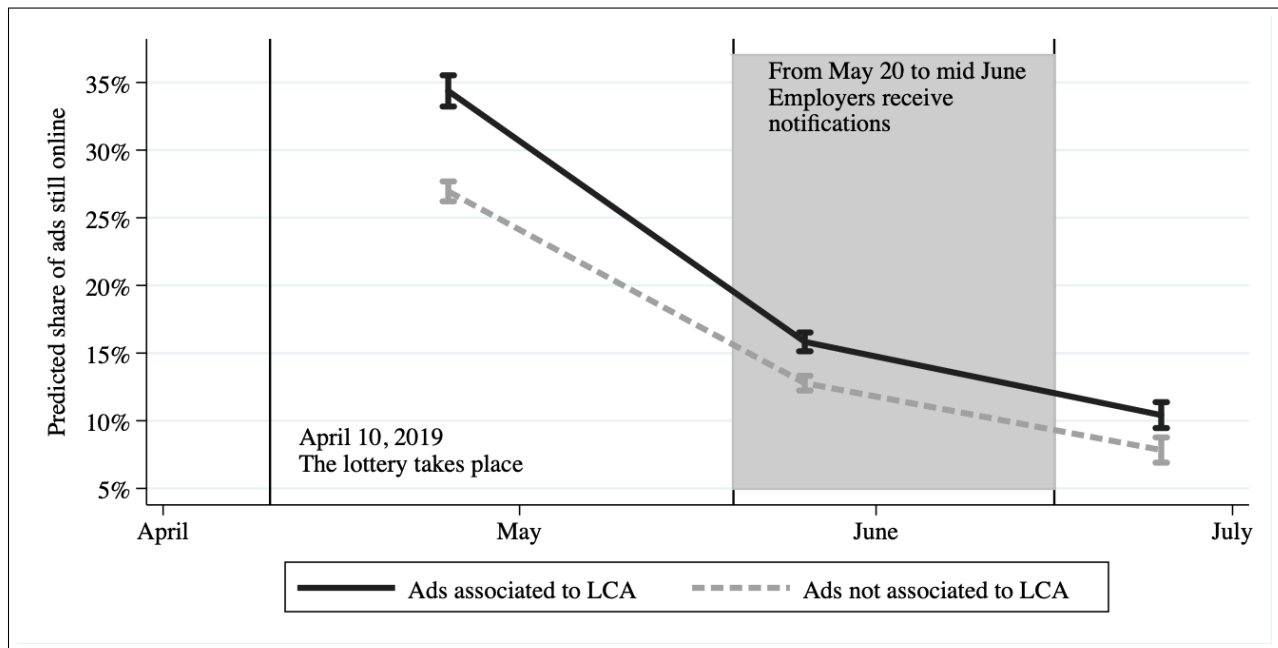
Table 4 rejects the role of not-generous employers in the relationship between job posting duration and the probability of submitting an LCA. The results are consistent across all definitions of generous employers. It shows that the effect is not driven by employers offering low wages. There is therefore no evidence suggesting that low wage offers are driving the estimates presented in table 1.

### **6.3 Employers' preferences for foreign workers**

Job posting duration could also be affected by employers' preferences for foreign workers. If employers prefer foreign over domestic workers, they could adopt a strategic behavior when advertising their vacancies. In particular, they could intentionally keep their domestic advertisements open in order to fulfill the requirements of applying for an H-1B. This section investigates this channel in three ways. First, I show that employers who are looking for both domestic and foreign workers still continue to seek domestic workers when they can no longer recruit foreign workers. Second, I document that vacancies posted after the H-1B application season need more time to be filled in labor markets that submitted more LCAs. Third, I show that the relationship between job posting duration and the probability of submitting an LCA is not driven by employers who have incentives to manipulate their job posting duration. Overall, I do not find any evidence of employer preferences for foreign over domestic workers.

I first investigated employers' preferences for foreign workers by studying their firms' posting strategies. I focused on the period at which the H-1B season ends. I therefore tested whether employers that were looking for foreign workers stopped advertising their vacancies after learning that they could no longer recruit a foreign worker. Considering all relevant jobs advertised between November 2018 and March 2019, I studied the rate at which ads were removed from Job Board A between April and June 2019. Figure 7 compares removal rates between ads associated with an LCA and all other ads. This graph highlights a similar trend across both groups of ads. This suggests that employers that submitted an LCA were not looking only for foreign workers in the first place. Otherwise, we would expect from them

Figure 7: Comparing the share of ads still online after the lottery



**Notes:** This graph studies the probability of a job ad still being online after the lottery awarding H-1B visas took place. It compares job postings for which the employer has submitted an LCA to other job postings. It reports predicted probabilities estimated with ordinary least squares. The dependent variable is a dummy variable indicating whether the vacancy was still online at each period. The main independent variable is a dummy variable distinguishing vacancies associated with an LCA from other vacancies. All regressions control for commuting zone and occupation fixed effects. They also control for the date at which vacancies were posted online in a linear way.  
**Source:** Job Board A and U.S. Department of Labor.

to stop advertising their vacancies after learning that they cannot recruit a foreign worker. Overall, this does not suggest that employers have intrinsic preferences for foreign workers.

I then explored whether a correlation between job posting duration and LCA submission held regardless of employers' strategic behaviors related to the H-1B application process. I used additional data collected between April and June 2019 on Job Board A to measure labor market average job posting durations computed from new ads posted from April 2019 onward. By definition, this measure of job posting duration is independent from the H-1B application process. I related this measurement to the number of LCAs previously submitted per local labor market between October 2018 and March 2019. Table 5 presents this correlation. Column (1) considers all occupations. Columns (2) to (5) focus on specific groups of occupations. All columns report positive and significant correlations. On average, a one standard deviation increase in job posting duration is associated with 10 additional LCAs submitted. This table reveals important variations across groups of occupations. This correlation increases by a factor of eight for computer and mathematical occupations. Overall,

Table 5: Relationship between job posting duration and LCAs submissions after April 2019

Dependent variable:	Number of LCAs submitted in the local labor market				
	All occupations (1)	Management (2)	Business and Financial Operations (3)	Computer and Mathematical (4)	Architecture and Engineering
Job posting duration	10.01*** (5.02)	9.59*** (1.83)	73.91*** (14.3)	81.03*** (31.95)	13.32*** (3.46)
Standard deviation	16.49	16.75	16.49	16.98	17.05
Number of observations	202,914	29,867	10,709	34,026	18,002

**Notes:** \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . Standard errors in parentheses. This table presents the correlation between the average job posting duration and the number of LCAs submitted per local labor market. Local labor markets are defined by major group of occupation and commuting zone. It measures job posting duration on vacancies posted from April 2019 onward. All columns control for occupation and commuting zone fixed effects. **Source:** Job Board A and U.S. Department of Labor.

this table shows that vacancies posted after the H-1B application season need more time to be filled in labor markets that submitted more LCAs.

Finally, I investigated whether the relationship between job posting duration and the probability of submitting an LCA was driven by employers who had incentives to manipulate their job posting duration. H-1B dependent employers and willful violators of the H-1B rules have a specific incentive to manipulate their job posting duration. These specific employers must follow additional rules in order to apply for H-1B visas. The employment law guide specifies that “the employer, before petitioning for H-1B status for any alien worker pursuant to an H-1B LCA, took good faith steps to recruit U.S. workers for the job for which the alien worker is sought.”<sup>7</sup> For example, Zhang and Associates P.C Us immigration lawyers and attorneys explain that “information such as where and when the job postings were advertised, salary offered, and actual job offers and acceptances should similarly be recorded and maintained” in order to document an employer’s good faith efforts.<sup>8</sup> This provides firms with an incentive to intentionally keep their advertisements open in order to fulfill this requirement. This strategic behavior could represent a potential confounder driving the relationship between job posting duration and the probability of submitting an LCA.

I explored this channel by introducing a heterogeneity dimension into the within-firm within-occupation specification. I distinguished the relationship between job posting duration and the probability of submitting an LCA between H-1B dependent and willful violator employers and other employers. This test investigates whether my estimate is driven by the first category of employers. The U.S. Department of Labor’s employment law guide defines an H-1B dependent employer as “one whose H-1B workers comprise at least 15 percent of the employer’s full-time equivalent employees.” Willful violators of H-1B rules are employers who have “committed either a willful failure or a misrepresentation of a material fact” in LCA

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<sup>7</sup>U.S. Department of Labor, [Employment Law Guide, Work Authorization for non-U.S. Citizens: Workers in Professional and Specialty Occupations \(H-1B, H-1B1, and E-3 Visas\)](#), seen on August 20, 2020.

<sup>8</sup>Zhang and Associates P.C US immigration lawyers and attorneys, seen on June 8, 2020.

Table 6: The relationship between job posting duration and the probability to submit an LCA is driven neither by H-1B dependent nor by willful violator employers.

Dependent variable:	Probability to submit an LCA				
Definitions of employers with incentives to manipulate	H-1B dependent (1)	Willful violators (2)	Both (3)	Both > \$60,000 (4)	Both > \$70,000 (5)
Job posting duration	0.0185*** (0.0021)	0.0188*** (0.0021)	0.0185*** (0.0021)	0.0185*** (0.0021)	0.0185*** (0.0021)
Job posting duration x Employers with incentives to manipulate	0.0150* (0.0086)	0.0111 (0.0416)	0.0150* (0.0086)	0.0160* (0.0088)	0.0173* (0.0089)
Observations	113,351	113,351	113,351	113,351	113,351

**Notes:** \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . Robust standard errors in parentheses. This table presents the relationship between the probability to submit a labor condition application for a given job and its job posting duration. In particular, it explores the heterogeneous effect of job posting duration between H-1B dependent and willful violator employers and other employers. An H-1B dependent employer is, generally, one whose H-1B workers comprise at least 15 percent of the employer’s full-time equivalent employees. Willful violators of H-1B rules are employers who have “committed either a willful failure or a misrepresentation of a material fact” in LCA attestations. Column (1) separates H-1B dependent employers from the others. Column (2) distinguishes willful violator from other employers. Column (3) gathers H-1B dependent and willful violator employers in one category opposed to the rest of employers. Column (4) restricts the category of employers who have an incentive to manipulate their job posting duration to H-1B dependent and willful violator employers whose average LCAs’ wage is larger than \$60,000 per year. Column (5) increases this threshold to \$70,000. The table reports marginal effects estimated from linear probability estimations. All regressions control posting date, commuting zone, and firm-occupation fixed effects. The measure of job posting duration is standardized. Standard errors are clustered at the firm level. **Source:** Job Board A and U.S. Department of Labor.

attestations. LCAs identify H-1B dependent and willful violator employers. I matched this information with job postings at the employer level.

Table 6 shows that the relationship between job posting duration and the probability of submitting an LCA is not driven by employers who have incentives to manipulate their job posting duration. It replicates the within-firm within-occupation specification and distinguishes



the main effect between employers who have this incentive to adopt a strategic behavior and employers who do not. Column (1) separates H-1B dependent employers from the others. Column (2) distinguishes willful violators from other employers. Column (3) distinguishes all H-1B dependent *and* willful violator employers from all others. It is worth noting that additional rules only apply for non-exempt H-1B workers. The U.S. Department of Labor’s employment law guide mentions that “H-1B dependent employers that hire H-1B workers who are paid at least \$60,000 per year or have a master’s degree or higher in a specialty related to the employment, can be exempted from these additional rules.” Columns (4) and (5) take this exemption into account when distinguishing employers. Because I cannot identify exempted jobs from job posting data, I used the wage information in the LCAs. Column (4) restricts the category of employers who have an incentive to manipulate their job posting duration to H-1B dependent and willful violator employers whose average LCA wage is higher than \$60,000 per year. Column (5) increases this threshold to \$70,000. Overall, table 6 shows that the relationship between job posting duration and the probability of submitting an LCA is not driven by H-1B dependent nor willful violator employers. The interaction term is slightly significant but most of the effect is driven by employers without any incentive. Results are robust across definitions of employers who have an incentive to manipulate their job posting duration. This does not provide any evidence supporting the role of the preference channel.

## 7 Heterogeneity analysis

This last section explores the heterogeneity of the relationship between job posting duration and the probability of submitting an LCA across employers, occupations, and industries. First, it studies which type of employers are most likely to seek foreign workers for lack of domestic labor supply. Then, it compares this relationship across occupations and industries to assess which positions are the most likely to be affected by the lack of domestic labor supply.

The distribution of H-1B applications is skewed toward a small number of employers. While half of all companies that submit LCAs send only ten or fewer applications, some recruiters submit a large number of LCAs. In this section, I first investigated whether these large petitioners are as likely as other employers to be driven by a lack of domestic labor supply. This test builds on the within-firm within-occupation specification and introduces a heterogeneity dimension across employers. Column (1) defines large petitioners as employers who have submitted more than 20 LCAs in fiscal year 2019. Column (2), (3), and (4) adopt larger thresholds. They respectively define large petitioners as employers who have submitted more than 50, 100 and 150 LCAs in fiscal year 2019. I compared the relationship between

Table 7: The relationship between job posting duration and the probability to submit an LCA is not driven by large petitioners.

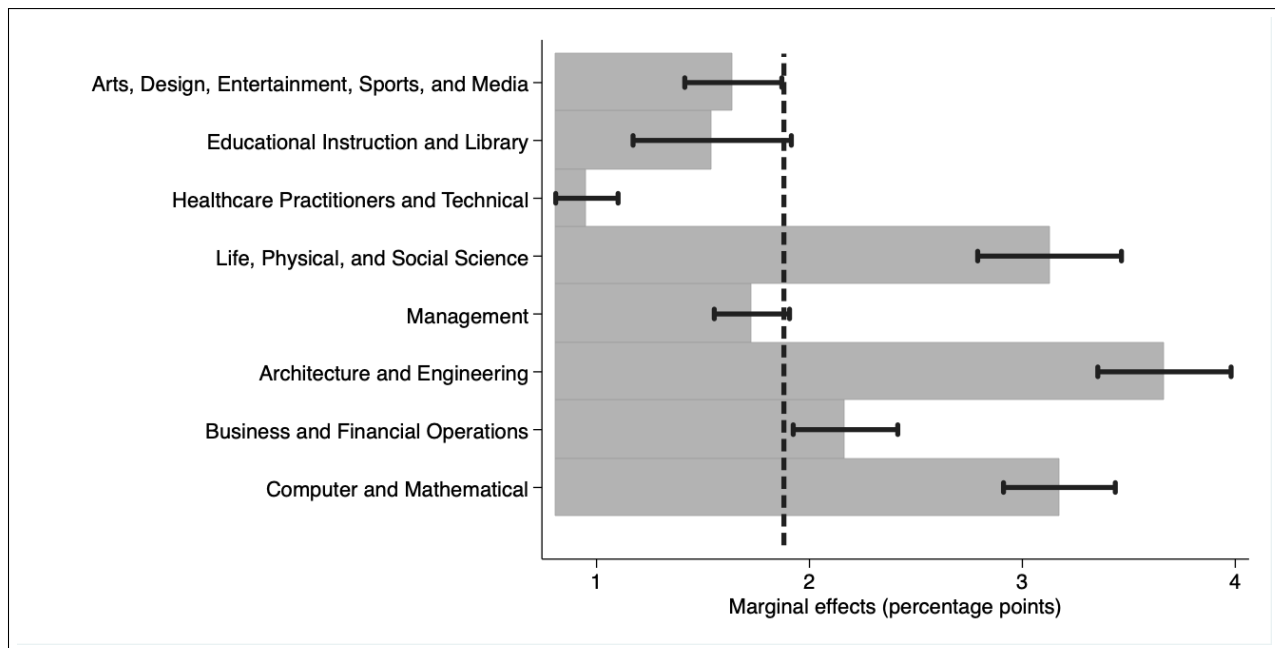
Dependent variable:	Probability to submit an LCA			
	Large petitioners submitted more than 20 LCAs (1)	50 LCAs (2)	100 LCAs (3)	150 LCAs (4)
Job posting duration	0.0216*** (0.0025)	0.0198*** (0.0024)	0.0192*** (0.0023)	0.0184*** (0.0022)
Job posting duration x large petitioners	-0.0068*** (0.0020)	-0.0055** (0.0024)	-0.0054* (0.0028)	-0.0032 (0.0029)
Observations	113,351	113,351	113,351	113,351

**Notes:** \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . Robust standard errors in parentheses. This table compares the relationship between job posting duration and LCA submission across two types of employers. First line estimates present the result for employers who are not considered as large petitioners. Second line estimates present the results for large petitioners. Column (1) defines large petitioners as employers who have submitted more than 20 LCAs in fiscal year 2019. Columns (2), (3), and (4) adopt larger thresholds. They respectively define large petitioners as employers who have submitted more than 50, 100 and 150 LCAs in fiscal year 2019. All regressions control for posting date, commuting zone, and firm-occupation fixed effects. The measure of job posting duration is standardized. Standard errors are clustered at the firm level. **Source:** Job Board A and U.S. Department of Labor.

job posting duration and the probability of submitting an LCA across large petitioners and the rest of employers. Table 7 shows that this relationship is mostly driven by employers who only submitted a few LCAs. Results are consistent with table 1. The interaction term between job posting duration and the dummy variable identifying large petitioners is negative and slightly significant. The results are robust across different definitions of large petitioners. This suggests that large petitioners are less likely to be driven by the lack of domestic labor supply when seeking foreign workers.

Balances between labor demand and labor supply vary across occupations. I investigated which groups of occupations are the most affected by a lack of domestic labor supply by comparing the relationship between job posting duration and the probability of submitting an LCA across major groups of occupations and groups of industries. Figure 8 reports the

Figure 8: Heterogeneity across major groups of occupations

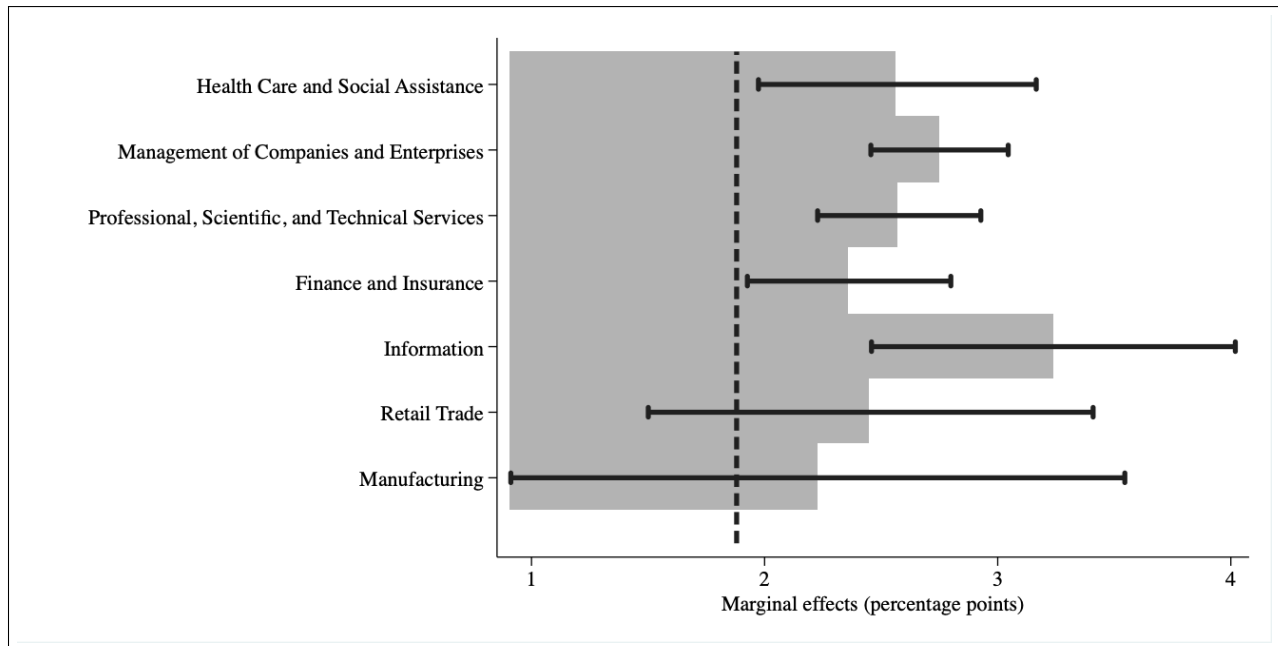


**Notes:** This graph presents the relationship between the probability of submitting a labor condition application for a given job and its job posting duration. It reports marginal effects estimated with a probit estimation. It highlights heterogeneous results across major groups of occupations. The vertical dash line represents the average estimate at 1.88 percentage points. The estimation controls for commuting zone and posting date fixed effects. The measure of job posting duration is standardized. **Source:** Job Board A and U.S. Department of Labor.

results for eight major groups of occupations. This graph highlights that the relationship is particularly important for three groups: computer and mathematical; architecture and engineering; and life, physical, and social science occupations. For these categories, a one standard deviation increase in job posting duration increases the probability of submitting an LCA by more than 3 percentage points. This effect is 30 to 70% smaller for the last five groups of occupations. This graph suggests that scientific, technological, engineering, and mathematical (STEM) occupations are the most likely to be affected by insufficient domestic labor supply.

Finally, figure 9 reports the results for seven major groups of industries. It shows that the relationship between job posting duration and the probability of submitting an LCA is more important in three groups of industries, namely information, management of companies, and

Figure 9: Heterogeneity across major groups of industry



**Notes:** This graph presents the relationship between the probability of submitting a labor condition application for a given job and its job posting duration. It reports marginal effects estimated with a probit estimation. It highlights heterogenous results across major groups of industries. The vertical dash line represents the average estimate at 1.88 percentage points. The estimation controls for commuting zone and posting date fixed effects. The measure of job posting duration is standardized.

**Source:** Job Board A and U.S. Department of Labor.

professional, scientific and technical services. Similarly, these groups are the most likely to be affected by insufficient domestic labor supply.

## 8 Policy implications

The objective of the H-1B visa program is to provide employers with the opportunity to recruit foreign workers for positions that are difficult to fill with domestic workers. This last section assesses the efficiency of the program with respect to this objective. It builds on the results presented above to identify positions that are difficult to fill with domestic workers. It then computes the number of H-1B visas delivered to these positions and the number of H-1B applications submitted. Finally, it quantifies the number of difficult-to-fill positions that did not obtain a visa in fiscal year 2019.

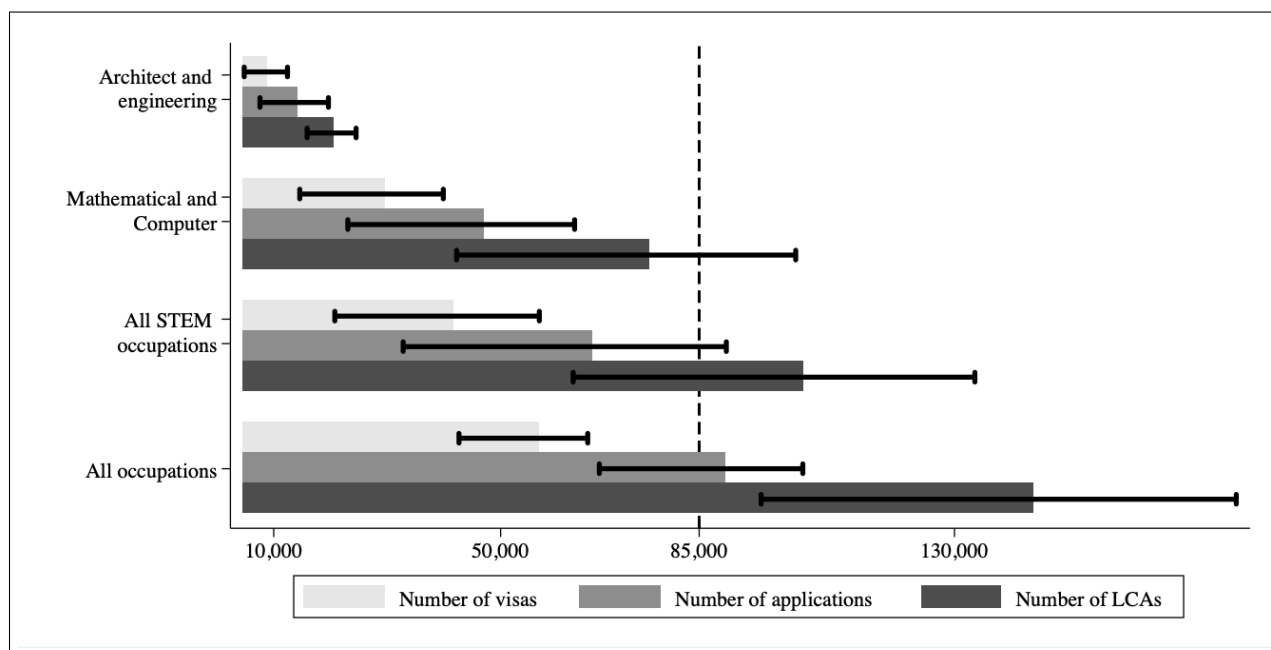
According to sections 6.2 and 7, employers defined as generous and small petitioners face more difficulties in filling their vacancies with domestic workers, especially in STEM occupations. Figure 10 presents the number of LCAs, the number of H-1B applications and the number of H-1B visas delivered to these positions. I first computed the number of LCAs submitted for difficult-to-fill positions with the data used throughout this paper. I then used additional data released by the U.S. Citizenship and Immigration Services (USCIS) on the number of visas delivered each year to each employer. This dataset is aggregated at the employer level and does not include information on occupations. I imputed this information by matching this additional dataset with LCAs on employer names.<sup>9</sup> Because H-1B visas are delivered through a lottery, the imputation of visas to occupation categories depends on the distribution of H-1B applications per occupation. USCIS data do not include information on H-1B applications. I therefore computed a range of results by making different assumptions based on the distribution of LCAs per occupation. Black whiskers present these ranges of results. The middle scenario assumes that the distribution per employer of H-1B

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<sup>9</sup>I compute a similarity score between each pair of company names using a Jaccard algorithm relying on a bigram method. It was computed with the `matchit` command in Stata 14. This algorithm matches 80% of employers registered in the H-1B dataset provided by the USCIS with their corresponding LCAs.

applications across occupations is similar to the distribution per employer of LCAs across occupations. The upper bound scenario assumes that employers first submitted applications for occupations identified as difficult to fill with domestic workers. The lower bound scenario does not make any assumption. It excludes visas for which the occupation is uncertain and only takes into account employers who submitted LCAs to only one group of occupations.

Figure 10: LCAs, H-1B applications and visas for difficult-to-fill positions



**Notes:** This graph presents the number of LCAs submitted, the number of H-1B applications submitted, and the number of H-1B visas delivered to positions identified as difficult to fill. This category includes vacancies advertised by small petitioners and generous employers. Small petitioners are defined as employers who submitted less than 50 LCAs in fiscal year 2019. Generous employers are defined as recruiters who offer wages to foreign workers above the average wage in the local labor market. Local labor markets are defined by commuting zones and 2 digits occupation codes. I imputed the number of H-1B applications according to the average winning rate in the H-1B visa lottery. The numbers of H-1B applications are 68% larger than the numbers of H-1B visas as the average lottery winning rate was 42% in fiscal year 2019. The vertical dash line highlights the 85,000 quota for H-1B visas. Black whiskers present several scenarios. The lower bound scenario only takes account of employers who submitted LCAs for only one group of occupations. This scenario adopts the most restrictive definition of generous employers and small petitioners. The middle scenario assumes that the distribution per employer of H-1B applications across occupations is similar to the distribution of LCAs. The upper bound scenario assumes that employers first submitted applications for positions that were difficult to fill with domestic workers. This scenario adopts the less restrictive definition of generous employers and small petitioners. **Source:** U.S. Citizenship and Immigration services and U.S. Department of Labor.

Finally, I imputed the number of H-1B applications submitted for each category. This computation was based on the average chances of selection in the lottery. In fiscal year 2019, 65,000 visas were granted among all H-1B applications. An additional 20,000 visas were then granted among the remainders. This second lottery only took into account applications made for foreign workers with a masters degree from an U.S. university. In fiscal year 2019, a total of 201,011 applications subject to the quota were received. However, USCIS data does not allow a distinction between visas granted through each of the lotteries. I approximated that 42% of H-1B applications were granted a visa by dividing the 85,000 visas by the 201,011 applications. The law of large numbers implies that this proportion is similar across the five categories. Therefore, I imputed that the aggregate numbers of H-1B applications are 58% larger than the number of H-1B visas observed in each category.

Overall, 25 to 38 thousand applications submitted for positions that are difficult to fill with domestic workers are not granted a visa. Among these applications, 12 to 33 thousand belong to STEM occupations.<sup>10</sup> This represents 63% of applications submitted for difficult-to-fill positions that are not granted a visa. Two levers of actions are possible to improve the efficiency of the H-1B visa program. To reduce the number of difficult-to-fill positions that are not granted a visa, the administration could first increase the 85,000 quota. By awarding more visas, the administration would reduce the number of these positions that remain unfilled. Alternatively, the administration could implement different quotas per category of jobs. For instance, targeting STEM jobs with a specific quota that is more than proportional to STEM applications would improve the efficiency of the H-1B visa program without changing the 85,000 visas cap.

## 9 Conclusion

This paper documents how U.S. employers seek to recruit skilled foreign workers to top up the insufficient labor supply of domestic workers. In particular, it shows that employers are more

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<sup>10</sup>These figures represent lower bound estimates as they rely on a definition of positions difficult to fill at the intensive margin.

likely to seek foreign workers when finding domestic workers takes more time. Within-firm within-occupation specifications show that employers are 28 percent more likely to submit an LCA when the job posting duration is one standard deviation longer. It then explores the mechanism driving this relationship. It provides evidence suggesting that this phenomenon is due to insufficient domestic labor supply in specific occupations. On the contrary, it does not find any evidence supporting the role of low wages or employers' preference for foreign workers. Finally, this paper explores the heterogeneity of this effect across firms, occupations and industries. It pinpoints the particular difficulty of recruiting a suitable domestic worker in STEM occupations, and especially for firms submitting only a few LCAs. Finally, this paper shows that 25 to 38 thousand difficult-to-fill positions were denied a visa to recruit a foreign worker in fiscal year 2019.

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## Appendix

## A Matching algorithm and lower bound estimate

Ads associated with LCAs:		Ads not associated with LCAs:	Average duration:
Ads matched with LCAs:	True positive ( $D_{A1}$ )	False positive ( $D_{B1}$ )	$\bar{D}_1$
Ads not matched with LCAs:	False negative ( $D_{A2}$ )	True negative ( $D_{B2}$ )	$\bar{D}_2$
Average duration:	$D_A$	$D_B$	

Interpreting how matching issues might affect the sign of my estimate relies on one assumption. I only assume that the probability of matching an ad with its LCA does not change over its lifetime. Building on this assumption, I distinguish three cases according to the correlation existing between job posting duration and the association with LCAs.

The first case assumes a positive correlation between job posting duration and the association with an LCA. In this scenario, the estimate of interest is denoted as follows:

$$D_A = D_{A1} = D_{A2},$$

$$D_B = D_{B1} = D_{B2},$$

$$\beta = D_A - D_B,$$

$$\beta > 0.$$

From an empirical perspective, what I do estimate is the following quantity:

$$\hat{\beta} = \bar{D}_1 - \bar{D}_2.$$

Without any matching issue:

$$\bar{D}_1 = D_{A1} = D_A,$$

$$\bar{D}_2 = D_B = D_{B2},$$

where my estimator  $\hat{\beta}$  is equal to the quantity of interest  $\beta$ . However, matching issues change my estimate  $\hat{\beta}$  as follows:

$$\bar{D}_1 = \frac{D_{A1} + D_{B1}}{2},$$

$$\bar{D}_2 = \frac{D_{A2} + D_{B2}}{2}.$$

Because  $D_{B1}$  is smaller than  $D_{A1}$  and  $D_{A2}$  is larger than  $D_{B2}$ , this implies:

$$\bar{D}_1 < D_A,$$

$$\bar{D}_2 > D_B,$$

$$\hat{\beta} < \beta.$$

In this scenario, matching issues introduce a downward bias driving my estimate toward zero.

The second case assumes a negative correlation between job posting duration and the association with an LCA. In this scenario, the computation described above leads to a symmetrical result. Matching issues introduce an upward bias driving my estimate toward zero. Note that the likelihood of this difference becoming positive is very small. By adopting the most conservative matching strategy, I limit the number of false positives as much as possible. Moreover, if the number of false negatives were larger than the number of false positives, it would drive the average duration of the unmatched ads ( $\bar{D}_2$ ) toward the average duration of the ads matched with LCAs ( $\bar{D}_1$ ). This would result in a null estimate.

Finally, the last case assumes no correlation between job posting duration and the association with LCA. In this scenario, matching issues do not introduce any bias in my estimate ( $\beta$ ).

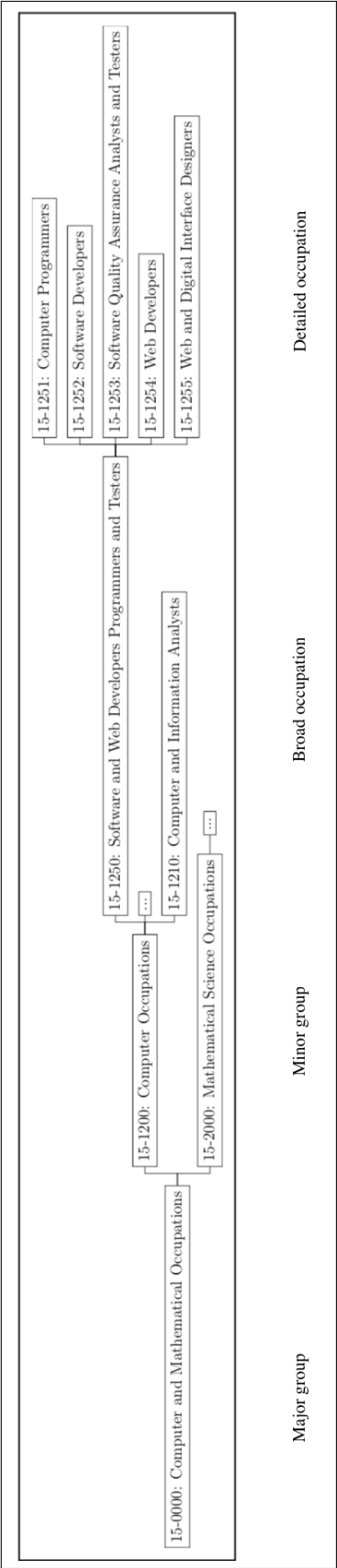
## B The U.S. Standard Occupation Classification system

Throughout the empirical analysis, I used the U.S. Standard Occupation Classification system to identify occupations. This section describes that categorization.

The SOC system aims to classify jobs into occupational categories. It is organized into a four-tiered system composed of 23 major groups, 98 minor groups, 459 broad occupations, and 867 detailed occupations. More especially, this classification system relies on SOC codes. The most precise level includes six digits. The two first ones correspond to the major group, the following two to the minor group, broad occupations are then specified by the 5th digit, and detailed occupations are indicated by the last digit. Each detailed SOC occupation includes all jobs with "similar job duties, and in some cases, similar skills, education, and/or training."

Figure 11 presents some of the hierarchy of SOC occupations within computer and mathematical occupations. This example highlights the high degree of precision in the distinction of detailed occupations. For instance, it distinguishes computer programmers from software developers. While the former "create, modify and test the code that allow computer applications to run," the latter "develop computer and network software or specialized utility programs." While job duties vary across both occupations, table 8 describes their similarities in skills. This table describes five main skills and the tools used for them in each occupation. Common tools are bolded in the text. They represent almost half of the toolbox used in both jobs. This suggests that workers performing one of these occupations could also be hired to fulfil the other.

Figure 11: SOC classification: the computer occupation example



This table presents the different levels of the U.S. Standard Occupational Classification. It focuses on the example of computer occupations.



Table 8: Five main skills per occupation

Detailed occupation SOC code	Computer programmers 15-1251	Software Developers 15-1252
Data base management system software	Apache Cassandra; <b>MongoDB</b> ; Oracle PL/SQL; <b>Teradata Database</b>	Apache Hadoop; <b>MongoDB</b> ; MySQL; <b>Teradata Database</b>
Development environment software	<b>Apache Maven</b> ; <b>C</b> ; Microsoft Visual Basic Scripting Edition VBScript ; Ruby	<b>Apache Maven</b> ; <b>C</b> ; Microsoft Power Shell; Verilog
Object or component oriented development software	<b>C++</b> ; <b>Oracle Java</b> ; Practical extraction and reporting language Perl ; <b>Python</b>	<b>C++</b> ; <b>Oracle Java</b> ; <b>jQuery</b> ; <b>Python</b>
Web platform development software	<b>AJAX</b> ; Google AngularJS; <b>jQuery</b> ; <b>Microsoft ASP.NET Core MVC</b>	<b>AJAX</b> ; Drupal; <b>Microsoft ASP.NET</b> ; Oracle JavaServer Pages JSP
Program testing software	Hewlett Packard LoadRunner; JUnit; Selenium ; Usability testing software	
Compiler and decompiler software		Command interpreters; Just-in-time compiler; Mixed code generator; Threaded code compiler

Notes: The set of skills used in both occupations is given by the O\*NET API from the US Department of Labor.

## C Measuring labor market tightness

This section presents both data sources used to construct my measure of labor market tightness. To construct this index, I used both online and survey data.

### C.1 Open Skills Project

The [Open Skills Project](#) aims to compile a classification of skills associated with each job included in the U.S. labor market. It is composed by a consortium including research institutions, online job boards, and non-profit developers. This partnership allows researchers to exploit proprietary data on U.S. job postings to build a crosswalk between occupations and skills with a high level of granularity. In particular, they "build on and expand on the Department of Labor's O\*NET data resources."

In this paper, I took advantage of the Open Skills Research Hub. This part of the project releases quarterly aggregate data on U.S. job postings at occupation and commuting zone levels. As data are provided by several of the main U.S. job boards ([ADP](#), [Career Builder](#), [the National Labor Exchange](#)), they provide me with the largest possible picture of the U.S. labor market. The hub details the quarterly aggregate number of job postings advertised online. These data are released at the local labor market level. The occupations are classified with six-digit SOC codes. Locations are identified through Core-Based Statistical Areas that correspond to commuting zones. These aggregate figures provided me with the numerator of my labor market tightness ratio.

### C.2 Occupational Employment Statistics

After measuring labor demand with online data, I approximated the supply side by taking advantage of the Occupational Employment Statistics (OES) released by the U.S. Department of Labor. This section describes this additional source of data.

The OES is a semiannual survey based on 1.2 million U.S. establishments. It produces employment estimates for approximately 800 occupations. As data are released with the same

level of granularity as the demand side, they provided me with indirect insights regarding the denominator of the tightness ratio. Theoretically, measuring labor supply would necessitate observing the number of unemployed workers per occupation and commuting zone. Due to data constraints, I approximated this measure with employment estimates provided by this survey. This approximation is rooted in models of on-the-job search. This framework describes firms that recruit workers already employed by other firms. According to this theoretical framework, the supply side includes the whole labor force rather than only unemployed workers. Therefore, there are two possible implicit assumptions supporting the identification. On the one hand, this approximation does not raise any issue if the share of unemployed workers per local labor market is much smaller than the share of employed workers. On the other hand, identification problems are minimized if both quantities are correlated. Relying on these assumptions, I measure the tightness denominator with employment estimates provided by the OES.

## D Results for fiscal year 2018

This appendix replicates all the results for fiscal year 2018. It thus tests the robustness of the main results on another sample. However, the quality of the data is poorer, because I collected online job postings for a shorter time frame. This sample only observes job postings in February and March 2018. Similarly to fiscal year 2018, the first part of the application process ended in late March. Visas were delivered through a lottery taking place in April 2018, and H-1B winners started their employment contracts in October 2018. Results are similar in terms of sign and magnitude to those estimated for fiscal year 2019. The significance of estimates is also similar for most results but heterogeneity analyses. Estimating these specifications with smaller samples increases the confidence intervals. The rest of this section follows the same order as that adopted in the core of the paper.

### D.1 Section 4: Results (2018)

Table 9: Employers are more likely to seek foreign workers to fill positions advertised longer (fiscal year 2018).

Dependent variable:	Probability to submit an LCA			
	(1)	(2)	(3)	(4)
Job posting duration	0.0420*** (0.0079)	0.0309*** (0.0047)	0.0315*** (0.0048)	0.0285*** (0.0045)
Observations	48,662	48,662	48,662	48,662
Posting date fixed effects	Yes	Yes	Yes	Yes
Firm fixed effects		Yes	Yes	
Commuting zone fixed effects			Yes	Yes
Firm x Occupation fixed effects				Yes

**Notes:** Standard errors in parentheses, \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . This table presents the relationship between the probability to submit a labor condition application for a given job and its job posting duration for fiscal year 2018. It reports average marginal effects from linear probability estimations. The measure of job posting duration is standardized. Standard errors are clustered at the firm level. **Source:** Job Board A and U.S. Department of Labor.

## D.2 Section 4: Robustness (2018)

Table 10: Employers are more likely to seek foreign workers to fill positions advertised longer (fiscal year 2018).

Dependent variable:	Probability to submit an LCA			
	(1)	(2)	(3)	(4)
Job posting duration	0.0009** (0.0004)	0.0081*** (0.0012)	0.0065*** (0.0011)	0.0057*** (0.0011)
Observations	282,536	282,536	282,536	282,536
Posting date fixed effects		Yes	Yes	Yes
Commuting zone fixed effects			Yes	
Commuting zone $\times$ occupation fixed effects				Yes

**Notes:** Robust standard errors in parentheses, \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . This table presents the relationship between the probability to submit a labor condition application for a given job and its job posting duration for fiscal year 2018. It reports average marginal effects from linear probability estimations. The measure of job posting duration is standardized. Standard errors are clustered at the local labor market level. Local labor markets are defined by commuting zone and major occupation group. **Source:** Job Board A and U.S. Department of Labor.

### D.3 Section 5: Lack of domestic labor supply (2018)

Table 11: Employers are more likely to seek foreign workers in tight labor markets (fiscal year 2018).

Dependent variable:	Probability to submit an LCA		
	(1)	(2)	(3)
Hiring difficulties proxy:	Job posting duration	Average duration on the labor market	Labor market tightness
	0.0123*** (0.0034)	0.0209*** (0.0041)	0.0378*** (0.0046)
Observations	20,156	20,156	20,156
Standard deviation	1.1212	0.1475	0.0571

**Notes:** Robust standard errors in parentheses, \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . This table presents correlations between the probability to submit a labor condition application and different proxies of hiring difficulties for fiscal year 2018. Job posting duration is the online duration of a given job  $j$ . Average duration on the labor market is the duration of all jobs belonging to the same group of occupations and commuting zone as job  $j$ . Labor market tightness is an index dividing the number of vacancies by the total employment in the same labor market as job  $j$ . Labor market by commuting zone and major group of occupations. This table reports average marginal effects from linear probability estimations. All measures of hiring difficulties are standardized. **Source:** Job Board A and U.S. Department of Labor.

## D.4 Section 5: Low wages (2018)

Table 12: The relationship between job posting duration and the probability to submit an LCA is driven by generous employers.

Dependent variable:	Probability to submit an LCA				
Definitions of Generous employers	(1)	(2)	(3)	(4)	(5)
Job posting duration	0.0342*** (0.0051)	0.0338*** (0.0053)	0.0316*** (0.0060)	0.0209** (0.0086)	0.0356*** (0.0055)
Job posting duration x not generous employers	-0.0044 (0.0035)	-0.0032 (0.0035)	-0.0003 (0.0044)	0.0109 (0.0077)	-0.0047 (0.0039)
Observations	43,784	43,784	43,784	43,784	43,784

**Notes:** \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . Robust standard errors in parentheses. This table compares the relationship between job posting duration and LCA submission across two types of employers for fiscal year 2018. First line estimates present the result for generous employers. Second line estimates present the results for non-generous employers. Column (1) defines as generous those employers who offer a wage premium on top of prevailing wages to foreign workers. Following columns progressively restrict this definition. Column (2) defines as generous those employers offering a wage premium larger than 1 percent of the annual wage on top of prevailing wages. In columns (3) and (4), the wage premium thresholds are respectively set to 5 and 10 percent of the annual wage. Finally, column (5) defines as generous those employers who offer wages larger than the local average wage defined by occupation and measured via the Occupational Employment statistics. All regressions control for posting date, commuting zone, and firm-occupation fixed effects. **Source:** Job Board A and U.S. Department of Labor.

## D.5 Section 5: Employers' preference for foreign workers (2018)

Table 13: The relationship between job posting duration and the probability to submit an LCA is driven neither by H-1B dependent nor by willful violator employers (fiscal year 2018).

Dependent variable:	Probability to submit an LCA				
Definitions of employers with incentives to manipulate	H-1B dependent (1)	Willful violators (2)	Both (3)	Both > \$60,000 (4)	Both > \$70,000 (5)
Job posting duration	0.0280*** (0.0045)	0.0285*** (0.0045)	0.0280*** (0.0045)	0.0280*** (0.0045)	0.0280*** (0.0045)
Job posting duration x Employers with incentives to manipulate	0.0171 (0.0110)	0.0171 (0.0110)	0.0171 (0.0110)	0.0171 (0.0110)	0.0171 (0.0110)
Observations	48,662	48,662	48,662	48,662	48,662

**Notes:** \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. Robust standard errors in parentheses. This table presents the relationship between the probability to submit a labor condition application for a given job and its job posting duration for fiscal year 2018. In particular, it explores the heterogeneous effect of job posting duration between H-1B dependent and willful violator employers and other employers. An H-1B dependent employer is, generally, one whose H-1B workers comprise at least 15 percent of the employer's full- time equivalent employees. Willful violators of H-1B rules are employers who have "committed either a willful failure or a misrepresentation of a material fact" in LCA attestations. Column (1) separates H-1B dependent employers from the others. Column (2) distinguishes willful violator from other employers. Column (3) gathers H-1B dependent and willful violator employers in one category opposed to the rest of employers. Column (4) restricts the category of employers who have an incentive to manipulate their job posting duration to H-1B dependent and willful violator employers whose average LCAs' wage is larger than \$60,000 per year. Column (5) increases this threshold to \$70,000. The table reports marginal effects estimated from linear probability estimations. All regressions control posting date, commuting zone, and firm-occupation fixed effects. The measure of job posting duration is standardized. Standard errors are clustered at the firm level.

**Source:** Job Board A and U.S. Department of Labor.



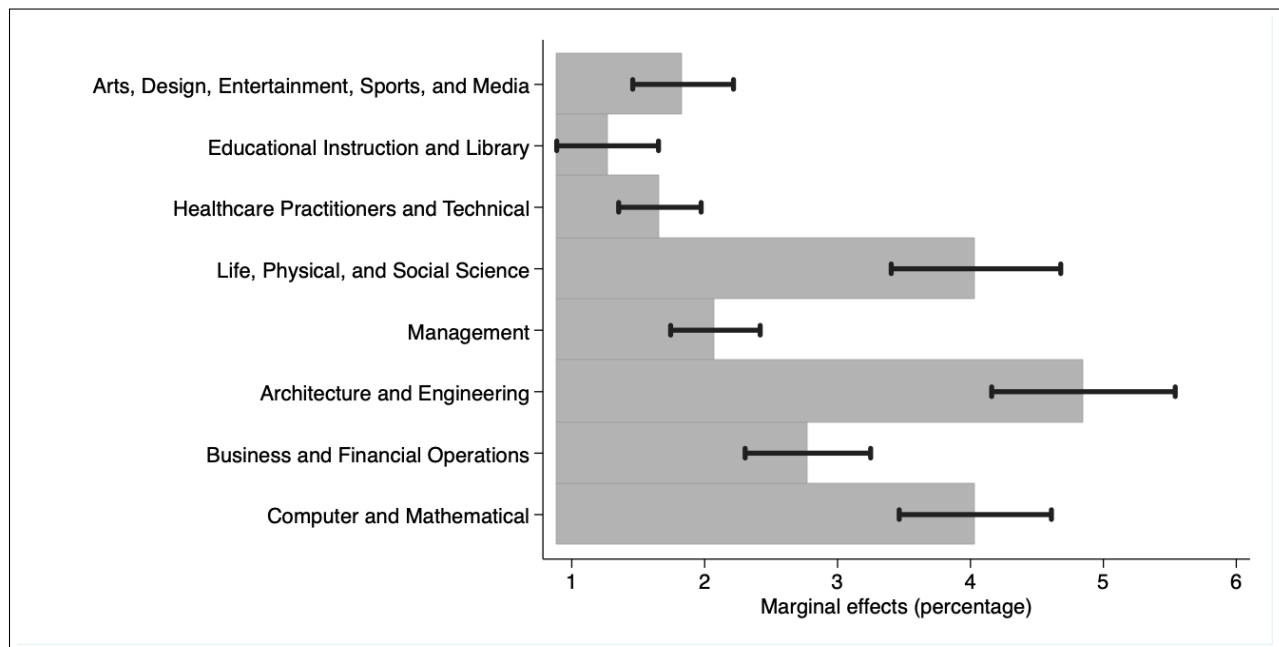
## D.6 Heterogeneity analysis (2018)

Table 14: The relationship between job posting duration and the probability to submit an LCA is not driven by large petitioners (fiscal year 2018).

Dependent variable:	Probability to submit an LCA			
	Large petitioners submitted more than			
	20 LCAs	50 LCAs	100 LCAs	150 LCAs
	(1)	(2)	(3)	(4)
Job posting duration	0.0315*** (0.0043)	0.0297*** (0.0043)	0.0291*** (0.0042)	0.0290*** (0.0042)
Job posting duration	-0.0069** (0.0034)	-0.0059 (0.0051)	-0.0074 (0.0084)	-0.0095 (0.0103)
Observations	48,662	48,662	48,662	48,662

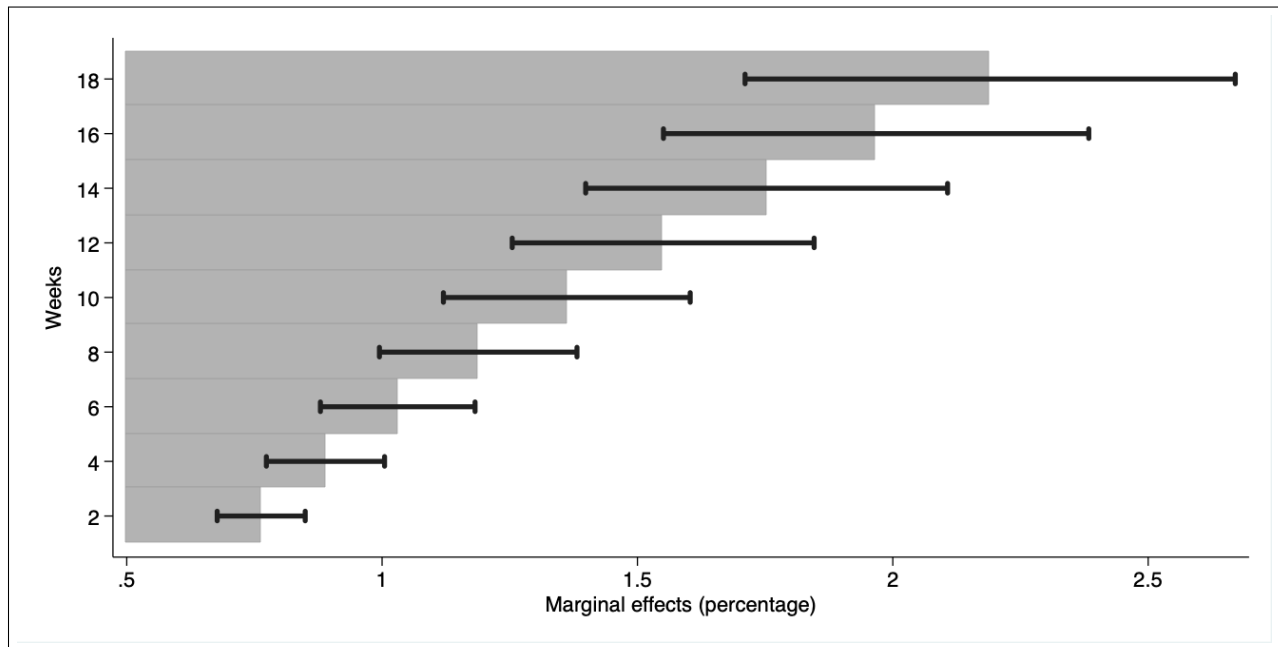
**Notes:** \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . Robust standard errors in parentheses. This table compares the relationship between job posting duration and LCA submission across two types of employers for fiscal year 2018. First line estimates present the result for employers who are not considered as large petitioners. Second line estimates present the results for large petitioners. Column (1) defines large petitioners as employers who have submitted more than 20 LCAs in fiscal year 2019. Columns (2), (3), and (4) adopt larger thresholds. They respectively define large petitioners as employers who have submitted more than 50, 100, and 150 LCAs in fiscal year 2019. All regressions control for posting date, commuting zone, and firm-occupation fixed effects. The measure of job posting duration is standardized. Standard errors are clustered at the firm level. **Source:** Job Board A and U.S. Department of Labor.

Figure 12: Heterogeneity across major groups of occupations (fiscal year 2018)



**Notes:** This graph presents the relationship between the probability of submitting a labor condition application for a given job and its job posting duration. It reports marginal effects estimated with a probit estimation. It highlights heterogenous results across major groups of occupations. The estimation controls for commuting zone and posting date fixed effects. The measure of job posting duration is standardized. **Source:** Job Board A and U.S. Department of Labor.

Figure 13: Heterogeneity over job posting duration (controlling for top petitioners)



**Notes:** This graph presents the relationship between the probability of submitting a labor condition application for a given job and its job posting duration. It reports marginal effects estimated with a probit estimation. It highlights the heterogeneity of the results along the duration scale. The estimation controls for commuting zone and occupation fixed effects. It also controls for posting dates. **Source:** Job Board A and U.S. Department of Labor.