Looking for the "Best and Brightest": Hiring difficulties and high-skilled foreign workers

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Abstract

This paper shows that firms' demand for high-skilled foreign workers partly results from their hiring difficulties. Relying on a within-firm identification strategy, I compare recruitment decisions made by a given employer for similar jobs differing in recruitment difficulties. I quantify how the time to fill a vacancy affects the employer's probability to look for recruiting a foreign worker. To identify this relationship, I have collected and assembled a new and original dataset at the job level. It matches online job postings to administrative data on H-1B visas applications in the US. I find that a standard deviation increase in job posting duration increases employers' probability to look for a foreign worker by 1.5 percentage points. This effect is mainly driven by firms sending only a few visa applications. It increases to 3 to 4 percentage points for architects, engineers and computer scientists.

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

JEL Classification: J61, J2, C26

1 Introduction

"Should the US increase its H-1B visa program?" titled a San Francisco Gate article in 2006.[1] In 2019, this question still lies at the core of the public debate on high-skilled immigration in the United States. Since the early 2000's, the effect of the program on labor market outcomes of natives is the cornerstone of this issue. Deciding to change the H-1B visa quota first necessitates to assess how newly arrived foreign workers affect native employment and wages. As visas applications are sponsored by employers, assessing whether H-1B workers are complements or substitutes for native employees depends on the motivations underlying firms' recruitment strategies. While three quarters of H-1B applications are sent for computer and STEM related occupations,[2] U.S. Tech companies raise concerns about the lack of native labor supply to fill these specific positions. In his 2007 Senate testimony, Bill Gates highlighted the "critical shortage of scientific talent" and called for "overhauling our [U.S.] high-skilled immigration system". Exploring the link between hiring difficulties and the recruitment of H-1B workers is therefore crucial to inform the public debate on U.S. immigration.

In this paper, I show that firms' demand for high-skilled foreign workers partly result from their hiring difficulties. This represents a direct evidence of the lack of native labor supply for these particular jobs. I use online job postings data and open the black box of the firm's hiring process. I link the job recruitment duration to employers' willingness to fill their vacancies with foreign workers. I rely on fixed effects specifications and show how a given employer adapts its recruitment strategy for positions that take longer to be filled. I then demonstrate that this result reflects the role of firms' hiring difficulties by exploring different aspects of the recruitment process. I conclude that a substantial part of H-1B workers are imperfect substitutes with other labor sources.

Employers claim that they need H-1B workers to fill positions that would otherwise stay unfilled. Matching online job postings to administrative data on H-1B visa applications

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[1]Matloff (2006)
[2]U.S. Citizenship And Immigration Services (2018)

allows me to investigate this claim at the job level. I have collected the entire universe of job postings advertised on one of the largest U.S. job board (hereafter "Job board A"),[3] from February 2018 onwards. By collecting those data twice a month, I observe ads disappearing from the website. This allows me to measure the duration of each job posting and use this information as a proxy for employers' relative difficulty to fill this position. The H-1B visa program necessitates for 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 match online job postings data with administrative data on LCA sent by employers. Therefore, I observe for each job eligible to the H-1B visa program wether its employer has tried to recruit a foreign worker to fill this given position.

I quantify the causal effect of hiring difficulties using a strategy in two parts. In the first part, I use a within-firm within-occupation identification strategy. I compare successive recruitment decisions made by a given employer between two similar positions as defined by occupation and location. I investigate whether recruiters are more likely to look for foreign workers when they have advertised their position for longer. In baseline regressions, one standard deviation increase in job posting duration increases the probability to submit a LCA by 1.5 percentage points. I highlight thereby the effect of job posting duration on firms' demand for H-1B workers.

In the second part, I precise the interpretation of this result. I show that this relationship reflects the causal effect of firms' hiring difficulties on their demand for foreign workers. I consider the other steps of firms' hiring process and reject alternative interpretations. After posting their job ad, employers receive applications, judge candidates during interviews and offer wages. These different steps provide a set of alternative explanations. I take advantage of the job posting panel to provide indirect evidence supporting the role of hiring difficulties. First, I study how employers react to the visa delivery. This allows me to ensure that the

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[3]The real name of the job board on which data have been collected is anonymized.

effect of job posting duration is not driven by employers that keep rejecting applications from natives. I show that employers who are not granted a visa continue to search for a non-immigrant worker in order to fill their position. This result is not consistent with a scenario where H-1B petitioners are specifically looking for foreign workers. In this scenario, firms would stop their search and remove their job posting after having been denied the visa. By rejecting this alternative explanation, this result suggests that the effect of job posting duration reflects the role of recruitment challenges.

Secondly, I demonstrate that the aforementioned effect of job posting duration is not driven by employers willing to recruit H-1B workers to reduce their labor costs. This second part investigates the heterogeneity of this effect between employers proposing wages above labor market prices and other recruiters. Reporting similar results for these generous employers, it provides evidence inconsistent with a scenario where employers would like to recruit H-1B workers to reduce their labor costs. On the contrary, it supports the interpretation that employers who try to recruit H-1B workers are really facing difficulties to fill some of their occupations.

Finally, I exploit two discontinuities in the H-1B application process to ensure that job posting duration is not manipulated by employers to obtain visas. There exist two cases were employers have to provide U.S. Citizenship and Immigration Services with the bill of their online job posting to prove that they first tried to recruit a native worker without success. This requirement holds for employers extensively relying on foreign workers. It is also the case for jobs paid under sixty thousand dollars per year. In both cases, firms have an incentive to voluntarily leave their vacancy online to obtain the visa, even if they are not affected by hiring difficulties. Comparing employers who have this incentive to other employers, I reject this alternative explanation. These last pieces of evidence show that the effect of job posting duration truly reflects the role of firms' hiring difficulties on their demand for H-1B workers.

The last section of the paper explores the heterogeneity of this effect across employers, occupations and time. It documents that recruitment challenges affect more hiring decisions

in small firms. Consistently with the literature, it reports a larger effect for Scientific Technological, Engineering and Mathematical (STEM) occupations. Finally, it shows that the results are mostly driven by vacancies located at the top of the duration distribution.

By focusing on the role of firms, this paper first contributes to the literature assessing the effect of the H-1B visa program on labor market outcomes of native workers. Most of this research has exploited quasi-random (Kerr et al., 2015, Mayda et al., 2016, and Mayda et al., 2018) or random (Peri et al., 2015 and Doran et al., 2016) experiments to investigate whether H-1B workers are complements or substitutes for natives. Papers focusing on labor market levels highlight consistent results supporting complementarity between both types of workers. On the contrary, Doran et al. (2016) provide firm-level evidence rejecting this complementarity hypothesis. By showing that firms' demand for H-1B workers partly result from their hiring difficulties, I propose an explanation to reconcile both approaches. My results show a lack of native labor supply for jobs filled with high-skilled foreign workers.[4] It can explain therefore, as shown by Peri et al. (2015), why cities restricted in their recruitment of H-1B workers do not hire natives instead. Simultaneously, it provides a way to understand the results of Doran et al. (2016) who show why firms do not increase their native labor force when they recruit more foreign employees. Finally, my paper also relates to the strand of research nuancing the negative effect of the H-1B visa program on wages (Mithas and Lucas, 2010, Lofstrom and Hayes, 2011, and Aobdia and Srivastava, 2018).

By introducing a new measure of firms' hiring difficulties, this paper also contributes to the literature assessing mismatches between local supply and demand for skills. This strand of research is motivated by policy reports highlighting employers' perception that specific skills are in short supply (Chambers et al., 1998, Deloitte and the Manufacturing Institute, 2011, Carnevale et al., 2011, Manpower Group, 2018). While aggregate data do not provide convincing evidence to support recruiters' complaints about the lack of labor supply (Barnow et al., 2013, Capelli, 2015, Abraham, 2015), I introduce a job level measure of hiring difficulties

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[4]These results complement Sparber (2015) who first provided indirect evidence on this phenomenon.

to cope with this issue. Deming and Noray (2018) document an important turnover of workers in STEM occupations supporting thereby the existence of a skill shortage. Exploring labor markets heterogeneity, my findings confirm how recruitment challenges are striking for these specific occupations.

Finally, this paper relates to the literature studying labor market issues using job postings data. Over the last decade, the availability of online data have been extensively used to study different aspects of labor markets. One strand of this literature exploits proprietary data collected from major job boards to study job search behaviors (Kuhn and Skuterud, 2004, Kuhn and Mansour, 2014, Kroft and Pope, 2014, Chéron and Decreuse, 2017, Marinescu, 2017, and Marinescu and Rathelot, 2018). More recently, Burning Glass Technologies has collected and assembled the near-universe of U.S. online job postings. Azar et al. (2019) and Azar et al. (2019) take advantage of this new source of information to study labor market concentration. Using the same data, Deming and Kahn (2017) investigate variations in skills demanded by employers. My contribution to this literature is twofold. First, I extend its scope to the study of migrations. This paper complements thereby Anastasopoulos et al. (2018) that have first introduced the use of newspaper vacancy data in this field. Secondly, I focus on the duration dimension that is usually overlooked. Collecting my own data over time allows me to observe the online duration of each ad. I report an average duration close from 1.5 months. My results diverge from what Davis and de la Parra (2017) find using DHI data, an industry and occupation specific job board.

The paper is structured as follows. Section 2 presents contextual elements on the H-1B visa program. Section 3 details the matching procedure between online job posting and administrative data on H-1B visa applications. Section 4 explains how the within-firm identification strategy capture the effect of job posting duration on H-1B demand. Section 5 details these results. Section 6 shows that the effect of job posting duration reflects the the role of firms' hiring difficulties on their demand for H-1B workers. Section 7 provides a better understanding of this effect by studying its heterogeneity. Section 8 concludes.

2   The H-1B visa program: Context

The H-1B visa program represents the main gate of entry to the United States for foreign workers with at least a Bachelor degree. It affects labor markets via two characteristics. First, visas are sponsored by firms. Second, the number of visas delivered is subject to a quota. This section explains why these characteristics must be taken into account to assess the effect of the program on native labor outcomes.

The H-1B visa program is an employer driven program. 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 accepting to hire the foreign worker through this procedure, the employer agrees to manage the visa application and to pay its cost. If obtained, an H-1B visa holds for three years and can be renewed once. However, this procedure is time consuming and costly. The U.S. General Accounting Office (2011) estimates the cost per visa between $2,300 and $7,500.

These characteristics of the program have two key implications. First, the immigrant labor supply depends on firms' demand. Secondly, it suggests that H-1B workers are more attractive to employers than native employees. Otherwise, it would not be rational for firms to pay this additional cost to hire foreigners. Both implications must be taken into account while trying to understand the drivers of the recruitment decision, and therefore the effect of the program.

The quota dimension of the H-1B program implies a recruitment timing way longer than usual. It represents thereby an additional cost in the hiring process, certainly compensated by additional benefits coming from foreign workers. This specificity must also be considered to understand firms' demand for high-skilled foreign workers. Figure 1 details this specific timing. First, U.S. visas are delivered per fiscal year. Therefore, the recruitment process can last even more than 12 months from the job interview to the first working day. During this period, the visa application process consists of two steps. Employers first submit a LCA

Figure 1: Timeline of the H-1B application process during fiscal year 2019.
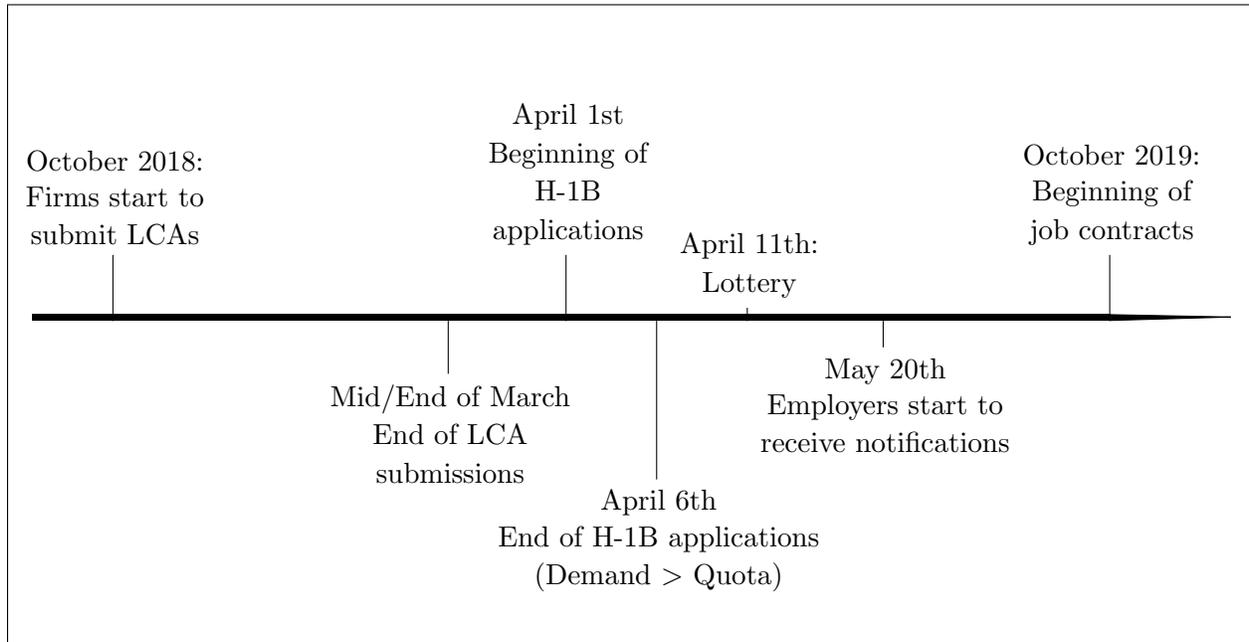
Notes: This graph presents the timeline of the H-1B application process for the fiscal year 2019. Fiscal years start and finish in October of each year. The process takes place in fiscal year 2019 in order to obtain visas valid from the begining fiscal year 2020 to the end of fiscal year 2022. There 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 a I-129 form to the U.S. Citizenship and Immigration Services. This second step starts on April 1, 2019.

to the Department of Labor. They signal hereby their intention to recruit a foreign worker. This document allows the administration to check that the job is eligible to the H-1B visa program and that the foreign worker will be treated in the same working conditions as natives. Employers send this first package from October to mid March and 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 exceed the 85,000 cap during the first week of April. To deliver the visas, the administration only selects applications received during this first week and run a lottery by the mid of April. On average, one third of applications obtain an H-1B visa. Employers learn about the result of the lottery from

mid May to mid June. Finally, winning applicants can start their job contract by the first of October.

H-1B visas impose a long recruitment process. They also imply additional recruitment costs (i.e. visas and attorneys' fees). This suggests that employers have to be strongly motivated to recruit a foreign worker rather than a native one. In this paper, I present different pieces of evidence showing that this motivation partly results from the lack of native supply for these particular occupations.

3 Data

To show the causal effect of firms' hiring difficulties on their demand for H-1B workers, I merge online job postings data to administrative data on visa applications. This section first details the procedure to merge both sources at job level. It then explains how job posting duration can be used as a proxy for firms' hiring difficulties. Finally, it presents the employers' characteristics exploited in the heterogeneity analysis.

3.1 Merging procedure

In this paper, I match online ads to H-1B applications at the job level to identify the effect of firms' hiring difficulties on their demand for foreign workers. I identify both the job posting and the LCA referring to a given job. This allows me to establish the link between the duration to fill the position and the employer's willingness to recruit a foreign worker. Moreover, it makes it possible to implement a within-firm identifcation strategy to quantify the effect of the job posting duration on the H-1B demand.

To identify both the job posting and the LCA referring to a same job, three pieces of information are necessary. The matching relies on the location of the job, the name of the company and the job title. While this procedure can include measurement errors when job postings or visa applications are duplicated, it represents a second best in the absence of a common identifier. On the one hand, this analysis takes advantage of LCAs released by the U.S. Department of Labor. These administrative data detail each position for which

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an employer has initiated a procedure to apply for an H-1B visa from October 2018 to March 2019. It includes therefore these three pieces of information. On the other hand, any job posting advertised online has to precise at least this information. For this analysis, I have collected the entire universe of job postings advertised on one of the largest U.S. job board (hereafter "Job board A"), using their Application Programming Interface (API) from November 2018 to the end of June 2019.

For any job advertised on Job Board A, the matching procedure checks whether there is a LCA associated to this job. The algorithm first focuses on the location dimension. Because some ads refer to the city (e.g., New York City) while other refer to their borough (e.g., Manhattan), I first translate the location information into Core Based Statistical Area (CBSA) codes corresponding to commuting zones. For each area, the algorithm then identifies a subset of companies included in both online and administrative data. Regarding the firm dimension, both datasets have to be harmonized. As both of them are collected in different contexts, firms can be called by slightly different names across sources (e.g., "Facebook", "Facebook, Inc."). To fix this issue, I first gets rid of usual suffixes before to compute a similarity score between each pair of company names.[5] Keeping only pairs whose score exceeds 80% of similarity between both strings, I check manually whether both names refer to the same employer. For the sake of analysis, any pair of firms for which doubt remains is categorized as dissimilar. Finally, the algoritm focuses on the subsample of firms identified as similar across both datasets and looks for identical jobs. Once again, both documents often refer to a same job with slightly different job titles. Quite often, job postings display more precise job titles than LCAs. I identify similar jobs when job titles are the same or when the LCA job title is a a part of the online job title. At each step, this matching procedure adopts a conservative strategy that mechanically increases the number of false negatives. This leads, if something, to create a downward bias pulling my estimator toward zero. Because I explore whether recruitment duration has an effect on the probability that a job posting is matched

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[5]This similarity score is computed using a Jaccard algorithm relying on a bigram method. It is computed with the matchit command in Stata 14.

with a LCA, the positive effect that I find can be interpreted as a lower bound. Note that the analysis relies on the assumption that the ad duration is uncorrelated with these matching issues.

The analysis relies on a subsample of 170,540 job postings collected by Job board A on the career pages of 4,547 employers. This dataset only includes jobs eligible to the H-1B visa program and employers who have sent at least one LCA in fiscal year 2019. Fiver percent of these ads are matched with a LCA. I classify jobs by occupation using the U.S. Department of Labor algorithm. This procedure matches job titles to occupation groups. I take advantage of job categories proposed by job board A to impute occupations. I take into account the limitations of this algorithm and only exploit information for major and minor group of occupations as defined by the U.S. Standard Occupation Classification (SOC). Appendix B presents the U.S. SOC. Identifying employers and occupations, I estimate fixed effects specifications to identify the causal effect of firms' hiring difficulties on their demand for H-1B workers.

## 3.2 Job posting duration: A proxy for hiring difficulties

The identification strategy relies on the duration of job ads. I use this duration as a proxy for firms' hiring difficulties at the job level. This section first presents how I measure recruitment duration. It then offers evidence that job posting duration is an accurate proxy for hiring difficulties.

I collected job postings data twice a month during more than one year using a web-scraping alike algorithm to measure job postings' duration. Rather than connecting directly to the website, the script takes advantage of the Application Programming Interface (API) of Job board A. This API aims to deliver job posting data to app developers in direct and continuous time. This allows me to incorporate a longitudinal feature to my dataset by collecting information successively over time. Therefore, I can observe in this panel when ads are removed from the job board. Because the job posting date is displayed as well, I can compute the time difference between both removing and posting dates. I interpret this

duration as the time needed to fill a vacancy by assuming that employers only remove their ad once their position is filled. Note that this measure is subject up to two weeks measurement error due to the time interval separating two waves of data collection. Figure 2 presents the distribution of this duration measure. Its values range from one day to six months. The average job posting duration for Job board A data equals to fourty-four days.

Exploiting job posting duration as a proxy for firms' hiring difficulties is the cornerstone of this paper. This assumes that ads are removed from the job board only when the job is filled. Relying on Job board A data is key to ensure the validity of this assumption. Job board A directly collects most of its job ads from the career pages of the largest companies in the United States. By mirroring the information available on firms' career pages, it gets rid of financial incentive influencing employers' behaviors on other job sites. On these platforms, employers usually post their ad for a fixed duration. After the duration is elapsed, they face

Figure 2: Distribution of job posting duration.
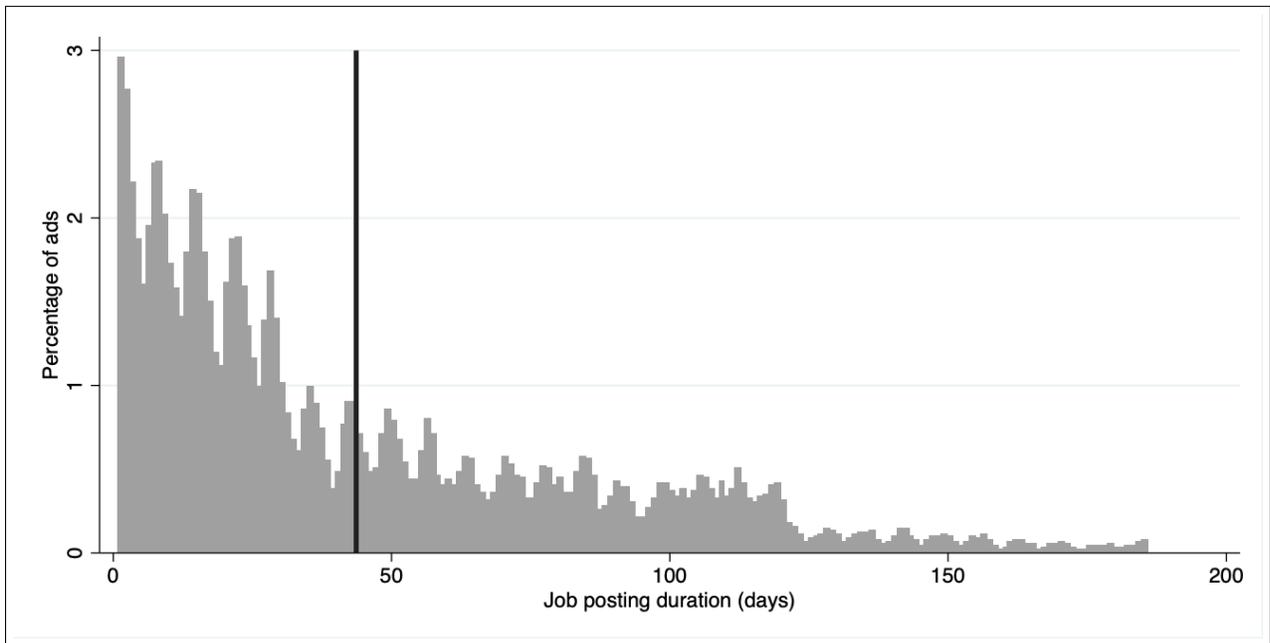
**Notes**: This graph presents the distribution of job posting duration on Job board A. It relies on job posting data collected from November 2018 to March 2019. The black vertical line represents the average. The distribution ranges from 1 to 186 days with an average equal to 44 days. Because data are collected every two weeks, this graph is subject up to two weeks mesurement errors. **Source:** Job board A.

a second decision: removing their job posting from the website or contracting for another time period. The cost of these contracts is likely to influence their strategic decision. On the contrary, the marginal cost of advertising a vacancy on their own career page is almost null. Therefore, relying on the career page information to approximate the recruitment duration is more accurate. However, one could fear that those ads could stay online after the position is filled. Figure 3 highlights empirical evidence getting rid of this identification threat. It depicts the number of ads disappearing from Job board A between December 2018 and January 2019. Reflecting the information available on firms' career pages, it shows that employers voluntarily remove their job posting at some point. According to the aforementioned rationale, I assume that those ads are withdrawn once the position is filled.

Job posting duration provides a relative measure of hiring difficulties across jobs. The longer a job is advertised online, the longer it takes to the employer to find the right applicant. Figure 4 highlights the relationship between the job posting duration and an indicator of the

Figure 3: Number of ads disappearing over time.
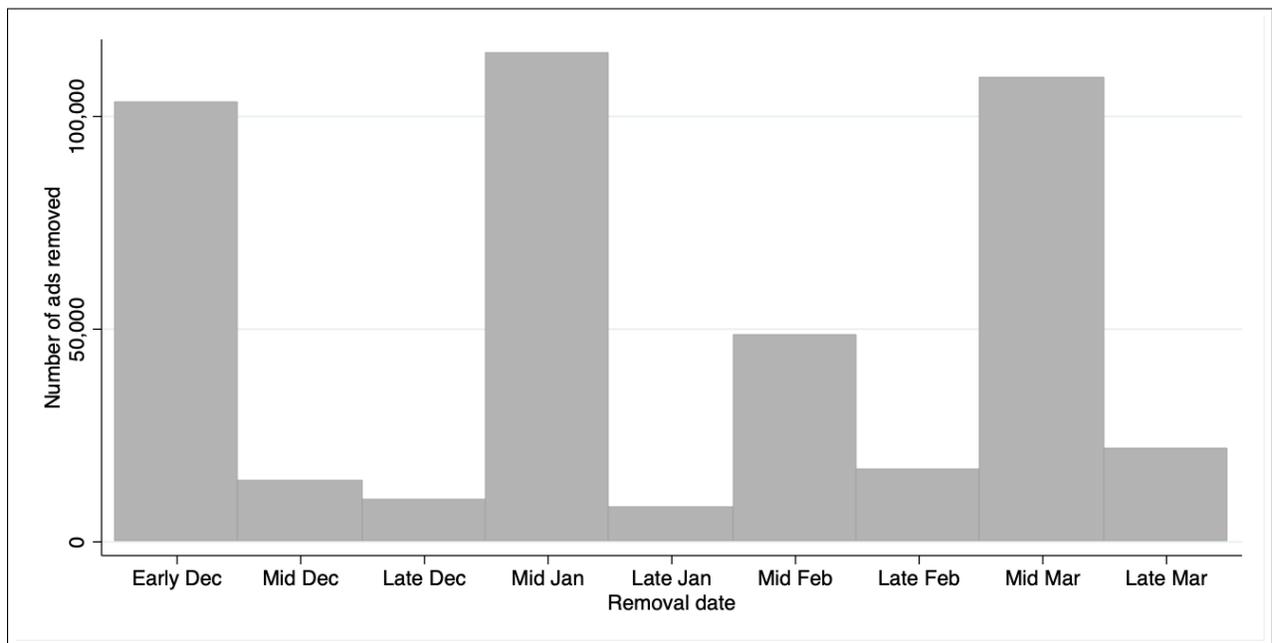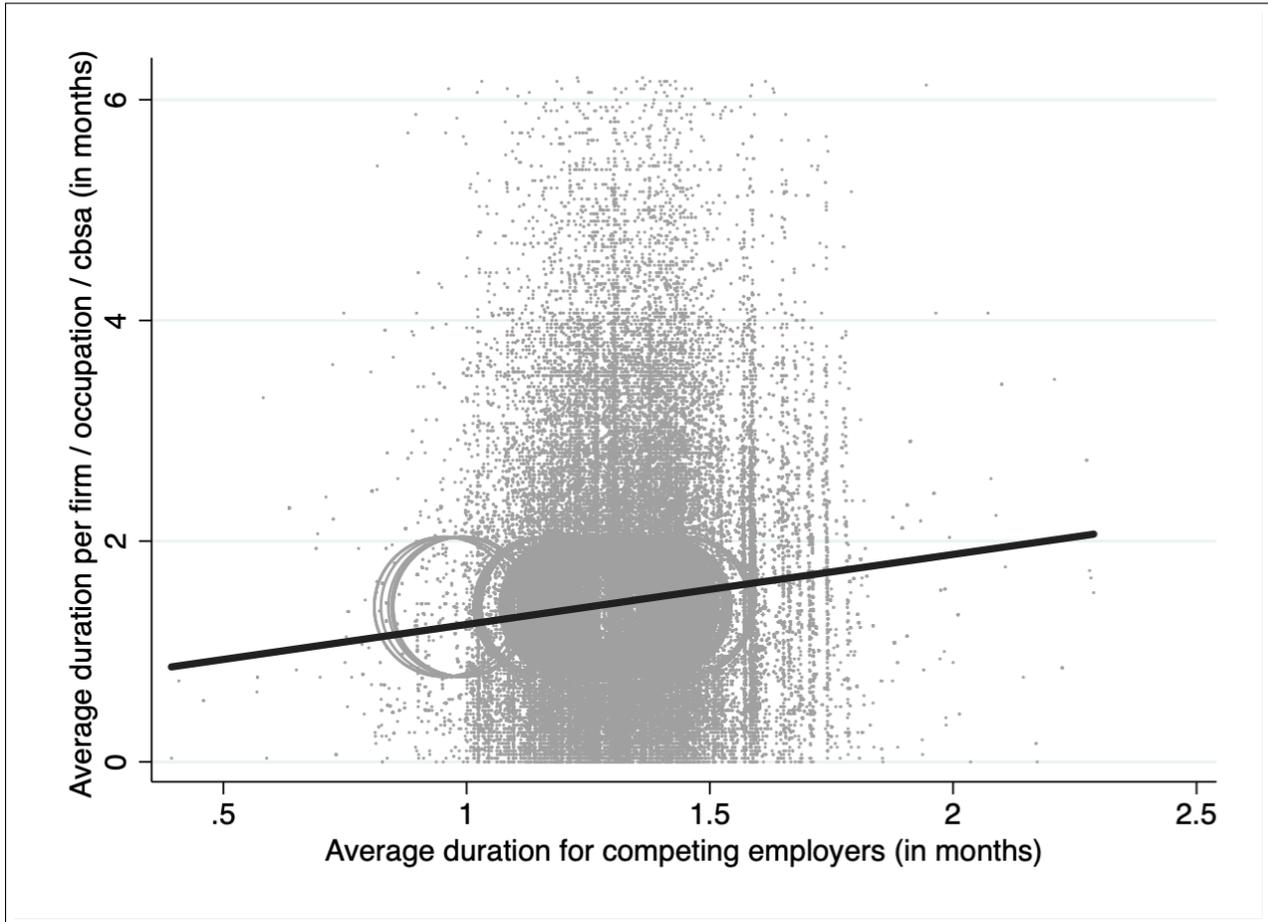

Notes: This graph presents the number of ads disappearing from December 2018 to March 2019. Because data are collected every two weeks, this graph is sensitive up to two weeks measurement errors. **Source:** Job board A.

potential hiring difficulties. This indicator relies on the average job posting duration faced by the other employers on the same local labor market. Each circle represents a cell defined by a commuting zone, an employer and a major group of occupation. Cells are weighted by the number of vacancies advertised on their local labor market. It relates therefore the average job posting duration of each employer on this segment of the labor market to the average duration faced by other employers for similar vacancies. The red line represents the linear fit of this scatter plot. It reports a 0.63 correlation, meanning that on average the duration of each job posting is correlated at 63% with competing vacancies. This graph supports the idea that job posting duration reflects structural phenomena of labor markets rather than the idiosyncratic behavior of each employer.

Exploiting job posting duration allows me to observe variations in hiring difficulty across major groups of occupations. Figure 5 presents the average duration for the eight most important groups from the Job board A database. It highlights a six days range from the bottom to the top of the duration distribution. According to this graph, Healthcare Practitionners and Technical occupations seem to be the shortest to fill. On the opposite, Educational Instruction and Library jobs take on average one additionnal week to find the right candidate. Compared to the whole range of the duration distribution represented in figure 2, six days only represent a small variation. But note that focusing on the average mechanically reduces these variations. Finally, figure 5 highlights the importance of hiring difficulties for STEM jobs. 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 Scieneces occupations).

Studying job posting duration provides me important insights on firms' recruitment processes. But employers make two other unobserved strategic decisions in this process. First, using web scraping techniques to collect data does not allow me to observe the applications received by each vacancy. Second, these data do not include information neither on the wage posted online nor on the wage bargaining that takes place between employers and candidates.

Figure 4: Relationship between job posting duration and the duration of the competing employers.

Notes: This graph presents the relationship between the duration of ads and the average duration experienced by other employers on the same local labor market (CBSA, major group of occupations). Each circle represents a cell defined by one employer, one occupation, and one commuting zone. Circles are weighted by the number of vacancies advertised on their local labor market. The black line represents the linear relationship fitted between both variables where the average correlation is equal to 0.63. **Source:** Job board A.

This missing information could potentially misslead the interpretation of the results. A longer job posting duration could reflect the employer's decision to keep rejecting applications from native candidates. It could also result from the employer's choice to propose wages below market prices. This paper implements additional tests based on employers characteristics to ensure that job posting duration is an accurate proxy for firms' hiring difficulties. These tests explore heterogeneous effects according to the dependence of employers to H-1B visas, their wage generosity and the number of LCAs they submit. The next section describes these em-

Figure 5: Job posting duration across major groups of occupations.
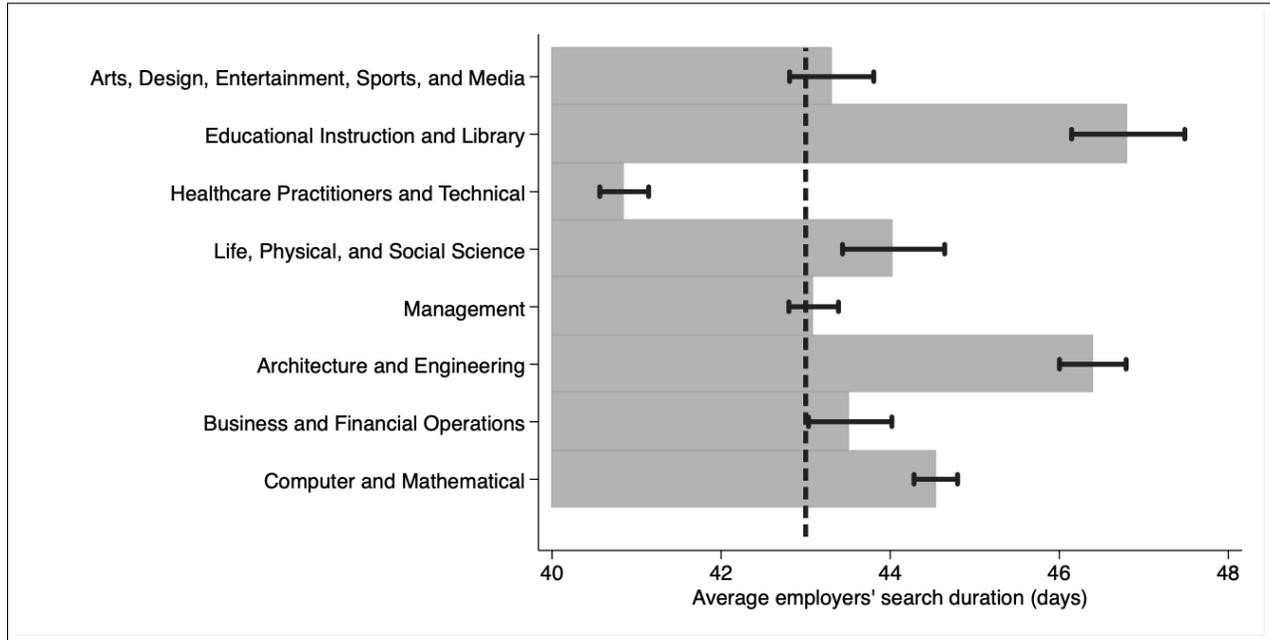
Notes: This graph presents the average job posting duration across major groups of occupations. It focuses on the eight most important groups within the job postings database. Grey bars represent the average duration. Black whiskers depict confidence intervals. The black dashed vertical line represents the mean of the whole sample. Average job posting duration ranges from 41 days for Healthcare Practitionners and Technical occupations to 47 days for Educational Instruction and Library jobs.**Source:** Job board A.

ployers' specificities. Section 6 shows that studying these three dimensions of heterogeneity support the identification of the hiring difficulties effect.

3.3   Heterogeneous employers

Comparing how different types of employers manage their recruitment process is key to identify the effect of firms' hiring difficulties on the demand for foreign workers. This paper focuses on three sources of heterogeneity across employers. First, it takes into account the number of LCAs sent by employers to explore firms' hiring motivation. Second, it relies on wages proposed to foreign workers as it provides information on the employer's recruitment strategy. Finally, it accounts for the proportion of foreign workers under H-1B visas in each company as it determines their visa application rules. Studying how the job posting duration

effect varies along these three aspects overcomes the missing information on both wage bargaining and received applications. This section introduces this approach by describing these heterogeneity dimensions. The details of this identification strategy are explained in section 6.

This heterogeneity analysis compares employers according to the number of LCAs they sent. I identify the effect of job posting duration for firms sending only a few applications by controlling for this characteristic. This refinement is particularly important as these firms represent the majority of LCA petitioners. I distinguish the behavior of top petitioners. They are defined as employers belonging to the top decile of the distribution of LCAs sent by employer. Figure 6 highlights this distribution. It shows that top petitioners are big companies sending between 148 and 4227 applications in fiscal year 2019. I take into account this distinction as top petitioners adopt different hiring strategies from smaller firms.

Figure 6: Distribution of labor condition applications submitted per employer.
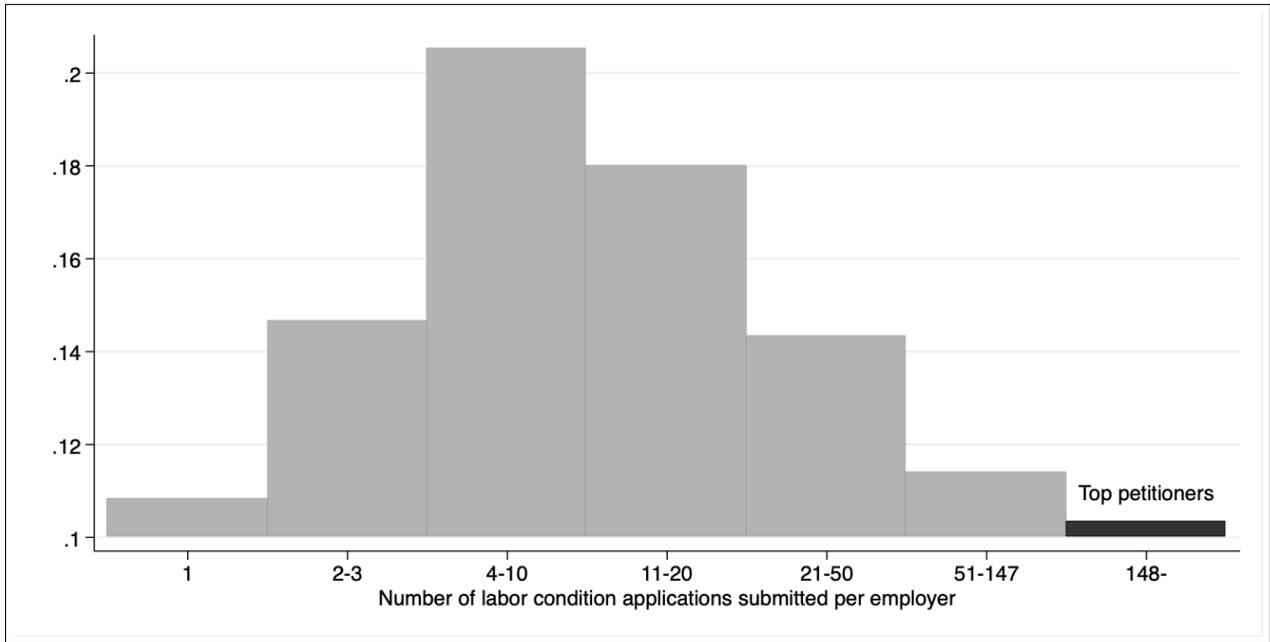
Notes: This histogram presents the distribution of labor condition applications sent per employer. The distribution is splitted over seven categories. Employers who belong to the top ten percents of this distribution are defined as top petitioners. **Source:** U.S. Department of Labor.

I overcome the missing information on the wage bargaining by studying wages proposed to H-1B workers. Comparing employers recruiting foreign workers above labor market prices to other recruiters supports the effect of structural hiring difficulties on firms' demand for H-1B workers. These generous employers do not recruit foreign workers to minimize their labor costs. Therefore, focusing on this subsample rules out this alternative interpretation.

I rely on the wage information embodied in LCAs to identify generous employers. In particular, I compute the difference between the prevailing wage that employers have to pay as a minimal requirement and the actual wage they pay to H-1B workers. Prevailing wages reflect local wage conditions. They are computed for each occupation by the U.S. Department of Labor by combining "hourly wage, usual benefits and overtime, paid in the largest city of each county, to the majority of workers". I observe actual wages offered to H-1B workers in LCAs data. Employers must indicate the salary range in their application. I adopt a conservative approach by assuming that foreign workers' wage equal the lower bound of this range. Employers who pay all their H-1B workers above the market price (i.e., prevailing wage) are defined as generous employers.

I take into account two firms' characteristics to identify generous employers. First, the distributions of wage premiums offered by generous employers is quite skewed. Figure 7 highlights that almost 50% of generous employers offer an annual wage premium smaller than five percent of the prevailing wage. I do not observe firms' motivations to offer such premiums. Though, the most likely explanation seems to attract the most productive workers. Secondly, jobs paid above market prices are not the highest paid jobs. Figure 8 shows that jobs paid above the market price belong to the bottom tail of the wage distribution. This observation supports the idea that employers offering wage premiums try to attract productive workers. On the contrary, employers offering the highest wages of the distribution do not need to offer wage premium to be attractive.

Finally, the heterogeneity analysis focuses on the proportion of H-1B workers within firms. Taking into account this proportion is key because it partly determines the H-1B application

rules that employers have to follow. The U.S. Department of Labor defines employers as H-1B dependent if their proportion of H-1B workers exceeds a given threshold. This cutoff depends on the size of their company. Firms with twenty five or fewer full-time equivalent employees are defined as H-1B dependent if they employ at least eight H-1B non-immigrant workers.[6] The threshold equals thirteen for companies employing between twenty six and fifty full-time equivalent employees. Finally, larger companies are defined as such if more than fifteen percent of their workforce are H-1B workers. H-1B dependent employers have the obligation to try to recruit an U.S. worker before to look for an H-1B worker. Moreover, they can be asked to provide evidence that they took "good faith steps to recruit U.S. workers". The bill of their job posting is usually accepted as a piece of evidence. These specific employers face therefore an incentive to leave their vacancy online more than necessary in order to provide

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[6]Foreign workers under H-1B visas are called non-immigrant workers since their visa is temporary.

Figure 7: Distribution of wage premiums paid by generous employers.
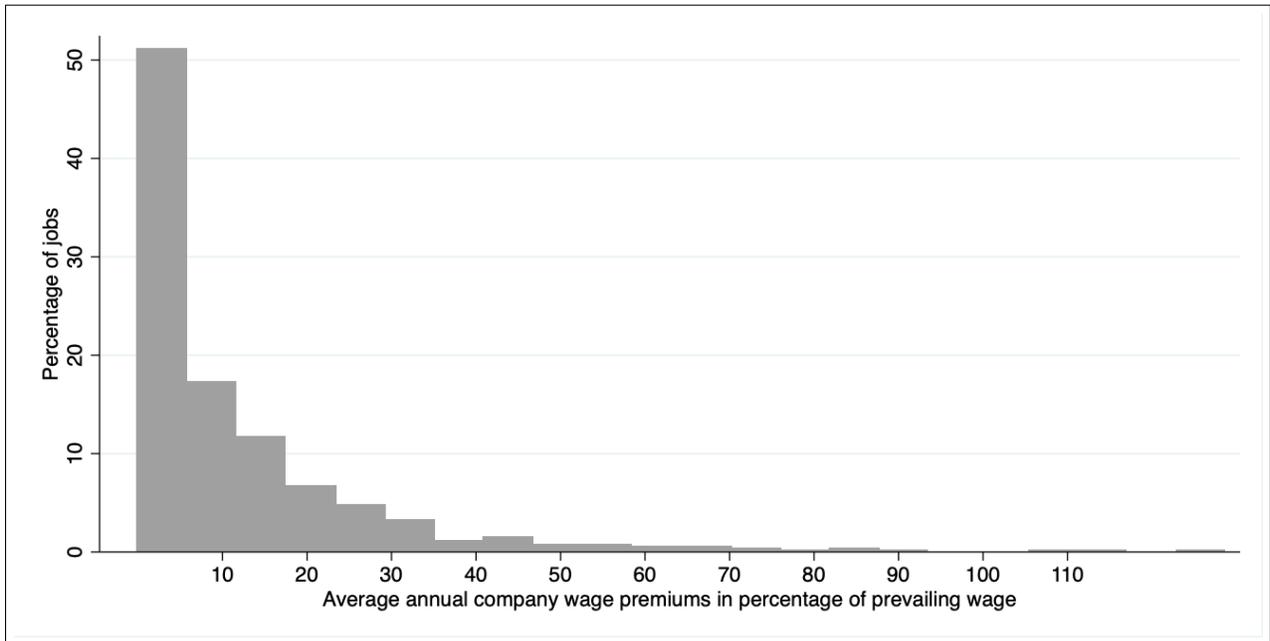
Notes: This graph presents the distribution of average wage premiums paid by generous employers. Each bar corresponds to five thousand dollars per year. Generous employers are companies only proposing labor condition application wages higher than the prevailing wage. **Source:** U.S. Department of Labor.

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Figure 8: Comparing wage distributions between generous employers and not generous employers.
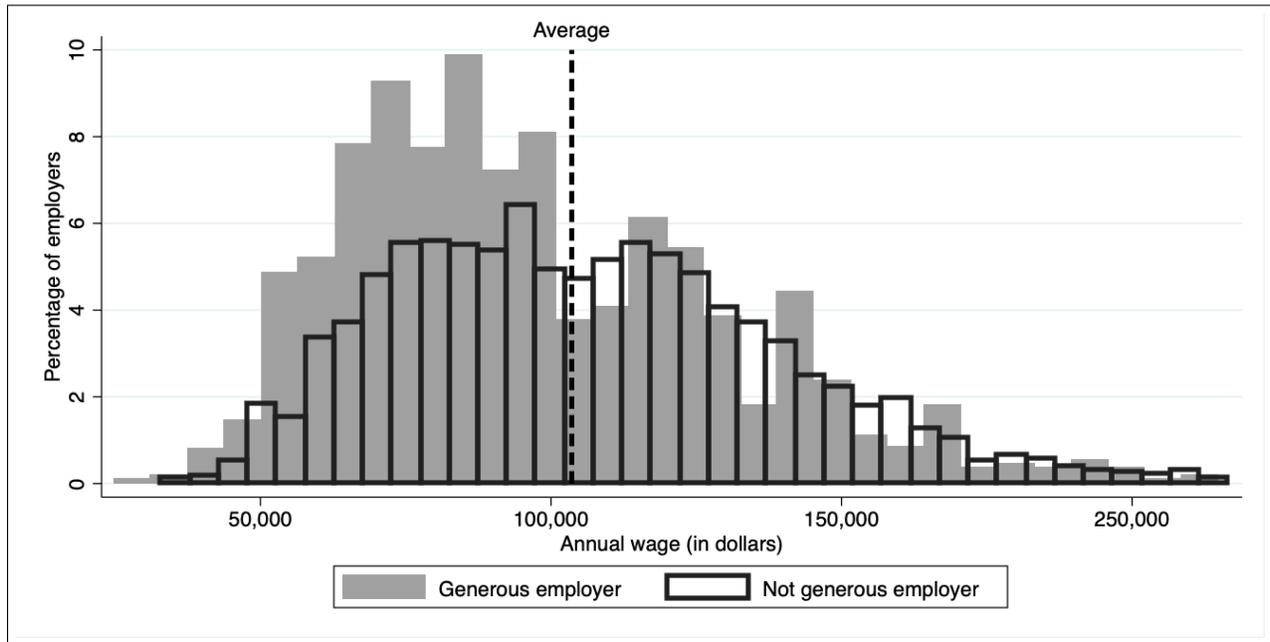
Notes: This graph compares wage distributions between generous and not generous employers. Full grey bars represent the lower bound of the wage range proposed by generous employers. Empty black bars represent prevailing wages paid by other employers. The black vertical dashed bar highlights the mean of the actual wage distribution. Generous employers are companies only proposing labor condition application wages higher than the prevailing wage. **Source:** U.S. Department of Labor.

such a proof. This administrative feature could lead H-1B dependent employers to manipulate their job posting duration, misleading thereby the interpretation of my results. I observe whether employers are defined as H-1B dependent and take into account this specificity in my analysis. Therefore, I support my interpretation of the effect of job posting duration.

Table 1 presents the main variations in job posting duration and H-1B demand across each category of employers. The first two columns compare the duration of job ads posted by top petitioners and other recruiters. They show that the former are advertised shorter. Columns (4) and (5) highlight a larger job posting duration for generous employers compared to other companies. This observation supports the idea that generous employers offer a wage premium to attract candidates. Because they face more difficulties to fill their positions, they use wages to make their vacancies more attractive. However, their probability to submit a

Table 1: Comparing categories of employers

Employers:	Top petitioners		Generous Employers		H-1B dependent		All
	Yes	No	Yes	No	Yes	No	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Average duration	41.56	43.25	45.16	42.69	46.88	43.61	42.56
(in days)	(35.57)	(39.39)	(40.28)	(38.95)	(41.39)	(39.43)	(39.86)
Difference	-1.69***		2.47***		3.27***		
	[0.35]		[0.19]		[0.69]		
Average probability	0.22	0.03	0.02	0.07	0.21	0.04	0.01
to send a LCA	(0.41)	(0.18)	(0.13)	(0.25)	(0.41)	(0.20)	(0.11)
Difference	0.19***		-0.48***		0.17***		
	[0.02]		[0.00]		[0.00]		
Observations	14,209	119,566	71,647	98,892	3,248	164,340	170,540

Notes: Standard errors in brackets, *** p<0.01, ** p<0.05, * p<0.1. Standard deviations in parentheses. This table presents the average job posting duration and the average probability to send a labor condition application for each category explored in the heterogeneity analysis. Top petitioners are employers who have submitted more than 148 applications in fiscal year 2019. Generous employers represent companies only proposing wages above labor market prices. H-1B dependent employers are employers whose labor force extensively rely on H-1B workers. This table presents the results of Student t-test taking into account the difference in sample sizes across categories. **Source:** Job board A and U.S. Department of Labor.

LCA is smaller than non generous employers. H-1B dependent companies also leave their job posting longer compared to other recruiters.

4 Within-firm within-occupation identification strategy

The identification strategy consists of two different steps to quantify the causal effect of firms' hiring difficulties on their demand for H-1B workers. This section uses fixed effects specifications to show how the time needed to fill a vacancy affects the employer's probability to search among foreign workers. To do so, it merges job postings to H-1B visa applications.

It then uses this new dataset to compare different recruitment decisions made by a same employer for similar occupations differing by their online duration. In section **??**, I show that this result reflects the effect of firms' hiring difficulties on their demand for H-1B workers. This second step implements a series of additional specifications to test alternative explanations to this channel.

Employer fixed effects specification gets rid of potential composition effects. This strategy takes advantage of successive decisions made by a given employer across similar positions that differ by their job posting duration. Exploiting within-firm within-occupation variations rather than comparing different employers behaviors provides estimates that get rid of firms' intrinsic preferences regarding foreign workers.

The fixed effects strategy relies on matching job postings to LCAs at the job level. Thereby, it compares successive decisions made by a given employer between positions that belong to a given group of occupations but differ by their online duration. It also controls for geographic specificities of labor markets as companies are located in several cities. Finally, the analysis takes into account the job posting date to compare vacancies that are as similar as possible. The main specification is the following:

$$\Pr[\text{LCA=1}]_j \quad = \quad \beta_1 + \beta_2 \text{Duration}_j + \varepsilon_e + \omega_o + \lambda_l + \delta_d + u_j, \tag{1}$$

where the dependent variable corresponds to the probability to send a LCA for a given position j. This specification focuses on the ad duration of position j, denoted Duration_j. Finally, $\varepsilon_{e(j)}$ represents the employer fixed effects, $\omega_{o(j)}$ the occupation fixed effects, $\lambda_{l(j)}$ the location fixed effects, $\delta_{d(j)}$ the posting date fixed effects and u_j the error term. By including this set of controls, the coefficient of interest β_2 compares jobs similar in all these dimensions but job posting duration.

Fixed effects specifications provide lower bound estimates. Within-firm variations do not capture a part of hiring difficulties as some employers are more attractive than others. Within-occupation variations also exclude hiring difficulties similarly encountered by a given

occupation group. However, this specification hedges against biases resulting from employers'
preferences for foreign workers in specific occupations.

The coefficient associated to job posting duration (β_2) shows how the time needed to
fill a vacancy affects the employer's probability to search among foreign workers to fill this
particular position. Interpreting this result as the causal effect of firms' hiring difficulties on
their demand for H-1B workers necessitates to take into account the whole hiring process.
After posting their vacancy, employers receive applications, judge candidates during inter-
views and offer wages. In Section 6, I present additional evidence regarding the rest of the
recruitment process. Thereby, I show that this coefficient (β_2) reflects the effect of firms'
hiring difficulties.

5   Results

This section shows that the time needed to fill a vacancy increases the employer's probability
to search among foreign workers to fill this particular position. It starts from aggregate cor-
relations and progressively narrows the analysis to within-firm within-occupation estimates.
Appendix A replicates and confirms the results for fiscal year 2018.

5.1   Aggregate variations

This section relies on aggregate variations and reports positive and significant relationships
between firms' demand for H-1B workers and four different proxies for hiring difficulties.
Table 2 reports similar levels of magnitude across these different estimates. Therefore, it
suggests a robust link between both phenomena.

Studying successively four different proxies for hiring difficulties supports the credibility
of this relationship. Column (1) estimates the correlation between the online duration of a
given job posting and the probability to submit a LCA for this particular vacancy. Column
(2) studies a similar correlation at the labor market level. It focuses on the average duration
by groups of job postings. Each cell is defined by commuting zone and major groups of
occupations. Finally, columns (3) and (4) explore the relationship between H-1B demand and

Table 2: H-1B demand and several measures of hiring difficulties (Probit estimation).

Dependent variable:	H-1B demand			
	(1)	(2)	(3)	(4)
Hiring difficulties proxy:	Job posting duration	Average duration on the labor market	Labor market tightness (Soc 2)	(Soc 4)
	0.0010***	0.0064***	0.0058***	0.0025***
	(0.0001)	(0.0001)	(0.0002)	(0.0001)
Observations	611,821	611,821	230,609	230,600
Standard deviation	1.3287	0.1449	0.0559	0.2079

Notes: Standard errors in parentheses, *** $p<0.01$, ** $p<0.05$, * $p<0.1$. This table presents correlations between the probabilty 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 than job j. Labor market tightness is an index dividing the number of vacancies by the total employment in the same labor market than job j. Column (3) defines this labor market by commuting zone and major group of occupations (respectively minor group of occupations in column (4)). This table reports average marginal effects from probit estimations. All measures of hiring difficulties are standardized. **Reading:** (column 1) on average one standard deviation (1.3287 month) increase in job posting duration increases the probability to send a labor condition application by 0.1 percentage point. **Source:** Job board A and U.S. Department of Labor.

labor market tightness: the classic indicator of hiring difficulties in the job search literature (Phelps, 1970, Pissarides, 1974). This index is defined as the ratio between the number of job postings on a specific local labor market and total employment on this same market. Appendix C describes how this proxy is measured. Column (3) aggregate jobs by major group of occupations. Column (4) aggregate jobs by minor group of occupations and present thereby more precise correlations.

Despite differences between proxies, magnitudes of the results presented in table 2 are rather similar. One standard deviation increase in hiring difficulties is associated to an increase in H-1B demand from 0.1 to to 0.64 percentage point. Both results are significant at the one percent level. The smallest correlation is quantified for job posting duration measured

at the job level. The largest is reported in column (2) when studying the average duration per local labor market. Finding similar levels of magnitudes across estimates suggests that the distributions of all four proxies are rather similar.

This first set of results suggests a relationship between firms' hiring difficulties and their demand for foreign workers. These estimate rely on aggregate variations. They are partly driven by differences across commuting zones, occupations and employers. Hiring difficulties result from a mismatch between demand and supply on labor markets. Locations and occupations are two relevant dimensions to capture the effect of hiring difficulties. On the contrary, recruitment challenges are supposed to affect all employers searching workers on a same local labor market. Therefore, between-firms variations in job posting duration could reflect different preferences for H-1B workers. The estimates presented above rely partly on these differences. Identifying the effect of firms' hiring difficulties on their demand for foreign workers cannot only rely on them.

5.2 Between firms variations

As long as estimates exploit between-employers variations, they do not identify the effect of firms' hiring difficulties. Nevertheless, introducing additionnal covariates provides informative insights on the relationship between job posting duration and H-1B demand. Table 3 focuses on the relationship between the duration of a job posting and the probability that the employer submit a LCA for this given job. Starting from the result presented in column (1) of the table 2, it progressively restricts the type of variations on which these estimates rely. Without controlling for employer fixed effects, these restrictions do not make a big difference.

Table 3 progressively increases the precision of the relationship between job posting duration and H-1B demand. It first controls for the date at which vacancies were posted. Therefore, this specification captures time specific shocks on labor demand. By introducing this covariate, column (2) slightly increases the magnitude of the coefficient associated to job posting duration. The three last columns exploit variations within local labor markets. Column (3) estimates the duration effect by comparing jobs within the same commuting

zone. Column (4) exploits variations across comuting zones but within occupation groups. Finally, column (5) reports estimates computed within each local labor market. By getting rid of differences between labor markets, this coefficient underestimates the role of hiring difficulties. The relationship between labor demand and supply varies from one market to another. These estimates do not capture hiring difficulties varying across occupations as they restrict the analysis to within-labor market variations. Consistently, the coefficient decreases from 0.59 to 0.26 percentage point.

Similarly to the first set of results, between-firms estimates could potentially capture employers' preferences for H-1B workers. These aggregate relationships between job posting duration and H-1B demand do not yet identify the effect of hiring difficulties. Nevertheless, they provide additional evidence consistent with the previous ones. The analysis then introduces employer fixed effects to overcome this limitation.

Table 3: The effect of hiring difficulties from between firms variations (Probit estimation).

Dependent variable:	H-1B demand				
	(1)	(2)	(3)	(4)	(5)
Job posting duration	0.0010***	0.0059***	0.0043***	0.0034***	0.0026***
	(0.0001)	(0.0002)	(0.0001)	(0.0001)	(0.0001)
Observations	611,821	611,821	578,176	611,821	578,176
Posting date		Yes	Yes	Yes	Yes
CBSA FE			Yes		Yes
SOC FE				Yes	Yes

Notes: Standard errors in parentheses, *** $p<0.01$, ** $p<0.05$, * $p<0.1$. This table presents the relationship between the probabilty to submit a labor condition application for a given job and its job posting duration. It reports average marginal effects from probit estimations. Columns (2) to (5) controls for the date at which the vacancy was posted. Commuting zone (CBSA) and occupation (SOC) fixed effects are progressively added. The measure of job posting duration is standardized. **Reading:** (column 5) on average one standard deviation (1.3287 month) increase in job posting duration increases the probability to send a labor condition application by 0.26 percentage point. **Source:** Job board A and U.S. Department of Labor.

5.3 Within-firm variations

This section presents within-firm within-occupation estimates. They show that employers are more likely to search among foreign workers to fill their vacancies that have been advertised longer. Introducing employer fixed effects in the analysis allows me to compare different hiring decisions made by a given employer. These estimates get rid of potential biases associated to firms' preferences in the recruitment of foreign and native workers. They fix thereby the main identification threat. Within estimators support the hiring difficulties interpretation by comparing positions similar in all dimensions but job posting duration. Table 4 presents the results. It progressively restricts variations on which estimates are identified.

Table 4: The effect of hiring difficulties from within firm variations (Linear probability model).

Dependent variable:	H-1B demand				
	(1)	(2)	(3)	(4)	(5)
Job posting duration	-0.0014***	0.0159***	0.0155***	0.0151***	0.0147***
	(0.0005)	(0.0007)	(0.0007)	(0.0007)	(0.0007)
Observations	170,540	170,540	162,441	170,540	162,441
Firm FE	Yes	Yes	Yes	Yes	Yes
Posting date FE		Yes	Yes	Yes	Yes
CBSA FE			Yes		Yes
SOC FE				Yes	Yes

Notes: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. This table presents the relationship between the probabilty to submit a labor condition application for a given job and its job posting duration. It reports average marginal effects from linear probability estimations. All regressions control for employer fixed effects (Firm FE). Posting date, commuting zone (CBSA FE) and occupation (SOC FE) fixed effects are progressively added. The measure of job posting duration is standardized. **Reading:** (column 5) on average one standard deviation (1.3165 month) increase in job posting duration increases the probability to send a labor condition application by 1.47 percentage points. **Source:** Job board A and U.S. Department of Labor.

Within firm estimates are presented in table 4. This table progressively increases the number of controls to compare similar vacancies. All specifications control for employer

fixed effects. Column (2) compares vacancies posted online on the same day by introducing posting date fixed effects. Therefore, it controls for time specific shocks and reduces noises in the duration measure. Combining employer and posting date fixed effects significantly changes the relationship estimated between job posting duration and H-1B demand. Results are consistent with aggregate and between-firms estimates presented above. Although, the magnitude of this relationship is way larger with this new specification. On average, one standard deviation increase in job posting duration increases the probability to submit a LCA for this given job by 1.59 percentage points. The last three columns of the table refine this estimate by comparing vacancies from similar labor markets. Column (4) and (5) present within-firm within-occupation estimates. Restricting the control groups to similar occupations in the same company get rid of employers' preferences. Column (5) controls for commuting zone fixed effects. It decreases the point estimate to 1.47 percentage points.

The firm fixed effects specification gets rid of preference biases by comparing successive decisions made by a given employer. Thereby, it identifies the causal effect of job posting duration on firms' demand for H-1B workers. It shows that employers are more likely to search among foreign workers for positions that are difficult to fill. Section 6 demonstrates that this result reflects the causal effect of firms' hiring difficulties. It rejects alternative explanations by exploring the other aspects of the recruitment process.

6   Interpreting the effect of job posting duration

In this section, I show that the effect of job posting duration reflects the role of firms' hiring difficulties on their demand for H-1B workers. I implement additional tests to support this interpretation. These test reject alternative explanations to the effect of recruitment challenges. In this part, I consider the firm's hiring process as a whole. After posting their job ad, employers receive applications, judge candidates during interviews and offer wages. Observing employers' strategies in these last two steps is important to interpret the effect of job posting duration as a result of firms' hiring difficulties. Not paying attention to these

strategic behaviors could otherwise mislead this interpretation. In this section, I provide indirect evidence supporting the role of hiring difficulties. I first show that the effect of job posting duration is not driven by employers specifically looking for native workers. I also demonstrate that these results are not driven by employers willing to recruit H-1B workers to reduce their labor costs. Finally, I show that job posting duration is not manipulated by employers to increase their chance to obtain a visa. By excluding each one of the possible alternative interpretations, I prove that the results presentd in table 4 truly reflects the causal effect of firms' hiring difficulties on their demand for H-1B workers.

6.1 Alternative interpretation 1: Employers' preferences for foreign workers

This section shows that the effect of job posting duration is not driven by employers specifically looking for native workers. It highlights that employers who are not granted a visa continue to search among native workers in order to fill their position. Therefore, it provides evidence inconsistent with a scenario where employers would have intrinsic preferences for foreign workers over natives. In contrast, it supports the idea that employers who try to recruit H-1B workers are really facing difficulties to fill some of their positions.

Without observing the number and the quality of applications sent by native workers, the effect of job posting duration could also reflect employers' preferences for foreign workers over natives, whatever the reason. In this scenario, employers would keep rejecting applications from native workers, increasing thereby their job posting duration. However, we would expect from these employers to remove their ad once informed about the results of the lottery. Otherwise, it would be irrational to start considering applications from natives so tardily in the recruitment process. Especially since they would probably have missed some of the most productive candidates.

Table 5 rejects this scenario by studying the online presence of ads after employers received the results of the lottery by late May. It investigates the probability to be still online by June

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2019 between two groups of ads. It compares ads that are associated with a LCA to other job postings. In the first group, employers are looking for both native and foreign workers. In the second group, recruiters only search among natives. Table 5 progressively increases the number of controls to make sure that job postings are comparable. All columns compare ads posted at the same time. They also control by the average duration of job postings on each local labor market. Column (2) compare positions belonging to the same major group of occuptions. Column (3) and (4) progressively control for commuting zone and firm fixed effects. This table shows that job ads associated to a LCA are more likely, if something, to be still online by the end of June 2019. This result rejects the scenario where employers would have intrinsic preferences for foreign workers over natives. Moreover, it finds a positive coefficient supporting the hiring difficulties interpretation. These results are consistent with the idea that employers apply for H-1B visas as a remedy for recruitment challenges. Therefore, this makes perfectly sense that jobs rejected in the visa lottery stay longer online. The two last columns support this interpretation. Comparing vacancies within the same occupation and commuting zone increases this estimate.

Table 6 explores the evolution of this relationship over time. Each column of the table refers to a different dependent variable. It compares the probability to be still online from mid April to late June between job postings associated to a LCA and the other ads. All specifications control for posting date, employers' type, occupation and commuting zone fixed effects. Even if these results show that positive estimates decrease over time, employers that were trying to recruit a foreign workers are still more likely to continue their hiring search. Therefore, it supports the interpretation of the results in terms of hiring difficulties.

Figure 9 illustrates this result. It simultaneously depicts the precise chronology of the lottery releasing H-1B visas and the evolution of the online presence of ads. Even if job postings associated to LCAs are progressively withdrawn over the period, they are still more likely to be advertised than ads not associated to LCAs.

Table 5: Jobs associated to LCAs are not less likely to stay online even after the lottery.

Dependent variable:	Still online by late June (1)	Still online by late June (2)	Still online by late June (3)	Still online by late June (4)
Submitted a LCA	-0.0019* (0.0011)	0.0032*** (0.0011)	0.0033*** (0.0011)	0.0042*** (0.0011)
Observations	611,820	170,539	170,539	162,440
Posting date FE	Yes	Yes	Yes	Yes
SOC FE		Yes		
CBSA FE			Yes	Yes
Firm FE				Yes

Notes: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. This table compares jobs for which the employer has submitted a labor condition application to the others in their probability to be still online once the results of the lottery delivering H-1B visas have been released. The main independent variable is a dummy variable distinguishing vacancies associated to a labor condition application from the other vacancies. This table reports average marginal effects from linear probability estimations. All regressions control for the date at which the vacancy was posted (Posting date FE). They also control for the average duration of job postings on the same labor market than job j where each market is defined by a commuting zone and a major group of occupation. Columns (2) includes for occupation fixed effects (SOC FE). Columns (3) and (4) control for commuting zone fixed effects (CBSA FE). Column (4) includes for firm fixed effects (Firm FE). **Reading:** (columns 2) on average the probability that the ad is still online by mid June is 0.45 percentage points larger for jobs associated to a labor condition application. **Source:** Job board A and U.S. Department of Labor.

These results provide indirect evidence to overcome the missing information on applications received by employers. Although, it worth noting that this test relies on a rationale that cannot be tested empirically. It rejects this alternative interpretation by assuming that employers are rationale in their recruitment process. Under this assumption, companies would not start to look for native workers after spending several weeks to reject their applications.

6.2 Alternative interpretation 2: Reducing labor costs

This second part demonstrates that the effect of job posting duration is not driven by employers willing to recruit H-1B workers to reduce their labor costs. It investigates the het-

Table 6: Jobs associated to LCAs are more likely to stay online, even after the lottery.

| Dependent variable:	Still online by mid April (1)	Still online by late April (2)	Still online by mid May (3)	Still online by late May (4)	Still online by mid June (5)	Still online by late June (6)
Submitted a LCA	0.1090***	0.0804***	0.0646***	0.0652***	0.0174***	0.0042***
	(0.0051)	(0.0046)	(0.0041)	(0.0040)	(0.0023)	(0.0011)
Observations	162,440	162,440	162,440	162,440	162,440	162,440

Notes: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. This table compares jobs for which the employer has submitted a labor condition application to the others in their probability to be still online once the results of the lottery delivering H-1B visas have been released. The dependent variable is a dummy variable indicating if the vacancy was still online at each period. The main independent variable is a dummy variable distinguishing vacancies associated to a labor condition application from the other vacancies. It reports average marginal effects from linear probability estimations. All regressions control for commuting zone and occupation fixed effects. They also control for the posting date and the number of labor condition applications sent by employer fixed effects. **Reading:** (column 6) on average the probability that the ad is still online by late June is 0.42 percentage points larger for jobs associated to a labor condition application. **Source:** Job board A and U.S. Department of Labor.

erogeneity of this effect between employers proposing wages above labor market prices and other recruiters. Reporting similar results for these generous employers, it provides evidence inconsistent with a scenario where employers would like to recruit H-1B workers to reduce their labor costs. On the contrary, it supports the interpretation that employers who try to recruit H-1B workers are really facing difficulties to fill some of their occupations.

Without observing wages proposed by employers for their vacant positions, the effect of job posting duration could also reflect unattractive salaries. If employers were proposing wages below labor market prices, it would repel native workers to apply for these jobs. Therefore, it would increase job posting duration. In this scenario, firms' difficulties to fill their jobs would arise from their own decisions. While hiring difficulties would be one part of the channel, the effect of job posting duration would essentially result from inadequate wages.

Table 7 rejects this scenario by studying the heterogeneity of this effect between generous employers and other recruiters. Compared to table 4, it introduces the interaction between

Figure 9: Comparing the share of ads still online after the lottery
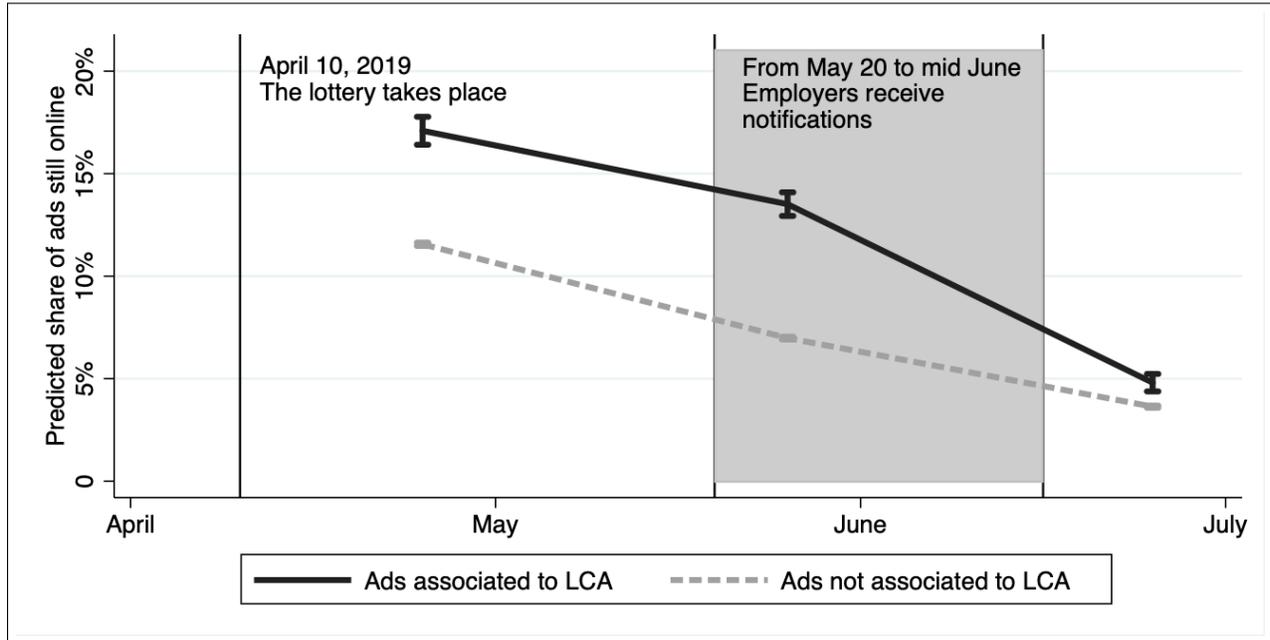
Notes: This graph studies the probability to be still online after the lottery delivering H-1B visas took place. It compares jobs for which the employer has submitted a labor condition application to other recruiters. It reports predicted probabilities resulting from probit estimations. The dependent variable is a dummy variable indicating if the vacancy was still online at each period. The main independent variable is a dummy variable distinguishing vacancies associated to a labor condition application from other vacancies. All regressions control for posting date fixed effects. They also control for the average duration of job postings by local labor market. Each local labor market is defined by a commuting zone and a major group of occupations. **Reading:** the probability to be still online by June is 1.2 percentage points larger for jobs associated to a labor condition application. **Source:** Job board A and U.S. Department of Labor.

job posting duration and a dummy variable distinguishing generous employers from other recruiters. Focusing on generous employers in the first row, it reports similar results to the average effect presented in table 4. Thereby, it confirms that the effect of job posting duration is not driven by employers trying to recruit foreign workers to reduce their labor costs. Moreover, the negative interaction coefficients in the third row shows that not generous employers are less affected by the effect of job posting duration. Together, these results indicate that the effect of job posting duration is mostly driven by these generous employers. This provides evidence supporting the scenario where employers offer wage premiums to increase the attractivity of their vacancy and fill their position.

Table 7: Comparing generous employers to other employers.

Dependent variable:	H-1B demand			
Specification:	Probit	LPM	LPM	LPM
	(1)	(2)	(3)	(4)
Job posting duration	0.0191***	0.0164***	0.0161***	0.0155***
	(0.0006)	(0.0009)	(0.0009)	(0.0009)
Not generous employers	0.6202***			
	(0.0195)			
Job posting duration	-0.0002	-0.0024**	-0.0027***	-0.0028***
x Not generous employers	(0.0123)	(0.0010)	(0.0010)	(0.0010)
Observations	170,539	170,539	162,440	162,440
Posting date	Yes	Yes	Yes	Yes
Firm FE		Yes	Yes	Yes
CBSA FE			Yes	Yes
SOC FE				Yes

Notes: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. This table presents the relationship between the probabilty to submit a labor condition application for a given job j and its job posting duration. In particular, it explores the heterogeneous effect of job posting duration between generous employers and the others. The main independent variable is a dummy variable distinguishing vacancies posted by employers who only propose wages above labor market prices from vacancies posted by other employers. The third line estimate is the interaction between job posting duration and this dummy variable. This table reports average marginal effects successively estimated from probit and linear probability (LPM) estimations. All regressions controls for the date at which the vacancy was posted (Posting date). From columns (2) to (4), firm (Firm FE), commuting zone (CBSA FE) and occupation (SOC FE) fixed effects are progressively included. The measure of job posting duration is standardized. **Reading:** (column 4) adding one standard deviation (1.3001 month) to the average job posting duration increases the probability to send a labor condition application by 1.27 percentage points for employers who do not belong to the top petitioners category. **Source:** Job board A and U.S. Department of Labor.

Table 7 successively presents a probit and three linear probability specifications. It switches from the first specification to the others in order to progressively increase the number of controls. Column (2) introduces employer fixed effects. Column (3) also controls for commuting zone fixed effects. Finally, column (4) narrows the comparison to job postings

belonging to the same occupation. All columns present marginal effects. They show that adding one standard deviation to the average job posting duration increases the probability to submit a LCA from 1.55 to 1.91 percentage points. Column (2) highlights that employer fixed effects no longer affect the results once controlling for the type of employer (i.e. generous or not generous employer).

6.3 Alternative interpretation 3: Manipulation of job posting duration

This last part shows that the effect of job postings duration is not driven by employers manipulating this duration to increase their chance to obtain a visa. This result relies on two discontinuities of the H-1B visa program. I show that vacancies paid under 60,000 dollars per year are not advertised longer. Results are similar for positions advertised by H-1B dependent employers. However, they are the only two categories of jobs to have incentive to manipulate their job posting duration. Finding no difference in job posting duration provides evidence inconsistent with this alternative interpretation for the effect of job posting duration.

H-1B dependent companies and employers proposing vacancies paid under sixty thousand dollars per year can face administrative incentives to voluntarily increase the duration of their job postings. In both cases, employers have to prove to the U.S. Citizenship and Immigration Services that they first searched for a native worker without success before to demand a visa. Because they can provide the bill of their job posting as a proof, employers looking for foreign workers for another reason than hiring difficulties still face an incentive to leave their vacancy online. This behavior could provide an alternative interpretation to the positive relationship between the time needed to fill a vacancy and H-1B demand.

Table 8 shows that that the effect of job posting duration is not only driven by H-1B dependent employers. This result relies on an heterogeneity analysis between H-1B dependent employers and other recruiters. Similarly to section 6.2, it introduces the interaction of job posting duration with a dummy variable distinguishing both types of companies. Focusing

on firms that do not face any incentive to manipulate the online duration of their ad, the results highlighted in the first row are close from the benchmark (i.e. table 4). Thereby, they reject the manipulation interpretation. This conclusion holds even if third row coefficients show that the results are still larger for H-1B dependent employers.

Table 8: Comparing H-1B dependent to other employers.

Dependent variable:		H-1B demand		
Specification:	Probit	LPM	LPM	LPM
	(1)	(2)	(3)	(4)
Job posting duration	0.0206***	0.0151***	0.0147***	0.0140***
	(0.0006)	(0.0007)	(0.0007)	(0.0007)
H-1B dependent	1.0118***			
	(0.0392)			
Job posting duration	-0.0160	0.0137***	0.0143***	0.0142***
x H-1B dependent	(0.0244)	(0.0042)	(0.0043)	(0.0043)
Observations	167,588	167,588	159,557	159,557
Posting date	Yes	Yes	Yes	Yes
Firm FE		Yes	Yes	Yes
CBSA FE			Yes	Yes
SOC FE				Yes

Notes: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. This table presents the relationship between the probabilty 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 employers and the others. The main independent variable is a dummy variable distinguishing vacancies posted by employers who have the H-1B dependent status from vacancies posted by other employers. The third line estimate is the interaction between job posting duration and this dummy variable. It reports average marginal effects successively estimated from probit and linear probability (LPM) estimations. All regressions controls for the date at which the vacancy was posted (Posting date). From columns (2) to (4), firm (Firm FE), commuting zone (CBSA FE) and occupation (SOC FE) fixed effects are progressively included in these regressions. The measure of job posting duration is standardized. **Reading:** (column 4) adding one standard deviation (1.3001 month) to the average job posting duration increases the probability to send a labor condition application by 1.27 percentage points for employers who do not belong to the top petitioners category. **Source:** Job board A and U.S. Department of Labor.

Table 8 successively presents a probit and three linear probability specifications. It switches from the first specification to the others in order to progressively increase the number of controls. Column (2) introduces employer fixed effects. Column (3) also controls for commuting zone fixed effects. Finally, column (4) narrows the comparison to job postings belonging to the same occupation. All columns present marginal effects. They show that adding one standard deviation to the average job posting duration increases the probability to submit a LCA from 1.40 to 2.06 percentage points.

Figure 10 completes this analysis by rejecting the manipulation interpretation for vacancies paid under sixty thousand dollars per year. Studying job posting duration along the wage distribution, it does not report any effect of administrative incentives on the duration metric. This figure depicts a regression discontinuity test around the wage threshold of sixty

Figure 10: Regression discontinuity on job posting duration
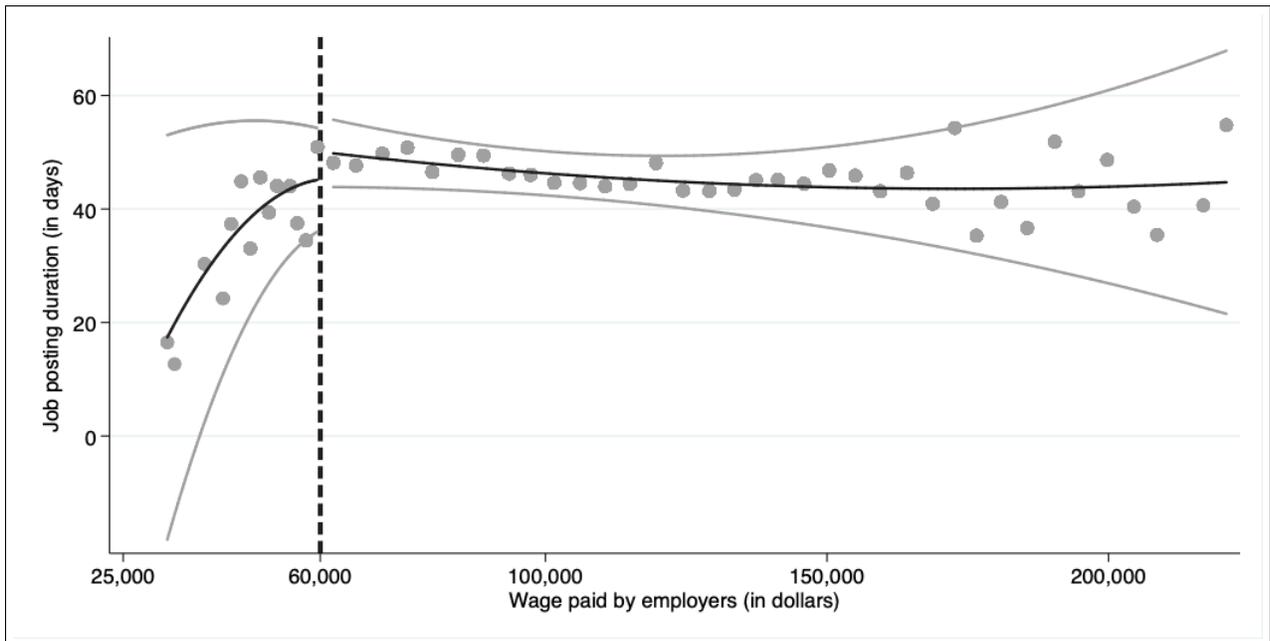
Notes: This graph presents a discontinuity analysis in job posting duration. It focuses on a wage threshold of sixty thousand dollars per year. Below, employers have to inform the administration about their posting duration to prove that they have been looking first for a native worker without success. By fitting quadratic polynomials on both sides of the threshold, this regression discontinuity does not report any significant difference. It suggests therefore the absence of manipulation in job posting duration. **Source:** Job board A and U.S. Department of Labor.

thousand dollars per year. With this test, I try to detect the presence of a significant difference in job posting duration between both groups of vacancies facing different manipulation incentives. This provide evidence inconsistent with the scenario where employers would voluntarily leave their vacancy online in order to get the right to apply for H-1B visas. In contrasts, it supports the interpretation that employers who try to recruit H-1B workers are really facing difficulties to fill some of their occupations.

As employers and job characteristics imply different procedures in the H-1B application process, they provide different ways of testing the manipulation hypothesis. This paper exploits these discontinuities through an heterogeneity analysis and a regression discontinuity. Therefore, it rejects this alternative interpretation for the effect of job posting duration. It worth noting that these conclusions rely on the implicit assumption that employers only manipulate their ad duration when they have incentives to do so. Under this fair hypothesis, both results are consistent with interpreting the duration effect in terms of hiring difficulties.

This section specifies the interpretation of the results presented in section 5. By rejecting each one of the alternative explanations, it shows that these results truly reflect the causal effect of firms' hiring difficulties on their demand for H-1B workers. More especially, one standard deviation increase in job posting duration increases the probability to search for a foreign worker by 1.47 percentage point. Moreover, this estimate represents a lower bound of the effect. By comparing recruitment decisions made by a given employer between vacancies from the same group of occupations, it does not capture hiring difficulties that differ across occupations. Comparing columns (2) and (4) of table 4 confirms this drawback. However, this comparison shows that the downward bias is quantitatively negligible.

7   Heterogeneity analysis

To better understand the effect of hiring difficulties on firms' demand for H-1B workers, this last section explores how it varies across employers, occupations and time. First, applying for an H-1B visa involves an important fixed cost. Table 9 extends the heterogeneity analysis. It

compares employers according to the number of LCAs they submit and highlights two types of firms' recruitment strategies. While half of companies only send ten or fewer applications, some recruiters submit a large number of LCAs. Distinguishing both cases is important to understand firms' recruitment strategies. Secondly, equilibriums between labor supply and demand vary across occupations. To understand which types of jobs are the most affected by recruitment challenges, figure 11 compares marginal effects across major groups of occupations. Finally, approximating recruitment challenges with job posting duration necessitates to explore its non-linearity over time. Employers interpret online duration as hiring difficulties only when it exceeds a certain time. Figure 12 highlights how the marginal effect evolves over weeks.

This section compares the effect of firms' hiring difficulties on their demand for H-1B workers between top petitioners and other employers. It reports a larger effect for recruiters sending only a few LCAs. Table 9 extends the heterogeneity analysis started in tables 7 and 8. Following the same specification, it controls for the interaction effect between job posting duration and a dummy variable distinguishing top petitioners from other employers. It successively presents a probit and three linear probability specifications. It switches from the first specification to the others in order to progressively increase the number of controls. Column (2) introduces employer fixed effects. Column (3) also controls for commuting zone fixed effects. Finally, column (4) narrows the comparison to job postings belonging to the same occupation. All columns present marginal effects. Table 9 shows that adding one standard deviation to the average job posting duration increases the probability to submit a LCA from 1.51 to 2.27 percentage points for employers not categorized as top petitioners. The negative interaction between ad duration and top petitioners indicates that their demand for H-1B workers is less affected by hiring difficulties. This suggests that the application fixed cost is especially striking for smaller employers.

Comparing the effect of hiring difficulties across occupations confirms the importance of this phenomenon for scientific technological engineering and mathematical (STEM) occupa-

tions. Figure 11 reports the marginal effects computed for eight major groups of occupations. These estimates result from a probit specification controlling for top petitioners. This graph highlights that the effect is particularly striking for three groups: computer and mathemati-

Table 9: Comparing top petitioners to other employers.

Dependent variable:	H-1B demand			
Specification:	Probit	LPM	LPM	LPM
	(1)	(2)	(3)	(4)
Job posting duration	0.0227***	0.0151***	0.0168***	0.0160***
	(0.0006)	(0.0007)	(0.0008)	(0.0008)
Top petitioners	1.1794***			
	(0.0211)			
Job posting duration	-0.0903***	-0.0065***	-0.0082***	-0.0091***
x top petitioners	(0.0149)	(0.0020)	(0.0021)	(0.0021)
Observations	133,775	167,588	127,486	127,486
Posting date	Yes	Yes	Yes	Yes
Firm FE		Yes	Yes	Yes
CBSA FE			Yes	Yes
SOC FE				Yes

Notes: Standard errors in parentheses, *** $p<0.01$, ** $p<0.05$, * $p<0.1$. This table presents the relationship between the probabilty 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 top petitioners and other employers. The main independent variable is a dummy variable distinguishing vacancies posted by employers defined as top petitioners (i.e. employers who have submitted more than 148 applications in fiscal year 2019) from vacancies posted by other employers. The third line estimate is the interaction between job posting duration and this dummy variable. It reports marginal effects successively estimated from probit and linear probability (LPM) estimations. All regressions controls for the date at which the vacancy was posted (Posting date). From columns (2) to (4), firm (Firm FE), commuting zone (CBSA FE) and occupation (SOC FE) fixed effects are progressively included in these regressions. The measure of job posting duration is standardized. **Reading:** (column 4) adding one standard deviation (1.3001 month) to the average job posting duration increases the probability to send a labor condition application by 1.6 percentage points for employers who do not belong to the top petitioners category. **Source:** Job board A and U.S. Department of Labor.

Figure 11: Heterogeneity across major groups of occupations (controlling for top petitioners)
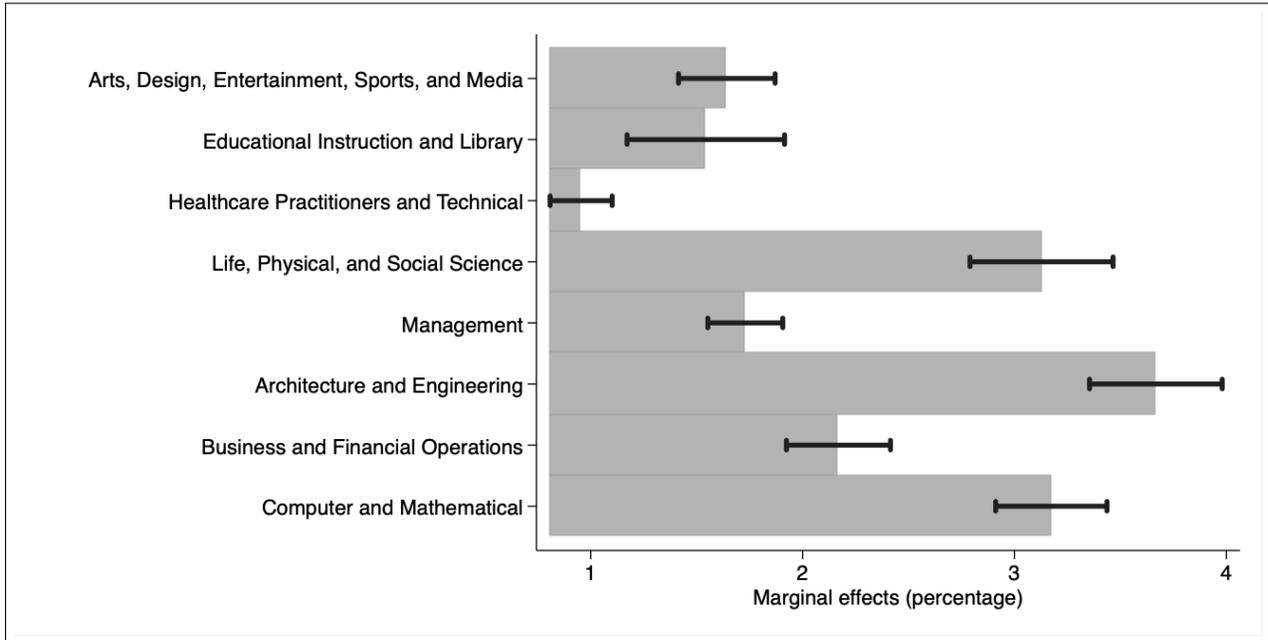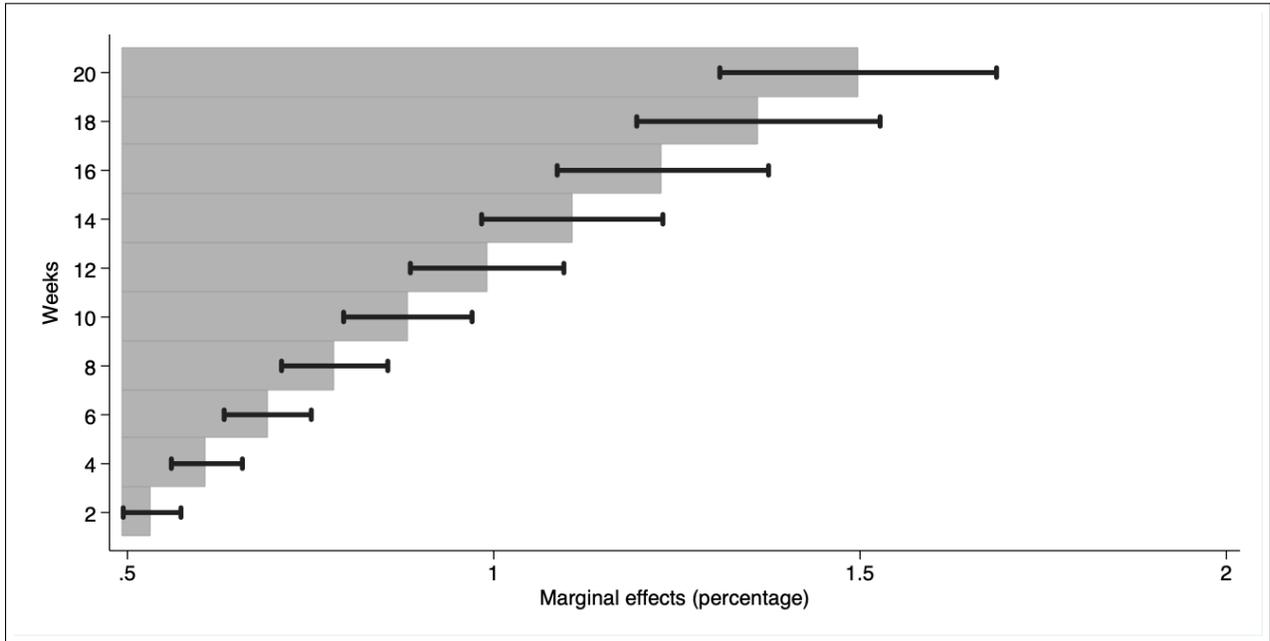

Notes: This graph presents the relationship between the probabilty to submit a labor condition application for a given job and its job posting duration. It reports marginal effects estimated with a probit estimation. It highlights heterogenous results across major group of occupations. The estimation controls for commuting zone fixed effects. It also controls for posting date and top petitioners (i.e. employers who have submitted more than 148 applications in fiscal year 2019). The measure of job posting duration is standardized. **Reading:** adding one standard deviation (1.3001 month) to the average job posting duration increases the probability to send a labor condition application by 3.17 percentage points for Computer and Mathematical jobs. **Source:** Job board A and U.S. Department of Labor.

cal, architecture and engineering, and life, physical and social science occupations. For these categories, one standard deviation increase in job posting duration increases the probability to submit a LCA by more than 3 percentage points. On the opposite, this effect is 30 to 70% smaller for the last five groups of occupations.

Figure 12 highlights how the effect of hiring difficulties varies over time. This effect increases by a factor three when comparing the bottom to the top of the duration distribution. These marginal effects result from a probit specification controlling for top petitioners. In terms of magnitude, each week added to the average duration increases the probability to submit a LCA by one percentage point. At the very top of the distribution, this relationship

is associated to 1.5 percentage points. As the effect of job posting duration increases over time, it supports the hiring difficulties interpretation.

Figure 12: Heterogeneity over job posting duration (controlling for top petitioners)

Notes: This graph presents the relationship between the probabilty to submit 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 date and top petitioners(i.e. employers who have submitted more than 148 applications in fiscal year 2019). **Reading:** employers are 0.5 percentage point more likely to submit a labor condition application for jobs that takes two more weeks than usual to be filled. **Source:** Job board A and U.S. Department of Labor.

8   Conclusion

This paper quantifies the causal effect of firms' hiring difficulties on their demand for H-1B workers. It first relies on a within-firm within-occupation identification strategy to show the effect of job posting duration on H-1B demand. It then precises the interpretation of this result by rejecting alternative explanations to hiring difficulties. It provides thereby the first direct evidence in the literature to relate the role of hiring difficulties to the recruitment of foreign workers.

Matching online job postings to administrative data on visas applications is the cornerstone of this identification strategy. With this dataset, I observe how employers adapt their recruitment decisions according to their difficulties to fill each position. Bringing job posting data in the literature, this paper deviates from the wage perspective to explore another aspect of the recruitment of high-skilled foreign workers.

I find that one standard deviation increase in job posting duration increases the probability to send a LCA by 1.47 percentage points. I explain why this estimate is a lower bound. This effect varies across firms and occupations. Hiring difficulties especially affect recruitment decisions for STEM occupations or decisions made by generous employers.

The public debate on H-1B visas mostly focuses on two dimensions: wages and hiring difficulties. While the former is extensively studied in the literature, this paper builds on a new source of data to explore the latter dimension. My results provide some insights to compare the relative importance of each mechanism. Because generous employers do not recruit H-1B workers to reduce their labor costs, they represent a lower bound to quantify the role of hiring difficulties in the total demand. Among all applications made in fiscal year 2019, 60% of them proposed wages above market prices. This suggests that recruitment challenges play a significant role in the demand for high-skilled foreign workers.

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Appendix

A   Results for fiscal year 2018

This appendix replicates all the results for fiscal year 2018. Although this sample only observes job postings in February and March 2019, 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 confidence intervals. The rest of this section follows the same order than the one adopted in the core of the paper.

A.1   Aggregate variations (2018)

Table 10: H-1B demand and several measures of hiring difficulties (Probit estimation)

Dependent variable: H-1B demand	Job posting duration (1)	Average duration on the labor market (2)	Labor market tightness	
			(Soc 2) (3)	(Soc 4) (4)
Hiring difficulties proxy	0.0009***	0.0064***	0.0071***	0.0030***
	(0.0002)	(0.0002)	(0.0003)	(0.0002)
Observations	296,326	296,326	112,268	112,257
Standard deviation	1.1741	0.1501	0.0567	0.2248

Notes: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. This table presents correlations between the probabilty 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 than job j. Labor market tightness is an index dividing the number of vacancies by the total employment in the same labor market than job j. Column (3) defines this labor market by commuting zone and major group of occupations (respectively minor group of occupations in column (4)). This table reports average marginal effects from probit estimations. All measures of hiring difficulties are standardized. Reading: (column 1) on average one standard deviation (1.1741 month) increase in job posting duration increases the probability to send a labor condition application by 0.09 percentage point. **Source:** Job board A and U.S. Department of Labor.

A.2 Between firms variations (2018)

Table 11: The effect of hiring difficulties from between firms variations (Probit estimation))

Dependent variable:	H-1B demand (1)	H-1B demand (2)	H-1B demand (3)	H-1B demand (4)	H-1B demand (5)
Job posting duration	0.0009***	0.0079***	0.0057***	0.0046***	0.0033***
	(0.0002)	(0.0005)	(0.0004)	(0.0003)	(0.0003)
Observations	296,326	296,326	277,688	296,326	277,688
Posting date	Yes	Yes	Yes	Yes	Yes
CBSA FE			Yes		Yes
SOC FE				Yes	Yes

Notes: Standard errors in parentheses, *** $p<0.01$, ** $p<0.05$, * $p<0.1$. This table presents the relationship between the probabilty to submit a labor condition application for a given job and its job posting duration. It reports average marginal effects from probit estimations. Columns (2) to (5) controls for the date at which the vacancy was posted. Commuting zone (CBSA) and occupation (SOC) fixed effects are progressively added. The measure of job posting duration is standardized. **Reading:** (column 5) on average one standard deviation (1.1741 month) increase in job posting duration increases the probability to send a labor condition application by 0.33 percentage point. **Source:** Job board A and U.S. Department of Labor.

A.3 Within firm variations (2018)

Table 12: The effect of hiring difficulties from within firm variations (Linear probability model)

Dependent variable:	H-1B demand (1)	H-1B demand (2)	H-1B demand (3)	H-1B demand (4)	H-1B demand (5)
Job posting duration	-0.0015*	0.0199***	0.0206***	0.0192***	0.0197***
	(0.0008)	(0.0020)	(0.0021)	(0.0020)	(0.0021)
Observations	79,902	79,902	76,740	79,902	76,740
Firm FE	Yes	Yes	Yes	Yes	Yes
Posting date FE		Yes	Yes	Yes	Yes
CBSA FE			Yes		Yes
Soc code FE				Yes	Yes

Notes: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. This table presents the relationship between the probabilty to submit a labor condition application for a given job and its job posting duration. It reports average marginal effects from linear probability estimations. All regressions control for employer fixed effects (Firm FE). Posting date, commuting zone (CBSA FE) and occupation (SOC FE) fixed effects are progressively added. The measure of job posting duration is standardized. **Reading:** (column 5) on average one standard deviation (1.1741 month) increase in job posting duration increases the probability to send a labor condition application by 1.97 percentage points. **Source:** Job board A and U.S. Department of Labor.

A.4   Robustness checks (2018)

Table 13: Comparing generous employers to the others

| Dependent variable:	H-1B demand Probit (1)	H-1B demand LPM (2)	H-1B demand LPM (3)	H-1B demand LPM (4)
Job posting duration	0.0255*** (0.0016)	0.0207*** (0.0019)	0.0214*** (0.0020)	0.0203*** (0.0020)
Not generous employers	0.7190*** (0.0256)			
Job posting duration x Not generous employers	-0.0219 (0.0170)	-0.0004 (0.0017)	-0.0006 (0.0017)	-0.0006 (0.0017)
Observations	79,902	79,902	76,740	76,740
Posting date	Yes	Yes	Yes	Yes
Firm FE		Yes	Yes	Yes
CBSA FE			Yes	Yes
SOC FE				Yes

Notes: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. This table presents the relationship between the probabilty to submit a labor condition application for a given job j and its job posting duration. In particular, it explores the heterogeneous effect of job posting duration between generous employers and the others. The main independent variable is a dummy variable distinguishing vacancies posted by employers who only propose wages above labor market prices from vacancies posted by other employers. The third line estimate is the interaction between job posting duration and this dummy variable. This table reports average marginal effects successively estimated from probit and linear probability (LPM) estimations. All regressions controls for the date at which the vacancy was posted (Posting date). From columns (2) to (4), firm (Firm FE), commuting zone (CBSA FE) and occupation (SOC FE) fixed effects are progressively included. The measure of job posting duration is standardized. **Reading:** (column 4) on average one standard deviation (1.1741 month) increase in job posting duration increases the probability to send a labor condition application by 2.03 percentage points for employers who do not belong to the top petitioners category. **Source:** Job board A and U.S. Department of Labor.

Table 14: Comparing H-1B dependent to other employers

Dependent variable:	H-1B demand Probit (1)	H-1B demand LPM (2)	H-1B demand LPM (3)	H-1B demand LPM (4)
Job posting duration	0.0288*** (0.0017)	0.0204*** (0.0017)	0.0210*** (0.0018)	0.0199*** (0.0018)
H-1B dependent	0.5752*** (0.0521)			
Job posting duration x H-1B dependent	0.0532 (0.0335)	0.0192*** (0.0058)	0.0199*** (0.0059)	0.0211*** (0.0059)
Observations	78,448	78,448	75,349	75,349
Posting date	Yes	Yes	Yes	Yes
Firm FE		Yes	Yes	Yes
CBSA FE			Yes	Yes
SOC FE				Yes

Notes: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. This table presents the relationship between the probabilty 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 employers and the others. The main independent variable is a dummy variable distinguishing vacancies posted by employers who have the H-1B dependent status from vacancies posted by other employers. The third line estimate is the interaction between job posting duration and this dummy variable. It reports average marginal effects successively estimated from probit and linear probability (LPM) estimations. All regressions controls for the date at which the vacancy was posted (Posting date). From columns (2) to (4), firm (Firm FE), commuting zone (CBSA FE) and occupation (SOC FE) fixed effects are progressively included in these regressions. The measure of job posting duration is standardized. **Reading:** (column 4) on average one standard deviation (1.1741 month) increase in job posting duration increases the probability to send a labor condition application by 1.99 percentage points for employers who do not belong to the top petitioners category. **Source:** Job board A and U.S. Department of Labor.

Figure 13: Regression discontinuity on job posting duration
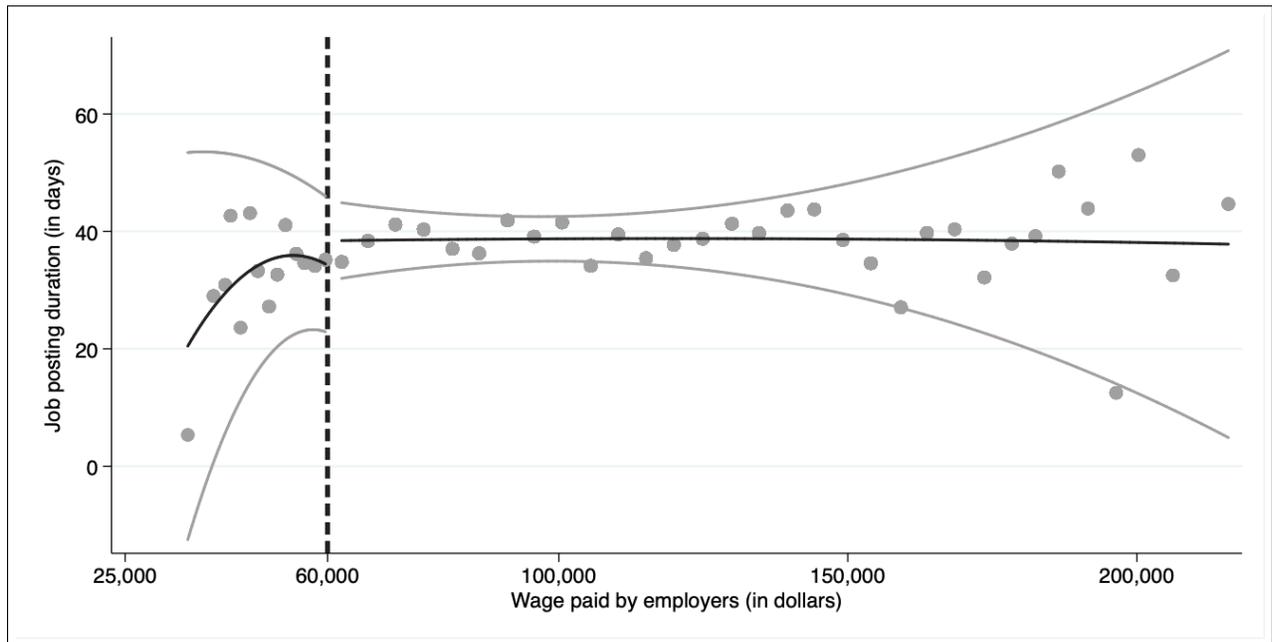
Notes: This graph presents a discontinuity analysis in job posting duration. It focuses on the sixty thousand dollars per year threshold. Below, employers have to inform the administration about their posting duration to prove that they have been looking first for a native worker without success. By fitting quadratic polynomials on both sides of the threshold, this regression discontinuity test does not report any significant difference. It suggests therefore the absence of manipulation in job posting duration. **Source:** Job board A and U.S. Department of Labor.

A.5 Heterogeneity analysis (2018)

Table 15: Comparing top petitioners to the other employers

Dependent variable:	H-1B demand Probit (1)	H-1B demand LPM (2)	H-1B demand LPM (3)	H-1B demand LPM (4)
Job posting duration	0.0264*** (0.0015)	0.0212*** (0.0017)	0.0218*** (0.0018)	0.0207*** (0.0018)
top petitioners	1.3587*** (0.0252)			
Job posting duration x Top petitioners	-0.0611*** (0.0175)	-0.0034 (0.0027)	-0.0036 (0.0027)	-0.0037 (0.0027)
Observations	78,480	78,480	75,381	75,381
Posting date	Yes	Yes	Yes	Yes
Firm FE		Yes	Yes	Yes
CBSA FE			Yes	Yes
SOC FE				Yes

Notes: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. This table presents the relationship between the probabilty 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 top petitioners and the others. The main independent variable is a dummy variable distinguishing vacancies posted by employers defined as top petitioners (i.e. employers who have submitted more than 148 applications in fiscal year 2019) from vacancies posted by other employers. The third line estimate is the interaction between job posting duration and this dummy variable. It reports average marginal effects successively estimated from probit and linear probability (LPM) estimations. All regressions controls for the date at which the vacancy was posted (Posting date). From columns (2) to (4), firm (Firm FE), commuting zone (CBSA FE) and occupation (SOC FE) fixed effects are progressively included in these regressions. The measure of job posting duration is standardized. **Reading:** (column 4) on average one standard deviation (1.1741 month) increase in job posting duration increases the probability to send a labor condition application by 1.6 percentage points for employers who do not belong to the top petitioners category. **Source:** Job board A and U.S. Department of Labor.

Figure 14: Heterogeneity across major groups of occupations (controlling for top petitioners)
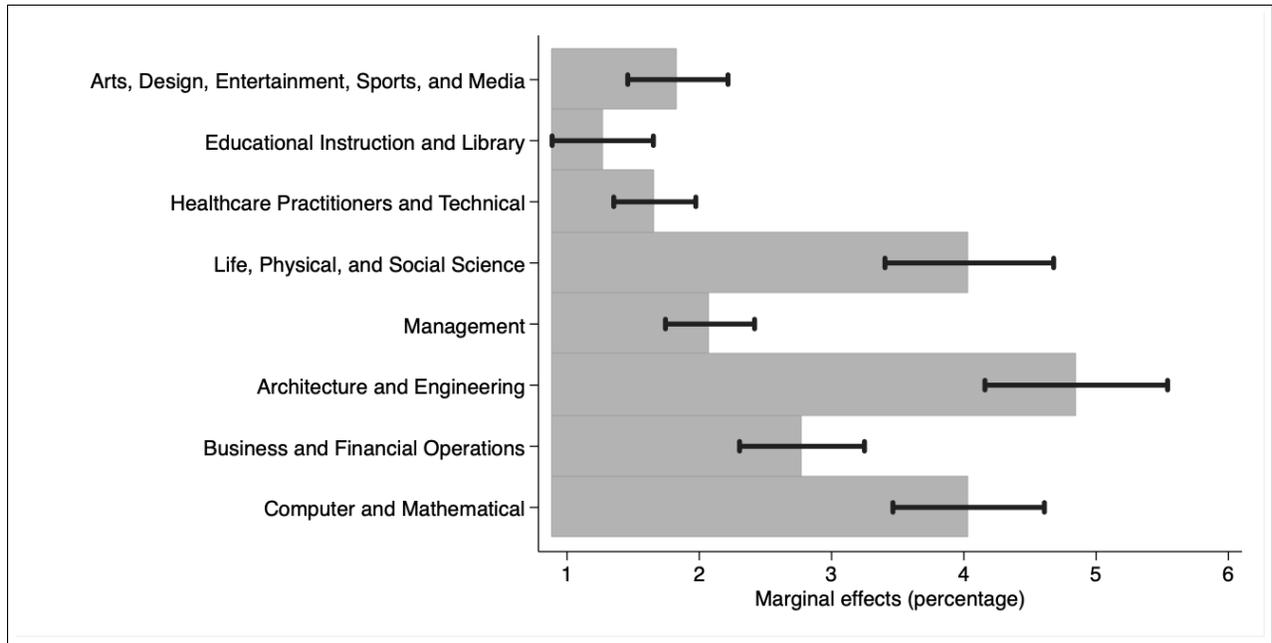
Notes: This graph presents the relationship between the probabilty to submit a labor condition application for a given job and its job posting duration. It reports average marginal effects estimated with a probit estimation. It highlights heterogenous results across major group of occupations. The estimation controls for commuting zone fixed effects. It controls also for posting date and top petitioners (i.e. employers who have submitted more than 148 applications in fiscal year 2018). The measure of job posting duration is standardized. **Reading:** on average one standard deviation increase (1.1741 month) in job posting duration increases the probability to send a labor condition application by 4 percentage points for Computer and Mathematical jobs. **Source:** Job board A and U.S. Department of Labor.

Figure 15: Heterogeneity over job posting duration (controlling for top petitioners)
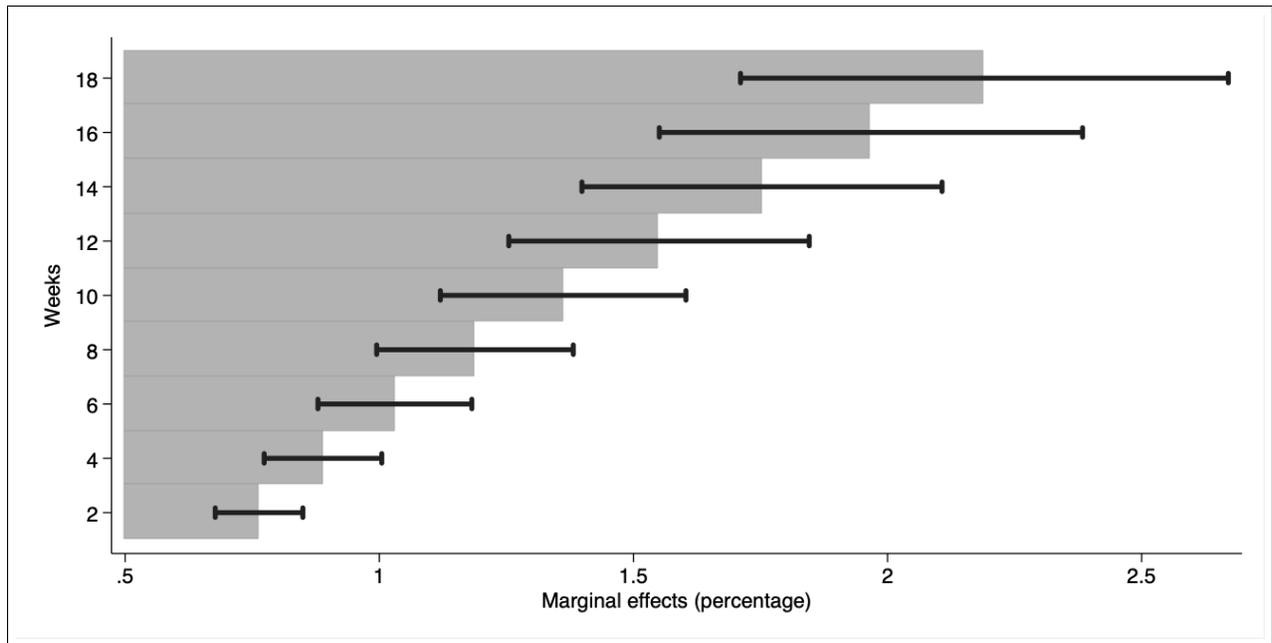
Notes: This graph presents the relationship between the probabilty to submit a labor condition application for a given job and its job posting duration. It reports marginal effects estimated with a probit estimation. It highlights the heterogeneity of the results along the duration scale. The estimation controls for commuting zone and occupation fixed effects. It also controls for posting date and top petitioners(i.e. employers who have submitted more than 148 applications in fiscal year 2019). **Reading:** employers are 0.75 percentage point more likely to submit a labor condition application for jobs that takes two more weeks than usual to be filled. **Source:** Job board A and U.S. Department of Labor.
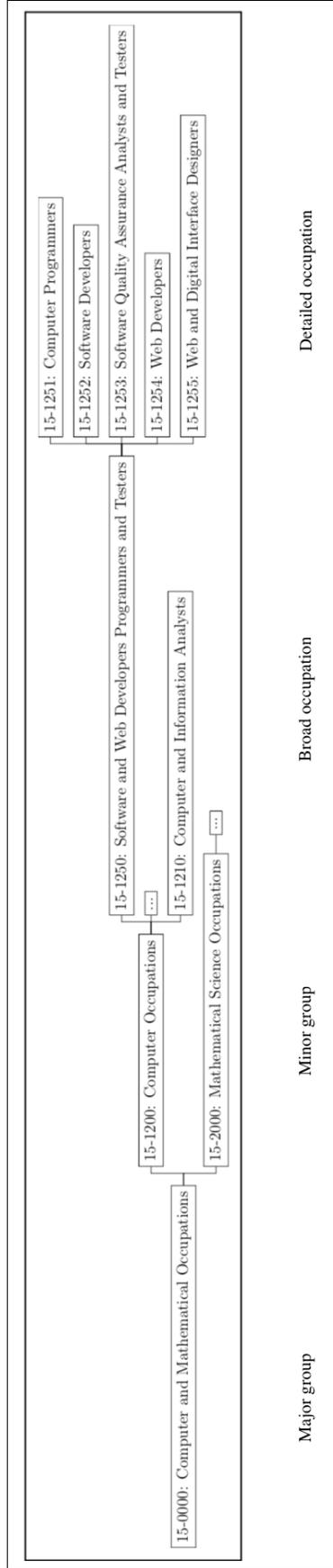
B The US Standard Occupation Classification system

All along the empirical analysis, I rely on the US Standard Occupation Classification system to identify occupations. This section details this 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 two following to the minor group, broad occupations are then precised by the 5th digit. Finally, detailed occupations are indicated by the last digit. Each detailed SOC occupation gathers all jobs with "similar job duties, and in some cases, similar skills, education, and/or training".

Figure 16 presents the decomposition of occupations within the SOC system by focusing on 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, modifie 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 16 describes their skills' similarities. This table describes both five main skills and tools used in each occupation. Highlighted in red, common tools represent almost half of the toolbox used in both jobs. It suggests that workers performing one occupation can also be hired to realize the second job.

Figure 16: SOC classification: the computer occupation example

15-0000: Computer and Mathematical Occupations	15-1200: Computer Occupations	15-1250: Software and Web Developers Programmers and Testers	15-1251: Computer Programmers
			15-1252: Software Developers
			15-1253: Software Quality Assurance Analysts and Testers
			15-1254: Web Developers
			15-1255: Web and Digital Interface Designers
		...	
	15-1210: Computer and Information Analysts		
	15-2000: Mathematical Science Occupations		
	...		
Major group	Minor group	Broad occupation	Detailed occupation

This table presents the different levels of the US Standard Occupational Classification. It focuses on the example of Computer occupations.

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Table 16: Five main skills per occupation

Detailed occupation SOC code	Computer programmers 15-1251	Software Developers 15-1252
Data base management system software	Apache Cassandra; **MongoDB**; Oracle PL/SQL; **Teradata Database**	Apache Hadoop; **MongoDB**; MySQL; **Teradata Database**
Development environment software	**Apache Maven**; **C**; Microsoft Visual Basic Scripting Edition VBScript ; Ruby	**Apache Maven**; **C**; Microsoft Power Shell; Verilog
Object or component oriented development software	**C++**; **Oracle Java**; Practical extraction and reporting language Perl ; **Python**	**C++**; **Oracle Java**; **jQuery** ; **Python**
Web platform development software	**AJAX**; Google AngularJS; **jQuery**; **Microsoft ASP.NET Core MVC**	**AJAX**; Drupal; **Microsoft ASP.NET**; 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 are 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. Measuring this phenomenon intends to support my interpretation of the relationship linking job posting duration to the demand for high-skilled foreign worker. To construct this index, I use both online and survey data. The former are used to measure labor demand and come from the Open Skills Project. The latter, the Occupational Employment Statistics allow me to approximate the labor supply side.

C.1 Open Skills Project

The Open Skills Project aims to edit a classification of skills associated to each job included in the US labor market. It is composed by a consortium gathering both research institutions, online job boards and non-profit developers. This partnership allows researchers to exploit proprietary data on US 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 take advantage of the Open Skills Research Hub. This part of the project releases quaterly aggregate data on US job postings at occupation and commuting zone levels. As data are provided by several of the main US job boards (ADP, Career Builder, the National Labor Exchange), they provide me with the largest possible picture of the US labor market. It details the quaterly aggregate number of job postings advertised online. These data are released at the local labor market level. First, occupations are detailed at the six-digit SOC code. Moreover, locations are identified through Core Base Statistical Areas that correspond to commuting zones. These aggregate figures provide me with the numerator of my labor market tightness ratio.

C.2 Occupational Employment Statistics

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

The OES is a semiannual survey based on 1.2 million US establishments. It produces employment estimates for approximately 800 occupations. As data are released with the same level of granularity than the demand side, they provide me with indirect insights regarding the denominator of the tightness ratio. Theorywise, measuring labor supply would necessitate to observe the number of unemployed workers per occupation and commuting zone. Due to data constraints, I approximate 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 gathers the whole labor force rather than the 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 to 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.