Skilled Labor Supply and Corporate Investment: Evidence from the H-1B Visa Program*

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Abstract

I study how a firm's ability to hire skilled workers affects corporate investment. To this end, I exploit the 2003 reduction in the legislative cap for the H-1B visa program, which U.S. firms use to recruit foreign skilled (college-educated) workers. I find that the reduction in the cap caused a significant decrease in the investment rate of firms that were ex-ante more reliant on H-1B workers as a source of skilled labor. The effect persists for several years past the 2003 cap drop, and is more pronounced for firms hiring workers in "industrial" occupations related to science and engineering compared with firms hiring workers in "knowledge" occupations related to information technology and professional services. The effect is also more pronounced for firms that are not easily able to access substitute sources of skilled labor. My research shows that constraints on access to human capital, much like constraints on access to financial capital, can hinder corporate investment.

Key words: Investment, skilled labor, capital-skill complementarity, immigration, hiring constraints, labor market frictions.

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1 Introduction

"In other businesses the capacity constraint is buildings, plant or equipment. In our business it's people."

—Jeff Owens, CEO of Advanced Technology Services, Inc.[1]

Complaints about skill shortages have become a common mantra among business leaders. A global survey conducted in 2012 found that one in four CEOs claimed they were unable to pursue a market opportunity or have had to cancel or delay a strategic initiative due to "talent constraints".[2] Laments about the difficulties in hiring workers are especially ubiquitous concerning skilled occupations in specialized fields. For example, a 2013 industry report estimates that a shortage of skilled workers in the oil and gas sector put $100-billion worth of industrial investment projects at risk,[3] while a separate industry survey found that 47% of Fortune 1000 firms reported business growth being impeded by unfilled jobs in technical occupations.[4] These examples suggest that difficulties in hiring skilled workers can meaningfully inhibit demand for capital. Considering the fundamental roles of capital and labor in economic production, it is surprising how little is known about how constraints on firms' access to skilled labor affect corporate investment.

Corporate finance is largely concerned with how imperfect financial markets affect firms' ability to pursue attractive business opportunities. However without also considering the imperfections of labor markets, one cannot gain a complete picture how firms make decisions. Zingales (2000) encouraged finance researchers to investigate the increasingly important interplay between human and physical capital to better understand the decisions of modern human capital-intensive firms. In this paper, I study how labor market frictions affect demand for physical capital by exploiting a 2003 policy shock that limited the entry of foreign college-educated workers into the United States.

I study how a shock restricting firms' ability to hire skilled workers impacts firms' investment decisions. It is not immediately obvious whether firms should increase or decrease investment in response to an adverse skilled labor supply shock. In line with the anecdotal accounts of hiring difficulties creating a drag on investment, there is a long literature, starting with Griliches (1969), that explores the idea that skilled labor is relatively more

[1] Weitzman, Hal "Skills gap hobbles US employers" *Financial Times* 13, Dec. 2011.
[2] "15th Annual Global CEO Survey 2012" *PWC Report*. Web. `www.pwc.com/ceo`
[3] Hirtenstein, Anna and Shankleman, Jess "Skilled worker shortage threatens US$100-billion in U.S. energy projects" *Bloomberg News* 7 Mar. 2013.
[4] Bayer Corporation. "The Bayer Facts of Science Education XVI: US STEM Workforce Shortage—Myth or Reality? Fortune 1000 Talent Recruiters on the Debate." *Journal of Science Education and Technology* 23 (2014): 617-623.

complementary to capital than unskilled labor. In contrast, Autor (2003) argues that the boundary between labor and capital generally moves in the direction of capital taking over tasks formerly performed by labor, even in traditionally skilled occupations. For instance, recent advances in automation and artificial intelligence may displace skilled workers in the modern economy, just as factories and assembly lines once displaced skilled artisans during the industrial revolution.

My empirical tests are designed to shed light on whether an adverse shock to the supply of skilled labor induces firms to cut investments (i.e. the complementarity hypothesis), as widely claimed by business leaders, or whether firms instead increase capital investment in order to mitigate the shock through substituting one factor of production for another (i.e. the substitution hypothesis). It is also possible that such shocks have no detectable effects on firms' investment decision. Under the null hypothesis, capital investment should remain unchanged after a shock to the supply of skilled workers.

To establish the causal impact of changes to skilled labor supply on corporate investment, one faces the classic identification challenge of disentangling supply shocks from shifts in demand. To overcome this challenge, I exploit an plausibly exogenous change in skilled labor supply created by a change to the regulatory limit on the total number of foreign college-educated workers allowed to be hired in the United States under the H-1B visa program. Specifically, the nation-wide number of visas issued each year is limited by a regulatory cap, and a significant reduction in the cap took effect in 2003. The president of the American Immigration Lawyers Association predicted at the time that *"[the] immediate impact of not being able to obtain an H-1B approval is that projects are put on hold, capital expenditures are deferred and lives are thrown into chaos."*[5]

The H-1B visa cap drop provides an ideal setting for my empirical investigation by placing the focus on *immigrant* workers. Borjas (2001) argues that immigrants constitute a relatively elastic supply of labor that serves to "grease the wheels" of the domestic labor market in large part due to their high intrinsic degree of mobility. In contrast, college-educated domestic workers in the U.S. have exhibited steadily declining mobility over the past several decades (Molloy, Smith, and Wozniak, 2014). Therefore, an artificial restriction on the elastic supply of skilled immigrant workers should be acutely felt by domestic firms facing a relatively inelastic domestic labor force.

My empirical approach is to compare changes in corporate investment between firms that were differentially affected by the cap drop. Firms which relied more heavily on H-1B workers ex-ante as a source of skilled labor were more exposed to H-1B policy shocks and therefore should have been more intensely affected by the cap drop. Accordingly, I set up a

[5] Gamboa, Suzanne "Limit reached for applications for skilled worker visas" *Associated Press*, 17 Feb. 2004.

difference-in-differences (DD) estimation approach in which the 2003 H-1B cap drop forms the "treatment" event, and the intensity of firm's exposure to H-1B policy is measured based on firms' ex-ante hiring rates of H-1B workers during 2001. I compare quarterly investment rates for firms with differing levels of H-1B exposure from one year prior to the cap drop (2002) and one year following the cap drop (2004). Under the complementarity hypothesis, firms facing greater exposure to H-1B policy shocks should experience declines in investment relative to firms facing less exposure, while the reverse should hold under the substitution hypothesis.

In line with the complementarity hypothesis, the results show that the 2003 H-1B cap drop caused more intense employers of H-1B workers to reduce capital expenditures relative to less intense employers of H-1B workers. The results are both statistically and economically significant, implying that a firm in the 75th percentile of H-1B usage experienced a 0.084 percentage point drop in their quarterly investment rate relative to a firm in the 25th percentile of H-1B usage. This corresponds to a 7.55 percent decline relative to the sample mean for the investment rate, or alternatively, a $27,989.74 decline in investment per H-1B worker for the median firm. I find that this result is robust to a variety of alternative definitions of firms' H-1B usage rates.

Crucially for identification, I find strong evidence in support of parallel trends, the key assumption behind the validity of my DD estimation approach, in that firms with differing exposures to H-1B policy did not experience diverging or converging trends in investment policy prior to the 2003 event. This suggests that my results are not driven by pre-existing differences in investment opportunity trends, and also that the event was not anticipated by firms prior to 2003. I also find that the dynamics of quarterly investment from 2002 to 2004 generally conform to the timeline of political events surrounding the H-1B cap drop. To further address concerns over the endogeneity of firms' H-1B usage, I use predicted values of H-1B hiring based on historical geographic characteristics of firm headquarter locations. These characteristics are plausibly exogenous to changes in investment opportunities around the time of the H-1B cap drop, and tests using the fitted values produce qualitatively similar results to my baseline tests.

I investigate the impact of the H-1B policy shock on other firm outcomes. First, I verify that firms that were ex-ante more dependent on H-1B workers indeed experienced a relative decline in their H-1B hiring intensity following the cap reduction. I also find that the H-1B cap reduction resulted in relative declines in the accumulation of intangible capital, as proxied by R&D and SG&A expenditures, which is consistent with findings from the existing literature. However, these declines are only detectable in terms of statistical significance at longer horizons. I also examine the impact on the average wage paid to new H-1B hires as well as acquisitions activity, but do not find any significant effects.

I examine whether the declines in investment for firms more reliant on H-1B workers persists beyond the immediate one-year window used in my benchmark analysis. It is possible that the complementarity holds in the short run, while over longer horizons, firms can substitute for the restricted foreign H-1B workers using domestic workers—in which case the adverse effect on investment should attenuate over time—or to alter their production technology in substituting capital for labor—in which case the reverse substitution effect may occur. However, I find that the impact on investment strongly persists for at least four years following the 2003 event, which suggests that it is difficult for firms to find substitutes for this elastic supply of skilled foreign labor.

A potential concern regarding my empirical approach is that the 2003 H-1B cap drop came about due to declining lobbying efforts from firms suffering declining investment opportunities. I mitigate this concern by showing that the documented effects on investment were not confined to the high-tech sector, which was strongly associated with political lobbying on H-1B policy issues. I find no significant differences between industries inside and outside of the high-tech sectors. Furthermore, I find no significant differences between large firms, which tend to be more politically active in lobbying, and small firms, which tend to be less politically active. These results suggest that my results are not driven by the potential political endogeneity of the 2003 event.

I explore how the complementarity between skilled labor and capital investment depends on the nature of the production technology that combines labor and capital. I find capital to be complementarity to workers in traditional "industrial" roles such as scientists and engineers, who are closely associated with working with physical capital, but not to workers in pure "knowledge" occupations such as computer programmers and accountants, who are more closely associated with working with ideas rather than physical machines.[6] I find limited evidence that the complementarity effects are stronger for manufacturing firms, in which capital expenditures tend to be directed towards more variable inputs such as equipment and machinery, and weaker for service sector firms, in which capital expenditures tend to be directed towards fixed overhead items such as buildings and offices.

I also show that the complementarity between skilled foreign workers and capital investment is concentrated in firms that cannot easily find substitutes for H-1B workers. In particular, I find that my benchmark effects are attenuated for firms that have access to alternative sources of skilled workers through the domestic labor market, offshoring, and alternative visa programs. This suggests that complementarity with capital, as well as non-

[6] For instance, software developers are tasked with the implementation of concepts and models, rather than the construction of physical machines.

substitutability with alternative labor sources, are both necessary conditions for H-1B policy to affect firm investment behavior.

The literature on corporate investment is extensive. Research has shown investment to be impacted by agency frictions (Panousi and Papanikolaou, 2012), information constraints (Foucault and Fresard, 2014), behavioral biases (Malmendier and Tate, 2005), and real options (Carlson, Fisher, and Giammarino (2004), Bloom, Bond, and Van Reenen (2006)). One of the most important areas of the investment literature focuses on the role of financial constraints. Starting with Fazzari, Hubbard, and Petersen (1988) and revitalized by Kaplan and Zingales (1997), researchers have long searched for evidence that financial constraints limit the ability of firms to respond to investment opportunities. Recent works by Lemmon and Roberts (2010), Duchin, Ozbas, and Sensoy (2010), and Almeida, Campello, Laranjeira, Weisbenner, et al. (2012) have empirically documented the adverse impact of financial sector shocks on corporate investment. The main contribution of my paper to this literature is to document how constraints on the supply of human capital, rather than financial capital, can affect investment policy.

My work also relates to the emerging body of finance research related to labor and employment. Previous works have explored both how labor market considerations affect financial and governance outcomes (Atanassov and Kim (2009), Chen, Kacperczyk, and Ortiz-Molina (2011), Simintzi, Vig, and Volpin (2015), Matsa (2010), Agrawal and Matsa (2013)), as well as how financial factors affect employment outcomes (Benmelech, Bergman, and Seru (2011), Mian and Sufi (2014)). While much of this literature looks at the impacts of unions, which is often associated with less-educated blue collar workers, I explicitly focus on highly-educated workers and their relationship to capital.

My focus on skilled labor is motivated by the literature, starting with Griliches (1969), that explores the premise that skilled labor is relatively complementary to capital when compared to unskilled labor. Much of the evidence in this literature is descriptive and uses aggregate data, with no strong identification of causation at the micro level (DiNardo and Pischke, 1997). Lewis (2011) provides the most relevant work, finding evidence that automation technology is more complementary to medium-skilled workers relative to low-skilled workers. While his work examines how low-skilled immigrants affect the technological mix used by manufacturing plants, I focus instead on high-skilled immigrants and their effects on total capital expenditures for firms across a broader set of industries. Furthermore, my dataset allows me to explore cross-sectional differences with respect to occupations and industries, and my quasi-experimental setting allows me to investigate the time horizon of the effect on investment.

The H-1B visa program itself is increasingly attracting attention from academic researchers. Most research in this area focuses on the effects of the program on the employment and wages of domestic workers (Lofstrom and Hayes (2011), Kerr, Kerr, and Lincoln (2015b), Peri, Shih, and Sparber (2014), Doran, Gelber, and Isen (2016)), while others study the effect on patenting and innovation (Lewis, Peri, et al. (2015), Kerr and Lincoln (2010)). Rather than investigate the effect on domestic workers, I focus on the outcome of capital investment, which is often neglected by labor and policy researchers working in the field. In addition, I provide evidence on the horizon of the effect on investment, which may be an important consideration for policymakers.

Ghosh, Mayda, and Ortega (2016) and Ashraf and Ray (2016), who study the impact of skilled immigrant workers on innovation and productivity, also use the 2003 H-1B cap reduction as a quasi-experimental setting. However, they use data on labor condition applications (LCAs), which are noisy measures of H-1B demand.[7] In contrast, I use data on firms' actual petitions to hire H-1B workers, which provides additional detailed data on workers' occupations, and nationalities. In addition, both Ghosh et al. (2016) and Ashraf and Ray (2016) use annual firm data, while I use quarterly data in order to better isolate the timing of the policy shock. Nevertheless, my finding of a negative effect on firm investment is consistent with the negative effect on innovation and productivity that they document.

The remainder of the paper is organized as follows. Section 2 provides a description of the 2003 regulatory change in the H-1B visa program and how I exploit this quasi-experimental event as part of my identification strategy. Section 3 describes the data and accompanying summary statistics. Section 4 reports my main results as well as follow-up findings. Section 5 concludes.

2 Empirical Strategy

I base my identification strategy on the sharp 2003 drop in the legislative cap of the H-1B visa program. In this section, I explain the importance of the H-1B visa program as a source of skilled workers for U.S. firms. I then briefly describe the history of the annual cap restricting the number of foreign workers that can be hired through the program. Finally, I describe the sharp drop in the annual cap drop that occurred in 2003, and how I exploit this event as part of my identification strategy.

[7] Filing an LCA is a necessary step towards hiring an H-1B worker, but does not necessarily lead to a H-1B hire.

2.1 Overview of the H-1B Program

Established by Congress through the Immigration Act of 1990, the H-1B visa program allows employers to hire skilled foreign workers to legally work in the U.S. on a temporary basis. Visas are issued for a period of up to three years, with the possibility of a one-time extension for an additional three years. According to the U.S. government's website, the program's stated intent is to allow employers to fill vacant positions for which *"the nature of the specific duties is so specialized and complex that the knowledge required to perform the duties is usually associated with the attainment of a bachelor's or higher degree"*.[8] Since the late 1990's, H-1B workers have largely consisted of workers in technical occupations related to science and technology fields.[9]

The H-1B visa program provides an economically significant source of skilled workers for U.S. firms. In 2003, U.S. employers hired 130,497 new H-1B workers, a substantial number when compared against the 442,755 new domestic bachelor's degree holders in science and technology disciplines.[10] The H-1B program is also comparable in magnitude to that of employment-based legal permanent residents (LPRs); LPRs are capped at 140,000 per year, and each foreign country is further limited to a maximum 7% of total worldwide admissions. Since the H-1B program places no such per-country limit, it is often the only channel for firms to hire workers from countries with large emigrant populations such as India and China.[11]

There is a legislative cap placed on the total number of H-1B visas issued per year, which applies to new H-1B hires and not to extensions of existing visas. This cap has fluctuated throughout the history of the H-1B program, starting with 65,000 in 1992 and reaching as high as 195,000 during the early 2000's. The cap was first raised to 115,000 through the American Competitive and Workforce Improvement Act (ACWIA) in 1998, and then raised again to 195,000 in 2000 by the American Competitiveness in the Twenty-First Century Act (AC21). The sharpest change came in 2003, when the cap reverted from 195,000 to 65,000 upon the expiration of the AC21.[12] This last event forms the quasi-experimental

[8] More than 98% of all approved applicants in 2004 possessed at least a bachelor's degree, with the remaining 2% coming from special exempt occupation such as fashion modelling.

[9] In 2003, the top five most common occupations for H-1B workers were found in systems analysis and programming (33.5%), college and university education (7.8%), accountants and auditors (4.8%), electrical/electrical engineering (3.9%), and computer-related occupations (3.1%), according to the *USCIS Characteristics of Specialty Occupation Workers (H-1B): Fiscal Year 2004*.

[10] See Appendix Table 2-18 of "Science and Engineering Indicators 2012" by the National Science Foundation, available online at `https://www.nsf.gov/statistics/seind12/appendix.htm`.

[11] A 2015 *National Foundation for American Policy* policy brief reports that skilled workers from high-population countries face expected wait times of 6-10 years in obtaining permanent residency. Unsurprisingly, India overwhelmingly supplied the largest share of new H-1B workers in 2003 at 46%, with China coming in at second at 8.7%.

[12] All changes to the H-1B cap up to this point focused exclusively on skilled immigration were not accompanied by policy changes relating to low-skilled immigration (Kerr, Kerr, and Lincoln, 2015a).

event behind my identification strategy.

2.2 Identification based on the 2003 H-1B Cap Drop

As shown in Figure 1, the 2003 H-1B cap drop from 195,000 to 65,000 resulted in a binding constraint on H-1B hires. Before the drop, employers were effectively assured of securing visas, as the 105,185 initial petitions submitted in 2002 fell well below the higher cap. In 2004, the newly-lowered cap of 65,000 was well above the 116,927 initial petitions submitted by employers. Consequently, employers found themselves rationed in their ability to hire H-1B workers due to the newly binding cap.

The main idea behind my empirical strategy is that the H-1B cap drop resulted in more severe hiring constraints for firms that were ex-ante more reliant on H-1B workers as a source of skilled labor. Accordingly, I employ a difference-in-differences (DD) estimation framework in which the 2003 H-1B cap drop marks the onset of the treatment, and the intensity of treatment is determined by the intensity at which firms employ H-1B workers during 2001. This follows the standard DD specification in which treatment is continuous rather than binary as in Card (1992):

$$CapEx_{it} = \alpha_i + \lambda_t + \delta \cdot \mathit{H1B\ use}_i \cdot Post_t + X_{it-1}\beta + \epsilon_{it} \tag{1}$$

where i indexes firms and t indexes time periods. *CapEx* represents capital expenditures, α represents a firm-specific dummy, λ denotes a time-specific dummy, *Post* represents a dummy for the "post-treatment" period, X represents a vector of lagged firm-level control variables, ϵ represents the error term, and *H1B use* represents the pre-treatment intensity at which firms hired H-1B workers. The coefficient of interest is δ, which should be zero under the null hypothesis, negative under the complementarity hypothesis, and positive under the substitution hypothesis. This standard DD specification controls for any time-invariant firm-level factors affecting investment, as well as for any time-specific shocks common to all firms.

I define the post-treatment period to consist of the four quarters in 2004, as illustrated in Figure 2. Although the lower cap officially took effect in October 2003, firms were able to continue filing petitions for hiring new H-1B employees until several months later. It was not until February of 2004 that the United States Citizenship and Immigration Services (USCIS) announced that it would no longer accept new H-1B petitions for the coming fiscal year, marking the point at which firms were first subject to hiring restrictions due to saturation of the cap.[13] Therefore, the impact of the cap drop should have been fully felt by the beginning

[13] The government's fiscal year starts in October and ends in September. The petition "window" never closed

of 2004.

Next, I define the pre-treatment period to consist of the four calendar quarters in 2002, also shown in Figure 2. Although the AC21 initially set the cap at 195,000 for a temporary period of three years, the previous trend of a rising cap created a reasonable expectation of permanence (Kato and Sparber, 2013).[14] Media reports suggest that the business community had expectations of a continued higher cap in early 2003, as the trade publication CIO Magazine reported in January that *"most expect the introduction of a bill that will either keep the cap high or eliminate it altogether"*.[15] It was not until February 2003 that the congressional chairman of the House Judiciary Committee indicated that the cap would revert back to 65,000 the following year.[16] Therefore, the sharp H-1B cap drop remained largely unanticipated by firms during the 2002 pre-treatment interval.

In my main regression analysis, I restrict the sample to the pre-treatment and post-treatment periods, while dropping the 2003 calendar year—i.e. the "legislative shift" period. This is so that δ captures the full extent of the effect of the H-1B cap drop on investment, and does not reflect any partial effects as expectations about the pending H-1B cap drop gradually built up throughout 2003. In later tests, I include the full time series, including the legislative shift period, in order to examine the quarter-by-quarter dynamics of investment around the event to verify that they align with the political timeline.

As is the case with all natural experiments involving legislative action, there is the concern that the 2003 H-1B cap drop arose endogenously due to shifts in forward-looking economic demand. In particular, one must be wary of the possibility that declining expectations about future investment opportunities resulted in reduced lobbying by firms looking to maintain a higher cap. However, Figure 3(a) reveals that the 2003 H-1B cap drop came at a time of growing rather than declining aggregate investment.[17] Figure 3(b), which displays the same data series at quarterly intervals, shows the same upward trajectory and also uncovers a sharp dip in aggregate investment during the latter parts of 2003 and early parts of 2004, precisely when the H-1B cap drop began to take effect.

I further address concerns about political endogeneity by investigating whether the effects on investment are confined to sectors most closely associated with political lobbying on H-1B policy. As noted by the press around the time of the cap drop, firms in the high-tech sector

for two years preceding the 2003 cap drop.

[14] Consider that the previous cap increase from the ACWIA was also originally set to expire after three years before being extended and raised by the AC21 in 2001.

[15] Overby, Stephanie "Cap on H-1B Visas Brought to Congress" *CIO Maganize* 1 Jan. 2003.

[16] "U.S. to tighten H1B visa norms" *The Hindu Business Line* 21 Feb. 2003.

[17] Note this series is taken from Bureau of Economic Analysis data, and represents aggregate investment activity across all sectors, not just Compustat firms in my sample.

were the most significant political lobbyists on the issue of H-1B policy.[18] If my results are driven by the declining investment opportunities of politically-active firms, for instance, then one would expect the relative investment declines to be stronger in firms in the high-tech sector. I show this not to be the case, using various definitions of high-tech industries.

Finally, plausibly exogenous political factors played a large role in influencing the regulatory shift towards to a lower cap. In particular, the September 11, 2001 terrorist attacks created a fear of foreigners being admitted into the country.[19] The Department of Homeland Security, specifically formed in response to the 9/11 attacks, assumed direct oversight of approving H-1B petition in March of 2003, taking over the mantle from the newly-defunct Immigration and Naturalization Services agency. Combined with the non-declining trend in investments, the circumstances during this period make a strong case for the exogeneity of the H-1B cap drop with respect to firms' changing investment opportunities.

3 Data

3.1 Sample Construction

My sample consists of firm-quarter observations from industrial firms, excluding utility firms (SIC code between 4900 and 4900), financial firms (SIC code between 6000 and 6999), and public sector firms (SIC code over 9000). All accounting and financial data come from the merged CRSP-Compustat Fundamentals Quarterly file. For my main results, I limit my sample to four quarters in the pre-treatment period (2002Q1-2002Q4) and four quarters of data in the post-event period (2004Q1-2004Q4).

I employ data selection criteria standard in the investment literature (Almeida, Campello, and Weisbach (2004), Almeida et al. (2012), Duchin et al. (2010)) by discarding firms for which the total market capitalization is less than $50 million as of the last quarter in the pre-treatment period (2002Q4). This serves to exclude the smallest firms with volatile accounting data and skewed investment patterns, resulting in a sample of 23,476 firm-quarter observations corresponding to 3,559 distinct firms.

I further restrict the sample to firms that have submitted at least one H-1B petition during the 2001 calendar year (i.e. "H-1B firms"), which results in a sample of 9,905 firm-quarter observations corresponding to 1,390 distinct firms that make up 36.23% of the total market capitalization for all publicly-listed companies listed on the Compustat quarterly

[18] Sickinger, Ted "Congress Lowers Visa Cap for Foreign Tech Workers" *The Oregonian*, 29 Sep. 2003.

[19] In its September 2003 10-K filing, telecommunications company Wireless Facilities Inc. noted that *"[immigration] policies are subject to rapid change, and these policies have become more stringent since the terrorist attacks on September 11, 2001."*

database as of 2002Q4. Having H-1B petition-level data for all firms in the sample allows me to conduct cross-sectional heterogeneity tests based on the observed characteristics of H-1B workers across firms. Furthermore, this restriction ensures that all firms in the sample have domestic operations in the U.S. and are potentially affected by H-1B policy.

Data on H-1B usage comes via a Freedom of Information Act (FOIA) request filed with the USCIS. The data contains information from petitions submitted by firms to the USCIS during the final step of the H-1B approval process, and includes details about the sponsoring employer, prospective H-1B employee, and job position, including employee age, education level, job wage, and occupational category. I match the USCIS data to Compustat firms via company names. Due to spelling mistakes and alternate variations of firm names in the USCIS data, I employ a matching procedure that incorporates fuzzy string matching as well as manual inspection of matches.[20]

By restricting the sample to only H-1B firms, my benchmark results are potentially subject to selection bias. In order to address this, I include tests based on the expanded sample of firms including "non-H-1B firms"—i.e. firms that did not submit a petition to hire H-1B workers in 2001. In particular, I show that non-H-1B firms experienced similar investment patterns to those of H-1B firms with marginally low exposure to H-1B policy, which suggests that the opportunity trends of H-1B firms are similar to the investment opportunity trends of non-H1B firms during the sample period. The expanded sample includes an additional 13,571 firm-quarter observations corresponding to 2,169 non-H1B firms.

3.2 Key Variables and Descriptive Statistics

My primary measure of H-1B usage intensity, *H1B use*, is defined as the total number of initial H-1B petitions filed during the 2001 calendar year by a given firm, scaled by average number of employees employed by the firm during the same interval. I use applications filed in 2001 in order to create an ex-ante measure with respect to my sample period, as shown in Figure 2. This mitigates the possibility of *H1B use* being correlated with changing investment opportunities surrounding 2003. The distribution for *H1B use* exhibits a sizable degree of positive skewness, and therefore it is winsorized at the 2% level at the upper tail.[21]

The dependent variable in my analysis is *CapEx*, which is defined as the ratio of quarterly capital expenditures to lagged total assets following the conventions of Baker, Stein, and

[20] Specifically, I first standardize the firm names found in both the Compustat and FOIA files, and employ a fuzzy string matching algorithm to arrive at a list of potential matches. I then inspect the list of potential matches to filter out the false positives. To cross-validate, I conduct a similar exercise by matching Compustat to LCA applications, and determine that a firm is hiring H-1B workers only if it is matched to both the LCA and USCIS datasets.

[21] The main results remain qualitatively unchanged if I winsorize by 1% at both tails like the other variables.

Wurgler (2003) and Rauh (2006).[22] I include lagged control variables commonly found in the investment literature. These include *Tobin's Q*, defined as the ratio between the market value and book value of assets, *ln*(*Size*), defined as the natural log of total assets, *Cash Flow*, defined as the ratio between quarterly net income before depreciation and total assets, *Cash Holdings*, defined as the ratio between cash holdings and total assets, and *Leverage*, defined as the ratio between long-term debt and total assets. A detailed definition of these variables can be found in Appendix A. To mitigate the effects of outliers, I winsorize each variable listed above at the 1% level at both tails. I further bound *Tobin's Q* to be no larger than 10, following Baker et al. (2003).

Table I presents the descriptive statistics for the variables defined above. Panel A displays the descriptive statistics for H-1B firms, while Panel B displays the descriptive statistics for non-H-1B firms. Note that in Panel A, *H1B use* exhibits positive skewness even after winsorization. In later robustness checks, I employ alternative measures of firm-level H-1B usage, including non-parametric measures that address potential concerns regarding skewness.

In comparing Panel A and Panel B, it is apparent that H-1B firms are on average larger than non-H1B firms, with lower average investment rates and leverage ratios but higher average Tobin's Q, profitability, and cash holdings.[23] This is consistent with anecdotes of large firms in high-growth technology industries being major employers of H-1B workers.[24] Panel A in Table II shows a list of the top 10 H-1B employers (in terms of total petitions submitted to the USCIS) found in my sample; the list indeed includes large technology companies such as Microsoft, Oracle, and Intel. Panel B in Table II shows that the firms most dependent on H-1B workers are not quite as large, but are also found in high-growth sectors such as telecommunications and high-tech manufacturing. In later tests, I include both H-1B and non-H1B firms in order to address concerns about selection bias stemming from focusing only on H-1B firms.

Table III presents a breakdown of H-1B petitions by occupational and industry group. Industry is defined at the SIC Division level and occupational categories are taken directly from the USCIS Dictionary of Occupational Codes.[25] The vast majority of H-1B employees are found in *Computer*, *Engineer*, *Science*, *Admin*, and *Management* occupations, with

[22] Because capital expenditure is reported on a year-to-date basis in quarterly financial statements, the previous quarter's capital expenditure is subtracted from the current quarter's capital expenditure (*capxy*) for fiscal quarters 2, 3, and 4 to arrive at the quarterly figure.

[23] The differences in means are significant for all variables.

[24] This could be due to the fact that large firms are better able to afford overhead costs associated with immigration lawyer fees and overcoming regulatory hurdles in the H-1B hiring process.

[25] A listing of more detailed occupational subcategories can be found in Appendix B. The occupational codes are also available online at `http://www.uscis.gov/files/form/m-746.pdf`. The physical sciences (Mathematics And Physical Sciences) and life sciences (Life Sciences) subgroups have been combined under a single "Sciences" group.

Computer occupations accounting for the largest group by a wide margin. In terms of a breakdown by industry, the vast majority of firms operate within the *Service* and *Manufacturing* industries. *Manufacturing* firms tend to employ the largest share of H-1B workers across the different occupational categories, with the exception of *Computer* workers, who are more than twice as likely to be found in the *Service* rather than *Manufacturing* sector. Overall, the top H-1B occupations are found across all industries, with the exception of *Construction* and *Agriculture*, *Forestry*, which contain relatively few firms.

The descriptive statistics are generally consistent with anecdotes of the H-1B program being an important source of young IT workers from India in the software and other IT-related service industries. However, the summary tables also show that manufacturing firms hire a significant number of H-1B workers, particularly in more traditional technical fields related to Science and Engineering. I later investigate heterogeneity across worker-level occupational characteristics as well as across industry classifications. This is done in order to investigate how complementarity or substitutability between skilled labor and capital depends on the nature of the production function.

4 Results

4.1 Effect of the 2003 H-1B Cap Drop

I run OLS regressions according to the Eq. 1 to estimate the impact of the 2003 H-1B cap drop on investment. Table IV presents the results under various sub-specifications on the sample described in the previous section. The coefficient estimate for the variable of interest *H1B use* $\times$ *Post* is negative and statistically significant under all specifications, implying that the H-1B cap drop induced a relative investment decline in firms that were ex-ante more dependent on the program, in support of the complementarity hypothesis.

Column (1) starts off with the most basic specification. This specification does not include any control variables, but does include firm fixed effects, which control for time-invariant factors, and year-quarter fixed effects, which control for time-specific macro shocks. The inclusion of control variables *Tobin's Q* , *Cash Flow*, *ln*(*Size*), *Leverage*, and *Cash Holdings* through columns (3) to (6) leaves estimates with slightly larger magnitudes and stronger statistical significance. The specifications represented in columns (2), (4), and (6) further include industry-year-quarter fixed effects, where industry is defined at the SIC Division level.[26] This addresses potential concerns that the main results are driven by time-varying

[26] SIC Divisions consist of broad categories of economic activity identified in the SIC manual, corresponding to ranges of two-digit SIC codes (Kahle and Walkling, 1996). I use a coarse industry classification since finer industry definitions result in many industries for which my sample only contains a single firm, in which case

industry-level demand shocks.[27]

Column (6) presents the most robust specification, which includes the full set of control variables and firm and quarter fixed effects. The economic magnitude here is significant: the coefficient estimate of -0.109 implies a firm in the 75th percentile of *H1B use* suffers 0.084 percentage point drop in their quarterly investment rate relative to a firm in the 25th percentile of H-1B use. For a firm with the sample mean value for *CapEx*, this corresponds to a 7.55 percent relative decline in proportional terms. Relative to the median firm, this also corresponds to a $27,989.74 drop in capital expenditures *per H-1B worker hired in 2001*.

4.2 Investment Dynamics and Pre-Event Trends

The validity of my DD estimation approach hinges on the "parallel trends" assumption, in that firms' ex-ante H-1B exposure are not correlated with trends in investment policy in the lead up to the 2003 H-1B cap drop. I provide evidence in support of this by estimating the following OLS regression:

$$CapEx_{it} = \alpha_i + \lambda_t + \sum_{\tau < 2004Q1} \delta_\tau \cdot H1B\ use_i \cdot \tau_t + \delta \cdot H1B\ use_i \cdot Post_t + X_{it-1}\beta + \epsilon_{it} \qquad (2)$$

where τ_t represents a dummy variable that takes on a value of one when τ is equal to t, and τ takes on values from 2002Q2 to 2003Q4 inclusive.[28] The sample consists of all quarters between 2002Q1 and 2004Q4; data from 2003 is added back to the sample in order to analyze the full dynamics of firm investment, including the legislative shift period. For the parallel assumption to hold, the coefficients δ_τ should not exhibit any significance prior to 2003.

The results are presented in Table V, and provide support for the parallel trends assumption. Both specifications contain the full set of control variables as found in column (6) of Table IV, while including different sets of fixed effects. Under both cases, δ_t is statistically insignificant for all $\tau <$ 2003Q3, which means that, relative to the baseline period of 2002Q1, firms with differing levels of *H1B use* did not experience differing trends in investment during the pre-treatment period. This implies that my results are not driven by differing trends

all variation is subsumed by the industry-time fixed effects. In unreported tests, I use 2-digit, 3-digit, and 4-digit SIC classifications and the results remain virtually unchanged.

[27] In a set of unreported tests, I estimate the same regression after collapsing the data along the time-series into a pre-treatment mean and a post-treatment mean for CapEx and all control variables. This is done, based on the recommendations from Bertrand, Duflo, Mullainathan, et al. (2004), in order to overcome concerns of serially-correlated standard errors resulting in excessive rejection of the null hypothesis. The results are qualitatively similar when the data is collapsed, and remain statistically significant at the 1% level.

[28] The dummy variable for 2002Q1 is omitted since it is subsumed by the *H1B use* level term and intercept. Note that I do not extend my sample back beyond 2002, as the September 11, 2001 terrorist attacks also impacted immigration policy and therefore may confound the results.

in investment opportunities already in place during the pre-treatment period, and that the pending cap drop was not anticipated by firms prior to 2003.

The timing of the detected effect also conforms to the legislative timeline outlined in Section 2. The first statistically significant coefficient in column (2) comes at the third quarter of 2003, meaning that it took two quarters following the February 2003 congressional announcement before firms implemented changes in investment policy. This is consistent with the political timeline of the legislative shift period: firms still had the opportunity to lobby for an extension of the higher cap following the congressional announcement, and therefore may have decided to refrain from major shifts in investment policy until the lower cap became more certain. It was not until late September of 2003 that the lower cap was officially finalized following a final congressional hearing on the subject, which coincided with the first significant negative coefficient corresponding to 2003Q3.

4.3 Long Term Impact of the H-1B Cap Drop

While the 2003 H-1B cap drop was of a permanent nature, the baseline results presented in Table IV are based on post-treatment investment policies at only a one year horizon.[29] However, it is possible that the effect on investment attenuated gradually over time, as the supply of potential domestic skilled worker substitutes becomes less inelastic in the long-run. The negative effect on investment may even eventually reverse if firms gradually adjust their production technology to replace labor with capital over longer horizons, as described by Autor (2003). Therefore, I extend the horizon past 2004 to investigate whether the effect of the H-1B cap drop persists beyond the initial year by expanding the sample to include data up to 2007.[30] I collapse the quarterly data along the time dimension by calendar year and run the following regression:

$$CapEx_{it} = \alpha_i + \lambda_t + \sum_{k=2004}^{2007} \delta_k \cdot \mathit{H1B\ use}_i \cdot \mathit{Year}\ k_t + X_{it-1}\beta + \epsilon_{it} \tag{3}$$

where $\mathit{Year}\ k_t$ represents a dummy variable that takes on a value of one when k is equal to t. Here, k takes on values from 2002 to 2007 inclusive, which allows me to estimate the

[29] In 2005, there was a small increase in the allowance for an additional 20,000 workers under the cap, but this was a relatively insignificant change in the cap compared to the 2003 decrease, and only applied to applicants holding a Master's or PhD degree from an U.S. institution. Furthermore, prospective legislation on skilled immigration became increasingly bundled with that on unskilled immigration in the years following the cap drop (Kerr et al., 2015a), making it politically difficult to enact policy changes to re-expand the H-1B program.

[30] I stop at 2007 due to the onset of the credit crunch and financial crisis that significantly impacted firm investment in 2008 and 2009.

effect on investment for four years following the 2003 cap drop.

The results are presented in in Table VI, and reveal that the effect on investment is indeed persistent for all four years following the 2003 cap drop, as δ_k remains negative and statistically significant for all $k > 1$. Furthermore, they do not shrink in magnitude over time—in fact they seem to grow larger. This is consistent with the anecdotal evidence of the increasing difficulties that firms faced in securing H-1B visas for their workers in the years following the cap drop. Over all, the results suggests that persistent rationing of foreign skilled workers is not gradually mitigated by domestic replacements, and that firms are not able to adjust their production technology to directly replace workers with capital at the time scale examined here. Nevertheless, it is still possible that reversals can occur in the very long run.

4.4 Effect of the H-1B Cap Drop on Other Outcomes

Shifting our attention away from capital expenditures, I examine how the H-1B policy shock impacted other firm-level outcomes. To this end, I estimate my benchmark specification following Eq 1 using a variety of alternative dependent variables. First, I check that the H-1B cap drop indeed had a stronger effect on the hiring of H-1B workers for more H-1B dependent firms. To this end, I estimate the effect on *H1B usage*, the time-varying measure of H-1B hiring intensity. Column 1 in Panel A of Table VII shows that the firms that were more dependent on H-1B workers prior to the policy shock indeed experienced a relative decline in their hiring of H-1B workers following the cap reduction. Column 1 in Panel B reports the estimation of the same specification for a longer sample that includes a post-treatment period extending to the end of 2007Q4, and shows a similar result.

Next, I examine the impact of the H-1B cap drop on *H1b AvgWage*, the natural log of the average wage across a firm's new H-1B hires. We expect a negative supply shock to result in an increase in price (wage), but column (2) in Panel A of Table VII shows that H-1B cap drop had no detectable effect on the relative H-1B worker wages between H-1B dependent on non-dependent firms. If we extend the sample to the end of 2007, the estimate is positive but still insignificant, as seen in column (2) in Panel B. However, without data on the wages of *domestic hires*, one cannot draw strong conclusions about whether the H-1B cap drop actually impacted wages.

The focus of this paper is on tangible and physical capital as measured by capital expenditures, but a supply shock to skilled labor may also affect how firms accumulate intangible capital. Existing research has shown that the 2003 H-1B cap drop adversely impacted innovation, as measured by R&D expenditures (Ghosh et al., 2016). Therefore, we should expect firms to scale back their accumulation of intangible capital following the 2003 H-1B cap reduction.

I proxy for the accumulation of intangible capital with *R&D*, defined as quarterly R&D expenditures scaled by lagged assets, and *SG&A*, defined as quarterly sales and general administration expenditures scaled by lagged assets.[31] The results presented in column (3) and (4) in Panel A of Table VII show a negative effect on both R&D and SG&A expenditures, but the estimates are not statistically significant. Once we extend the sample to 2007, however, the negative estimates become significant at the 5% level. This suggest that spending on R&D and SG&A tend to be sticky and that the responses of the firms in our sample to the H-1B policy shock is not detectable at the one-year horizon.

Lastly, I examine the effect of the H-1B cap drop on *Acquisitions*, defined as total acquisitions scaled by lagged assets. It is not ex-ante clear whether the H-1B skilled labor supply shock should induce a positive or negative response in acquisition activity. On one hand, we may expect a negative response following the complementarity hypothesis, as acquisitions constitute a form of capital accumulation. On the other hand, firms deprived of H-1B hires may turn to the market for corporate control in order to acquire skilled workers at target firms (Ouimet and Zarutskie, 2016). The insignificant estimates from column (5) in both Panel A and Panel B of Table VII reveal that we cannot find evidence in support of either prediction.

4.5 Which Occupations have the Largest Impact?

Shifting our focus back to capital investment, I investigate cross-sectional heterogeneity in the effects of the H-1B policy shock. The degree of complementarity between capital and labor should depend on the specific production process that combines labor and capital. Since my main focus is on capital expenditures, I check whether my benchmark results are more pronounced among industries and occupations that are more closely associated with *physical* production processes. I also check for cross-sectional differences in the degree to which H-1B hires can be easily replaced by substitute sources of skilled labor, as we should expect the effects of the H-1B policy shock to be weaker for industries and occupations in which firms can more easily transition to alternative sources of skilled labor.

First, I compare differences in occupational roles using the categories listed on H-1B applications. Table III shows these categories include *Admin*, *Computer*, *Engineer*, *Management*, and *Science*. Workers in *Science* and *Engineer* in fields such as civil engineering, mechanical engineering, physics, chemistry, and biology (see Appendix B) typically work in

[31] Eisfeldt and Papanikolaou (2013) uses SG&A expenditures to proxy for the accumulation of organization capital

close physical proximity to machinery, laboratories, and other physical hardware to produce physical products. Accordingly, I place these workers under broader category of traditional *industrial* workers, who should be expected to exhibit stronger complementarity to physical capital.

In contrast, workers in *Computer* and *Admin* occupations in fields such as computer programming, technical support, accounting, and public relations work more closely with ideas and abstract models rather than heavy machinery and equipment, software rather than hardware, and digital rather than analogue technologies. Rather than generating physically capital-intensive projects, the value of such workers lies in the development of organizational capital, defined by Eisfeldt and Papanikolaou (2013) as intangible capital embodied in the firm's specialized labor inputs and distinct from physical capital. Therefore, I group these workers under the broader category of *knowledge* workers, and one should expect workers in such occupations to exhibit weaker complementarity to physical capital.

Lastly, managers provide oversight over all aspects of the firms' operations and strategic direction and have received significant attention from academic research (see Bloom and Van Reenen (2007) for instance). Managers typically possess power over decisions on capital budgeting, but their decisions also depend on input from employees involved in day-to-day operations (Harris and Raviv, 2005). I place workers in *Management* occupations in their own category, but it is not clear ex-ante where they fall on the spectrum, relative to industrial and knowledge workers, in terms of complementarity to physical capital.

To test for differences in the degree of complementarity to capital across the different occupational categories, I run the following regression:

$$CapEx_{it} = \alpha_i + \lambda_t + \sum_j \delta_j \cdot \mathit{H1B\ use}_{ij} \cdot Post_t + X_{it-1}\beta + \epsilon_{it} \tag{4}$$

where $\mathit{H1B\ use}_{ij}$ is defined as the total number of initial petitions submitted by firm i for workers in occupational category j scaled by the average number of employees during 2001, and j takes on the values of *Computer*, *Engineer*, *Science*, *Admin*, and *Management*, as described in Table III, as well as the broader categories of *Industrial* and *Knowledge*, as defined above. The coefficients δ_j reveal whether the H-1B cap drop resulted in investment declines for firms that relied more intensely on H-1B workers in occupation j relative to firms that relied less intensely on H-1B workers in occupation j.

The results are presented in Table VIII. While the coefficient estimates δ_j are negative across all specifications, they are not statistically significant for workers in *Knowledge*, *Computer* and *Admin* occupations (columns (4), (5), and (6)), which is consistent with knowledge workers not exhibiting strong complementarities to capital expenditures. On the other hand, the estimates are statistically significant with respect to $Industrial$, *Engineer*, and *Science* occupations (columns (1), (2), and (3)), which is consistent with industrial workers exhibiting strong complementarities with capital-intensive projects.[32] Finally, the coefficient estimate on *Management* is large, as seen in column (4).[33] However, the estimate is imprecisely measured with large standard errors, which may be attributed to the relatively few H-1B workers in management roles as seen in Table III.

4.6 Differences across Industries and H-1B Worker Replaceability

I compare my benchmark results across different industries, based on the idea that some industries are more closely associated with physical production processes. According to U.S. census data, manufacturing firms tend to spend a significantly greater proportion of their capital expenditures on equipment (e.g. computers, industrial machines, and communications equipment) relative to structures (e.g. offices, commercial buildings, and transportation facilities) when compared to firms in the service sector.[34] In addition, previous work by Lewis (2011) finds that expenditures on machines and equipment are sensitive to changes in the skill mix of employees. Therefore we should expect our benchmark results to be more pronounced for manufacturing sector firms and less pronounced for service sector firms.[35]

I run the following triple-differences OLS regression, in which the DD interaction term $\textit{H1B use}_i \cdot Post_t$ from my baseline specification is interacted with industry dummy variables:

$$CapEx_{it} = \alpha_i + \lambda_t + \delta \cdot \textit{H1B use}_i \cdot Post_t + \theta \cdot W_i \cdot Post_t + \gamma \cdot \textit{H1B use}_i \cdot W_i \cdot Post_t + X_{it-1}\beta + \epsilon_{it} \quad (5)$$

where W_i represents an dummy variable for the manufacturing industry and for the service industry, respectively.

The results are presented in columns (1) and (2) from Table IX. The negative significant estimate corresponding to $\textit{H1B use} \cdot Manufacturing \cdot Post$ and the positive significant estimate corresponding to $\textit{H1B use} \cdot Services \cdot Post$ are consistent with complementarity being stronger in the manufacturing sector and weaker in the service sector. However, these results

[32] In terms of economic magnitude, a 1-standard deviation change in $\textit{H1B use}_{ij}$ corresponds to a 4.39% and 9.41% decline in investment relative to the sample for $j = Engineer$ and $j = Science$, respectively.

[33] The results for which all occupational categories are omitted to conserve space. When all categories are included, the coefficient estimates on the industrial occupation interaction variables remain significant, the coefficient estimates on the knowledge occupation interaction variables remain insignificant. and the coefficient estimate on $\textit{H1B use}_{i,Management}$ is no longer significant

[34] According to the U.S. Census 1998 Annual Capital Expenditures Survey (the last survey that the survey was available), manufacturing sector firms spent \$4.21 on equipment for every dollar spent on structures, while service sector firms only spent \$1.66 on equipment for every dollar spent on structures.

[35] As seen in Table III, the vast majority of firms in the sample are found within these two major industry groups.

may be driven by the different occupational mix of workers in manufacturing versus service industries: as seen in Table III, workers in *Science* and *Engineer* occupational fields are largely concentrated in the manufacturing sector, while the services sector is dominated by workers in *Computer* occupations. Indeed, in an unreported test, I focus only on *industrial* workers (i.e. running the same triple-differences regression using $H1B\ use_{i,Industrial}$ instead of $H1B\ use_i$), and find the triple interaction term for both *Manufacturing* and *Services* to be no longer statistically significant.

A offsetting factor that potentially explains the lack of convincing evidence for differences between manufacturing and service sector firms is that manufacturing jobs, which have experienced a long recent trend of offshoring, are more easily relocated abroad relative to service sector jobs, which typically involve an worker's physical presence and personal touch. This points to the broader insight that firms can mitigate the impact of the H-1B policy shock by shifting to alternative sources of skilled workers. To empirically test this, I check for cross-sectional differences in my benchmark results with respect to measures relating to the availability of alternative sources of skilled workers. Substitute skilled workers come from three major sources: the domestic labor market, offshoring, and alternative visa programs. I use empirical proxies for all three sources of skilled substitutes and run difference-in-difference-in-difference estimations.

To proxy for the tightness of the domestic labor market, I use *Wage Growth*, the average annual wage growth at the industry-region level obtained from the Bureau of Labor Statistics Quarterly Census of Employment and Wages (QCEW), where industry is defined as the 3-digit NAICS industry and region is defined as commuting zone of firm headquarters.[36] A tight local labor market is commonly marked by rising wages, and therefore we should expect our benchmark results to be more pronounced in firms located in high wage growth industry-regions. This confirmed by the results presented in column (3) of Table IX, as the estimate for the triple interaction term involving *Wage Growth* is negative and significant.

To proxy for offshorability, I construct a firm-level measure based on the geographic proximity of H-1B workers to company headquarters. Specifically, for each H-1B application used to construct *H1B use*, I construct an indicator variable *HQ State* that takes a value of one if the location for the H-1B worker's position listed on the application is in the same state as the firm's headquarters. I then calculate the average *HQ State* for each firm to arrive at the proportion of new H-1B hires working in the same state as company headquarters in the pre-treatment period. We should expect our benchmark results to be more pronounced high *HQ State* firms, under the assumption that it is more difficult to offshore jobs that

[36] A commuting zone are logical geographic units for defining local labor markets. See Tolbert and Sizer (1996), Autor, Dorn, and Hanson (2013).

are geographically concentrated jobs around headquarters. This is supported by the results reported in column (4) of Table IX, as the estimate for the triple interaction term involving *State HQ* is negative and statistically significant.

Lastly, I proxy for the availability of alternative visa programs that allow domestic U.S. firms to circumvent the H-1B cap. The two major alternatives available to U.S. firms are the L-1 visa program, which allows international firms to internally relocate employees from offices located abroad into offices located inside the U.S., and the TN visa program, which is allows U.S. firms to hire workers from Mexico and Canada as part of the North American Free Trade Agreement (NAFTA). Correspondingly, I construct *Foreign Segment*, an indicator variable for whether a given firm is listed in the Compustat Segments File to have a geographic segment in a foreign country, and *Pct NAFTA* which measures the proportion of new H-1B hires that are born in Canada or Mexico.[37] We expect our benchmark results to be smaller in *Foreign Segment* firms and *Pct NAFTA* firms, as these firms have access to alternative visa programs to bring in foreign workers.

Column (5) of Table IX shows that the triple interaction term involving *Pct NAFTA* is indeed significant and positive, which supports the notion that firms with access to Canadian and Mexican workers are able to circumvent the 2003 H-1B cap drop. The interaction term involving *Foreign Segment* is also positive but not statistically significant. The absence of significance may be attributed to the fact that having a foreign segment serves as a noisy measure of L-1 transfer eligibility, as L-1 workers can be transferred across parent/subsidiaries as well as across sister companies owned by a mutual parents. However, if we focus on firms with a segment *located in India*, the largest source of H-1B workers as well as L-1 transfers, we find that such firms experience a significant attenuation of the H-1B policy shock's effect on investment. In column (7) of Table IX, the triple interaction term involving *Indian Segment*, an indicator variable for the presence of a geographic segment located in India, is significant and positive.[38]

In interpreting the results presented in this section, one should note that it is often difficult to disentangle the degree to which an H-1B worker's role is tied to physical capital from how easily an H-1B worker can be replaced. For example, there is a great deal of anecdotal evidence to suggest that H-1B workers in information technology (IT) fields can be easily replaced by domestic workers,[39] which offers an alternative explanation for the

[37] The USCIS H-1B petitions data reports only country of birth but not nationality/citizenship.

[38] One should caution against interpreting the large economic magnitude of this estimate, as there are only a few firms in the sample with a geographic segment located in India.

[39] Several IT consulting firms have gained notoriety as "body shops" for funneling cheap Indian IT workers into the U.S. through the H-1B program, and in certain cases, domestic IT workers were tasked to train their own replacement H-1B workers before being laid off. In addition, the heaviest users of L-1 visas largely consists of IT consulting body shops: computer and IT related outsourcing service firms specializing in labor

insignificant estimates for *Computer* occupations reported in Table VIII. This is consistent with the notion that industrial workers need to be in close proximity to physical capital, while knowledge workers are more easily relocated as their productive activities can be more easily augmented by modern telecommunication technologies.

4.7 Political Lobbying and Endogeneity of Investment

Firms in the high-tech industries, and in particular large firms in the IT sector, were the most prominent corporate lobbyists for maintaining the higher H-1B cap. If my results are driven by correlations between investment trends and lobbying efforts, then effects of the H-1B cap drop on investment should be more pronounced for these firms in these politically-active industries. In order to address this concern, I demonstrate that the previously documented effects on investment are not concentrated in industries most involved in H-1B lobbying, which mitigates concerns regarding the endogeneity of the H-1B cap drop driving my results. To this end, I split the sample by industry characteristics and conduct a triple-differences regression similar to the one presented in the preceding section:

$$CapEx_{it} = \alpha_i + \lambda_t + \delta \cdot H1B\ use_i \cdot Post_t + \theta \cdot I_i \cdot Post_t + \kappa \cdot H1B\ use_i \cdot I_i \cdot Post_t + X_{it-1}\beta + \epsilon_{it} \quad (6)$$

where I_i takes on the form of the following dummy variables related industry characteristics: IT_i, which indicates whether firm i is in the information technology sector,[40] $New\ Econ_i$, which indicates whether firm i is in the "new economy" sector,[41] $High\ TQ_i$, which indicates whether firm i is in an industry with above-median average $Tobin's\ Q$, $High\ RD_i$, which indicates whether firm i is in an industry with above-median average R&D spending, and $High\ Size_i$, which indicates whether firm i is in an industry with above-median average total assets. All industry dummies are defined using data from the pre-treatment period, and more detailed definitions for these variables can be found in Appendix A.

Table X reveals the estimates for κ are not statistically significant across all specifications. Therefore, the documented complementarity effects on investment are consistently found across IT and non-IT sector firms, as well as across new economy and old economy firms. Splitting the sample by other industry-level characteristics associated with the high-tech sector—i.e. high-growth versus low-growth industries, high R&D versus low R&D

from India constituted nine of the ten firms that applied for the most L-1 workers during the 1999 to 2004 time period (see `https://www.oig.dhs.gov/assets/Mgmt/OIG_06-22_Jan06.pdf`)

[40] The IT sector is defined according to BEA classification, which is found online at `http://www.bea.gov/industry/xls/GDPbyInd_VA_NAICS_1998-2011.xls`.

[41] Defined to be any industry that *"involves acquisition, processing and transformation, and distribution of information"* as in Nordhaus (2002). This includes SIC code 35 (industrial machinery and equipment), 36 (electronic and other electric equipment), 48 (telephone and telegraph), and 873 (software).

industries—also reveals no significance differences. Finally, splitting the sample according to asset size, which is a strong predictor of immigration-related political lobbying according to Kerr, Lincoln, and Mishra (2014), also reveals no significant differences. These results suggest that my main results are not driven by the correlation between investment demand and lobbying activity by the most politically-active firms. The findings also suggest that skilled workers play an important role in implementing a wide range of investment projects, and not only those based on R&D intensive technologies in high-tech sectors.

4.8 Exogenous Predictors of H-1B Usage

I exploit variation in *H1B use* based on geographic characteristics in order to address concerns that firms with different usage rates of H-1B workers in 2001 faced different investment opportunity trends during the 2002-2004 time frame. Specifically, I conduct a cross-sectional regression of *H1B use* on lagged county-level characteristics of firm headquarter locations, and use the fitted values from this regression in place of *H1B use* in the baseline specification according to Eq. 1. Importantly, these geographic characteristics are taken from several years prior to the 2003 cap drop and unlikely to be related to sharp changes in firm investment opportunities around the treatment event.

The first predictor is $PctASTEM_i$, the percentage of post-secondary students enrolled in the county of firm i's headquarters of Asian ethnicity enrolled in a science, technology, engineering, and math (STEM) field, as of 1998. This variable is constructed using data from the Integrated Post-Secondary Education Data System (IPEDS), which maintains an annual survey that requires mandatory completion by all U.S. post-secondary institutions receiving or applying for federal financial assistance.[42] As discussed in Section 2, a majority of H-1B workers come from Asia—from India and China in particular. In addition, a significant portion of these workers studied at American post-secondary institutions as international students prior to being hired. Therefore, we expect the enrollment composition of Asian students in STEM fields as of 1998 to predict the composition of graduating students around 2001 at the local county level. Given that firms tend to hire workers in geographically proximate locations in order to reduce search costs (Wheeler, 2001), $PctASTEM_i$ should predict $H1B\ use_i$.

The second predictor is $PctIndPop_i$, the percentage of residents living in the county of firm i's headquarters who speak a language from the Indian subcontinent (i.e. an "Indic language") at home, according to the 1990 U.S. Census.[43] The predictive power of this

[42] I use the "Asian/Pacific Islander" categorization for Asian students, as there is no separate classification for Asians only. Collection of racial/ethnic data became mandatory following the Civil Rights Act of 1964.

[43] Indic languages consists of languages classified under Census 3-digit language codes 662–678. Examples

variable comes from the ethnic enclave effect, in that dense local networks of immigrant populations tend to be persistent across time due to preferences for new immigrants to congregate in locales with existing concentrations of residents with similar ethnic and cultural backgrounds.[44] Through the ethnic enclave phenomenon, we expect the geographic distribution of Indian immigrants circa 1990 to predict the geographic distribution of new Indian H-1B worker arrivals in 2001. Since Indian workers make up such a large proportion of H-1B workers, as discussed in Section 2, $PctIndPop_i$ should predict $H1B\ use_i$.

The results from the first stage cross-sectional regression of *H1B use* on the two geographic predictors are presented in Panel A of Table XI. The results indicate that *PctASTEM* and *PctIndPop* are both significant predictors of *H1B use*, either individually or included together. However, the column (2) shows that $PctIndPop_i$ by itself yields only a F-statistic of just above 12, which makes it a borderline weak instrument. Therefore, we take only the predicted values corresponding to the specifications from column (1) and (3), in which the first stage F-statistic is greater than 19, in estimating our second stage regression. Note that all standard errors are clustered at the county level, the unit of observation for the predictor variables.

The results from substituting in the fitted values of *H1B use* in estimating Eq 1 are presented in Panel B of Table XI. We see that the coefficient on the interaction term between $\widehat{H1B\ use}$ and *Post* are significant whether we use the fitted value based on a first-stage regression using only *PctASTEM* (columns (1) and (2)), or using both *PctASTEM* and *PctIndPop* (columns (3) and (4)), and are larger in magnitude than those found in Table IV. The caveat is that this test does not constitute a formal two-stage least squares estimation since the "first stage" in this case is only cross-sectional while the "second stage" is a panel regression. Nevertheless, these results should serve to mitigate concerns related to *H1B use* being correlated with investment opportunity trends around 2003.

In columns (2) and (4) of Panel B in Table XI, the sample is restricted to exclude counties popularly defined to be part of "Silicon Valley" (i.e. Alameda, San Francisco, San Mateo, and Santa Clara). This region contains a large concentration of Asian post-secondary students as well as being the headquarter locations for many information technology sector firms. Therefore excluding these locales helps to address concerns that the results from Table XI are driven by investment opportunity shocks to Silicon Valley high-tech firms around the time of the 2003 cap drop. We see that excluding firms located in the Silicon Valley does not attenuate our results, and in fact results in larger point estimates.

include Hindi, Bengali, Gujarathi, Punjabi, Urdu, Nepali, and Sinhalese.

[44] See Cortes (2008) for an example of immigrant enclaves being used as an instrumental variable.

4.9 Robustness Tests

All analysis presented so far is based on the sample restricted to firms that have submitted at least one petition during 2001 to hire H-1B workers. This gives rise to the potential for selection bias, due to the fact that selection into H-1B and non-H-1B firms is non-random—i.e. the ϵ_{it} error term in Eq. 1 may be correlated with $H1B\ use_i \cdot Post_t$, conditional on firm i being an H-1B firm. Therefore, I estimate Eq. 1 based on the expanded sample that includes both sets of H-1B and non-H-1B firms, where $H1B\ use_i$ is set at zero for all non-H1B firms.

The results are presented in column (1) from Table XII, and show the estimate for δ to be statistically significant at the 1% level and similar in economic magnitude to the benchmark results from Table 1. This suggests that my earlier results are not driven by selection effects. I also run the following regression:

$$CapEx_{it} = \alpha_i + \lambda_t + \eta \cdot H1B_i \cdot Post_t + \delta \cdot H1B\ use_i \cdot Post_t + X_{it-1}\beta + \epsilon_{it} \tag{7}$$

where $H1B_i$ represents a dummy variable indicating whether firm i is an H-1B firm. The coefficient η captures the differential effect of the 2003 H-1B cap drop on non-H-1B workers versus H-1B firms with marginal exposure to H-1B policy (i.e. the extensive margin),[45] while δ still captures the differences in investment rate changes between firms of varying ex-ante H-1B dependence (i.e. the intensive margin). If the status of being an H-1B firm has no bearing on investment policy changes around the 2003 event, then there is no reason to expect a significant difference between non-H-1B firms and firms that were marginal employers H-1B workers, in which case η should be zero.

The results are presented in column (3) of Table XII, and show the estimate for η to be both economically and statistically insignificant. Therefore, there is nothing about being in the category of H-1B firms that affects investment policy changes around the 2003 event, further mitigating concerns of selection bias. Note that all results in Table XII are based on the fully saturated specification including all fixed effects and control variables.

It is also worth noting the question of whether to include non-H-1B firms in the sample depends on the specific economic question being asked. Since the impact of H-1B policies falls on H-1B firms rather than non-H-1B firms, it makes certain sense to focus on the former population. This frames the question as whether restrictions on the H-1B visa cap affects the investment policies of existing employers of H-1B workers—i.e. the firms most likely to be affected. The concern then becomes one of external validity, as we are limited in

[45] This is because *H1B use* is equivalent to $H1B \cdot H1B\ use$ (since *H1B use* is set at zero for all non-H1B firms), so that Eq. 7 in effect forms a triple-differences specification, where the double interaction term $H1B \cdot Post$ captures the differences between non-H-1B and marginal H-1B firms, and the "triple interaction" term $H1B \cdot H1B\ use \cdot Post$ captures any additional differences between high H-1B users and low H-1B users.

our ability to answer broader questions about how access to skilled labor affects investment more generally. The inclusion of non-H-1B firms in the sample does not completely address this issue, since the entire set of non-H-1B firms should be unaffected by the policy and thus reveals no information about how such firms may be affected by skilled labor supply restrictions. Nevertheless, this is a common limitation facing any study that exploits an event that affects a limited cross-section of the population.

Lastly, I check the robustness of my main results by using alternative definitions of *H1B use* within the regression framework from Eq. 1. This serves to mitigate concerns that my earlier results are driven by the skewed distribution of the *H1B use* variable. The results are presented Table XIII, and show that the main results hold under a variety of alternative definitions. Column (1) present the baseline results using ln(*H1B use*), the natural log of *H1B use*, and column (2) presents results using *High H1B use*, a dummy variable indicating whether *H1B use* is above the sample median. In both cases, the coefficient estimates remain statistically significant and similar in economic magnitude to the baseline results.

I also employ definitions of H-1B policy exposure based on the wages of H-1B workers, as these measures potentially capture additional information regarding firms' exposure to H-1B policy beyond those found in *H1B use*. Column (3) presents results based on *H1B wage*, which is defined as the sum of the wages listed across USCIS petitions submitted by a given firm in 2001, scaled by the total imputed wage bill for that firm during the same year.[46] Columns (4) and (5) present results based on ln(*H1B wage*), the natural log of *H1B wage*, and *High H1B wage*, a dummy variable indicating whether *H1B wage* is above the sample median, respectively. In all cases, the estimates remain statistically and similar in economic magnitude to the baseline results.

5 Conclusion

In this paper, I find evidence that firms' access to skilled workers is an important determinant of investment policy. The sharp 2003 drop in the regulatory cap for H-1B visas provided a quasi-experimental setting in which some firms were affected more than others due to differing rates of ex-ante reliance on the visa program. I find firms relying more heavily on H-1B workers experienced a sharper decline in their investment rates relative to firms relying less heavily on H-1B workers, which is consistent with the capital-skill complementarity hypothesis. The effects on investment persist for several years, and the evidence suggests that they are unlikely to be driven by pre-existing trends in investment opportunities, endogenous

[46] The imputed wage is calculated by multiplying the total number of firm-level employees by the national average wage for the industry for the firm according to data from the Bureau of Labor Statistics.

public policy related to H-1B lobbying, or selection effects specific to H-1B-employing firms.

I further find evidence suggesting the complementarity effects to be linked to the specific nature of the firm's worker characteristics, with the effect more pronounced for workers in "industrial" occupations and less pronounced for workers in "knowledge" occupations. I also find the effects to be more pronounced for firms that could not easily find substitute sources of skilled workers from the domestic labor market, offshoring, or alternative visa programs. These results imply that the effect of the H-1B policy shock on investment depends on both the degree of complementarity between capital and skilled labor, as well as the degree of substitutability between H-1B workers and other sources skilled workers.

In addition to helping advance our understanding of the relationship between labor and capital, my research also provides practical policy implications. Specifically, my empirical findings suggest that, rather than focusing only on the immediate impacts on domestic employment and wage growth when evaluating immigration policy, policymakers should also consider the long-term impact on capital investment and subsequent implications for overall economic growth. My results further suggest that policymakers should bear in mind the mix of occupational roles likely to be affected by prospective legislation when evaluating policy, as restrictions on some occupations may have a large impact on businesses while restrictions on other occupations may simply result in the jobs relocating abroad.

The findings of this paper lay fertile groundwork for future research on related topics. One particular avenue would be to investigate whether the rents generated by labor market restrictions such as the H-1B visa cap are captured by firms or by domestic workers—i.e. whether more restrictive policies result higher wages for domestic workers or whether the increased scarcity of foreign workers may increase the values of existing workers and subsequently captured by the firm. Answering such questions will help clarify the welfare implications of labor market restrictions, as well as improve our understanding of the political economy surrounding immigration policy.

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Figure 1: Trends in H-1B Petitions vs. Regulatory Cap

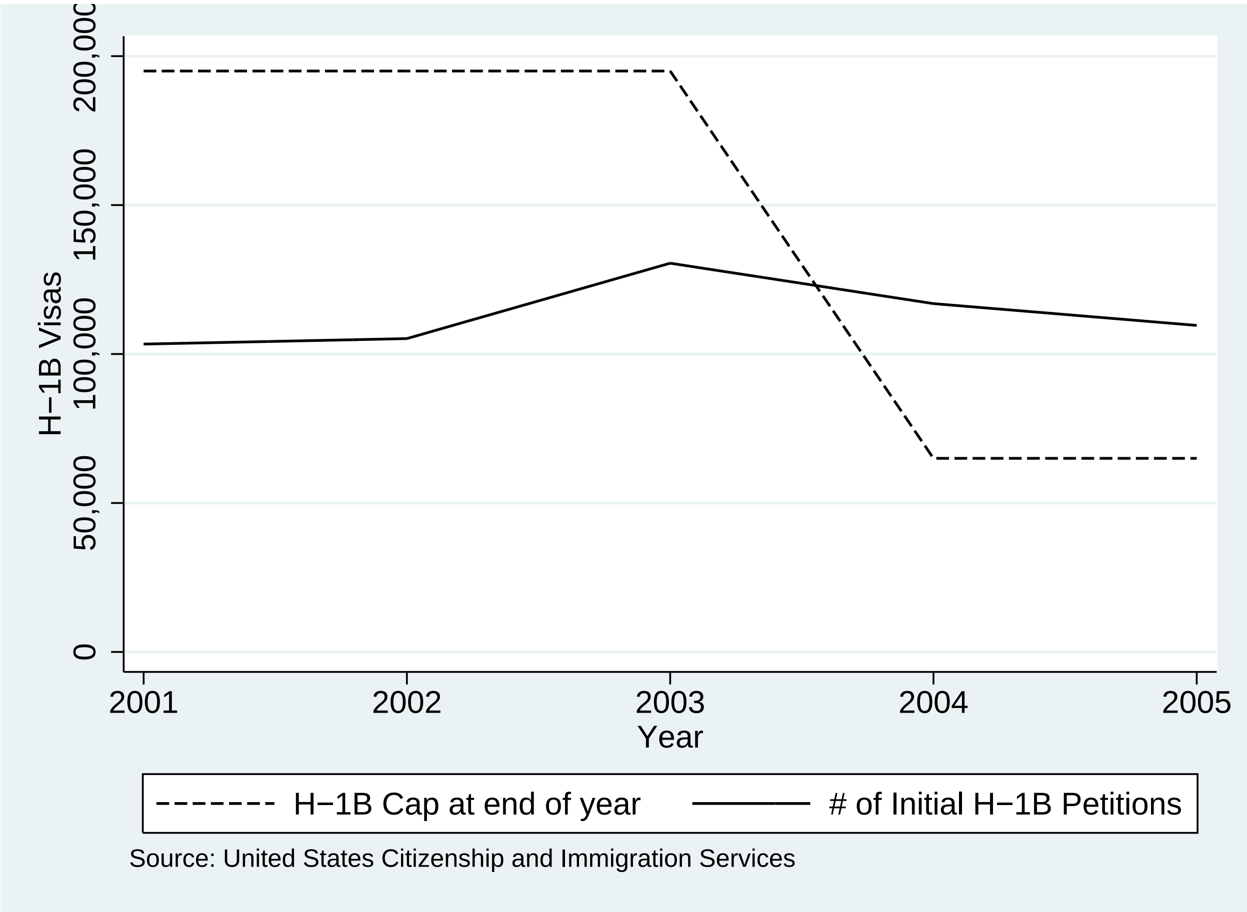
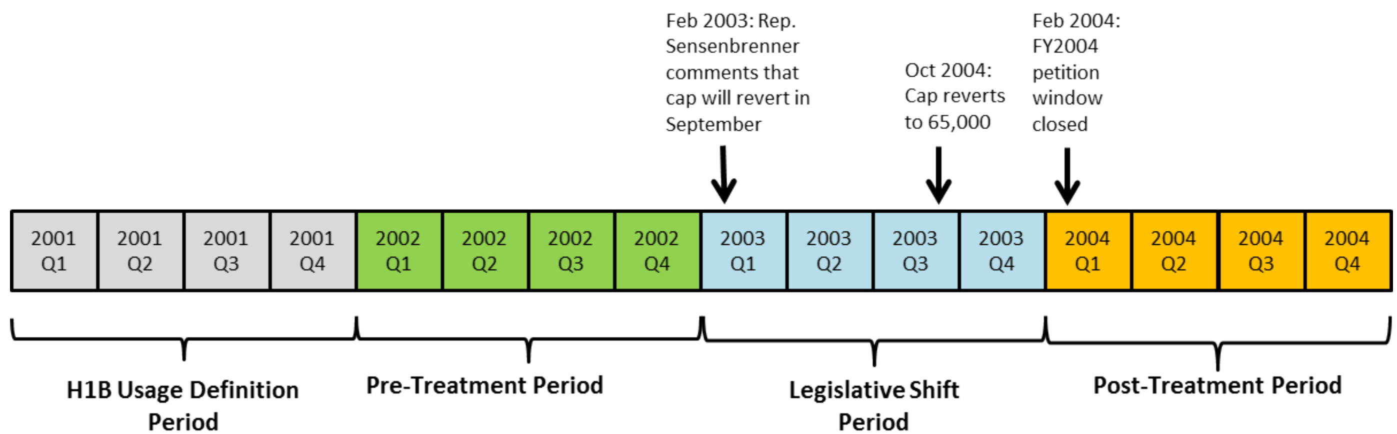
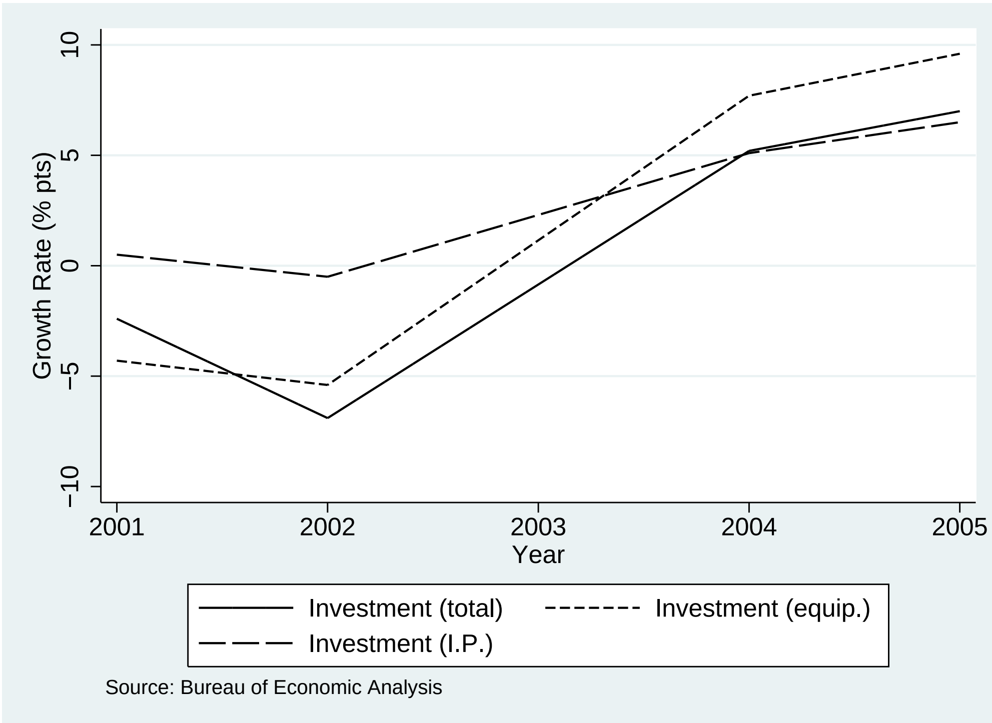


Figure 2: Timeline of H-1B Cap Drop

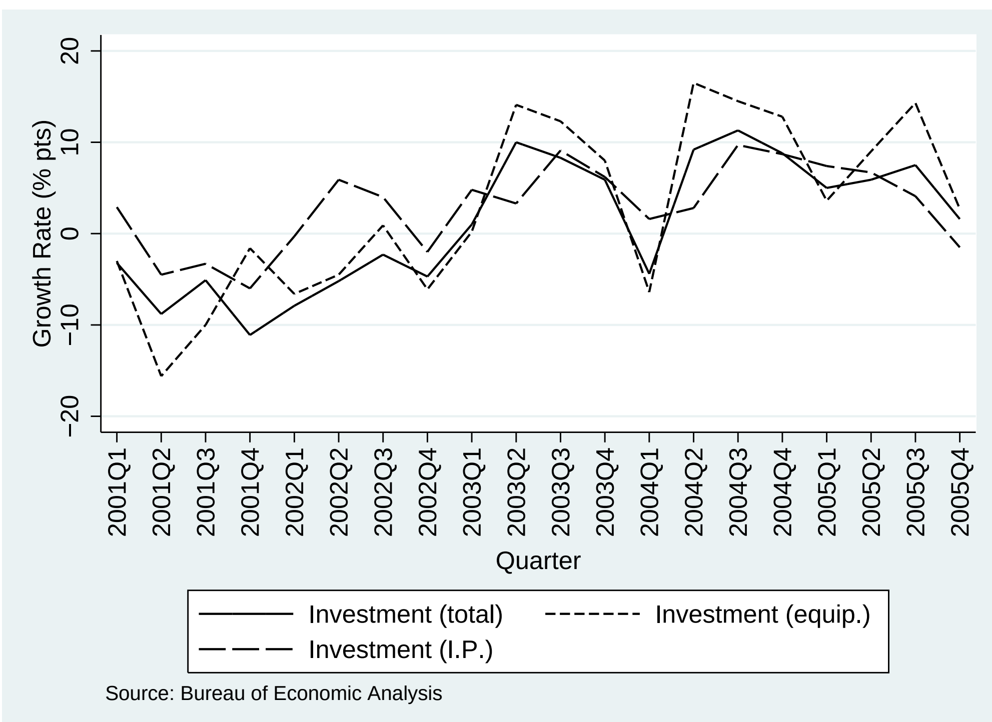


Note: Figure shows the timeline of the H-1B cap drop, which officially took effect on October 1, 2003. In February 2004, the United States Citizenship and Immigration Services (USCIS) announced that it was no longer accepting petitions for the upcoming fiscal year.

Figure 3: Aggregate U.S. Fixed Non-Residential Private Investment



(a) Annual Aggregate Private Investment



(b) Quarterly Aggregate Private Investment

Table I: Descriptive Statistics

This table presents summary statistics for the main variables in my regression models. In Panel A, the sample consists of 1,395 industrial firms (excluding utilities, financials, and public-sector firms) over the 2002Q1-2002Q4 ("pre-treatment") and 2004Q1-2004Q4 ("post-treatment") periods, for firms submitting at least one H-1B application during 2001 (i.e. "H-1B Firms"). In Panel B, the sample consists of 2,205 industrial firms (excluding utilities, financials, and public-sector firms) over the same time interval as the sample from Panel A, for firms that did not submit any H-1B applications during 2001 (i.e. "Non-H-1B Firms"). *CapEx* is quarterly capital expenditures scaled by lagged quarter-end total book assets (atq), $Tobin's\ Q$ is the quarter-end market value of total assets ($atq + prccq \times cshoq - ceqq - txditcq$) scaled by quarter-end book value of total assets (atq), $ln(Size)$ is the natural log of quarter-end total book assets (atq), *Cash Flow* is quarterly income before depreciation ($ibq + dpq$) scaled by lagged quarter-end total book assets (atq), *Cash Holdings* is quarter-end cash holdings ($cheq$) scaled by lagged quarter-end total assets (atq), and Leverage is quarter-end long-term debt ($dltt$) scaled by lagged quarter-end total book assets (atq). *H1B use* represents the total number of initial H-1B petitions filed during the 2001 calendar year, scaled by average number of employees (emp) during the same interval. Detailed definitions for all variables can also be found in Appendix A. All variables constructed using Compustat variables are winsorized at the 1% level at both tails, $Tobin's\ Q$ is bounded to be no larger than 10, and *H1B use* is winsorized at the 2% level at the upper tail.

Panel A: H-1B firms

	Observations	Mean	Std Dev	P25	Median	P75
CapEx	9,905	0.011	0.013	0.004	0.007	0.014
Tobin's Q	9,905	2.174	1.488	1.237	1.711	2.576
ln(Assets)	9,905	6.664	1.747	5.355	6.489	7.806
Cash Flow	9,905	0.003	0.065	-0.002	0.017	0.032
Cash Holdings	9,905	0.265	0.254	0.051	0.178	0.429
Leverage	9,905	0.165	0.200	0.000	0.105	0.267
H1B use	9,905	0.007	0.010	0.000	0.002	0.008

Panel B: Non-H-1B firms

	Observations	Mean	Std Dev	P25	Median	P75
CapEx	13,571	0.015	0.022	0.004	0.008	0.018
Tobin's Q	13,571	2.114	1.754	1.133	1.511	2.316
ln(Assets)	13,571	5.858	1.893	4.819	5.912	6.996
Cash Flow	13,571	-0.000	0.101	0.005	0.020	0.034
Cash Holdings	13,571	0.176	0.229	0.021	0.077	0.240
Leverage	13,571	0.188	0.209	0.002	0.139	0.301

Table II: Top H-1B Employers in 2001

Panel A lists the top 10 firms in the sample in terms of total H-1B initial petitions submitted to the USCIS in 2001, according to data from the USCIS. Panel B lists the top 10 firms in the sample in terms of *H1B use* (defined in Appendix A), according to data from the USCIS and Compustat.

Panel A: Top 10 H-1B employers in 2001 (ranked by total petitions submitted)

Company Name	SIC Division	2-digit SIC
Infosys Ltd	Services	Business Services
Microsoft Corp	Services	Business Services
Intl Business Machines Corp	Services	Business Services
Cisco Systems Inc	Manufacturing	Industrial Machinery & Equipment
Oracle Corp	Services	Business Services
Intel Corp	Manufacturing	Electronic & Other Electric Equipment
Motorola Solutions Inc	Manufacturing	Electronic & Other Electric Equipment
Lucent Technologies Inc	Services	Business Services
Wipro Ltd	Services	Business Services
Compuware Corp	Services	Business Services

Panel B: Top 10 most H-1B-dependent firms in 2001 (ranked by *H1B use*)

Company Name	SIC Division	2-digit SIC
Telecommunication Sys Inc	Services	Business Services
Broadwing Corp	Manufacturing	Electronic & Other Electric Equipment
Pharmacyclics Inc	Manufacturing	Chemical & Allied Products
Array Biopharma Inc	Services	Health Services
Actuate Corp	Services	Business Services
Catapult Communications Corp	Manufacturing	Instruments & Related Products
Alliance Semiconductor Corp	Manufacturing	Electronic & Other Electric Equipment
Enzon Pharmaceuticals Inc	Manufacturing	Chemical & Allied Products
Maxygen Inc	Services	Engineering & Management Services
Wink Communications Inc	Services	Business Services

Table III: Number of Applications by Occupation and Industry Group

This table presents the number of H-1B worker applications submitted during the 2001 calendar year by firms in the sample, broken down across major industry and occupational groups. Industries are defined at the SIC Division level while occupations are defined at the 3-digit Dictionary of Occupational Code level, with “Occupations in Life Sciences” and “Occupations in Mathematics and Physical Sciences” combined under the “Science” category. The occupational categories are taken directly from the USCIS Dictionary of Occupational Codes, and detailed definitions for occupational categories can be found in the Appendix B.

	Computers	Engineering	Admin	Management	Scientist	Other	Total
Agriculture	3	0	1	1	0	0	5
Construction	6	21	6	7	0	0	40
Manufacturing	6,345	5,989	801	649	1,356	426	15,566
Mining	15	24	19	7	20	2	87
Retail	323	11	49	68	9	242	702
Services	15,090	1,099	418	442	324	292	17,665
Transportation	314	260	98	81	2	32	787
Wholesale	95	10	22	13	9	9	158
Total	22,191	7,414	1,414	1,268	1,720	1,003	35,010

Table IV: Effect of the H-1B Cap Drop on Investment

The table below reports the estimation results from the OLS regression $CapEx_{it} = \alpha_i + \lambda_t + \delta \cdot H1B\ use_i \cdot Post_t + X_{it-1}\beta + \epsilon_{it}$ in which δ captures how the 2003 H-1B cap drop affects the investment policy of firms with different levels of H-1B usage intensity. The sample is limited to four quarters prior to the H-1B cap drop (2002Q1-2002Q4) and four quarters following the H-1B cap drop (2004Q1-2004Q4), for firms submitting at least one H-1B application during 2001. $CapEx_{it}$ denotes firm i's investment rate during quarter t, $H1B\ use_i$ denotes firm i's H-1B usage intensity during 2001, and $Post_t$ represents a dummy variable that takes on a value of 1 if quarter t is in the post-treatment period 2004Q1-2004Q4. X_{it} denotes the set of quarterly firm-level control variables, which are all lagged by one quarter relative to the dependent variable $CapEx_{it}$. Detailed definitions for all variables can be found in Table I as well as Appendix A. F denotes firm fixed effects, T denotes year-quarter fixed effects, and $I \times T$ denotes industry-year-quarter fixed effects. Standard errors are corrected for heteroskedasticity and clustered at the firm level. Standard errors are in parentheses, with *, **, and *** denoting significance at the 10%, 5%, and 1% level, respectively.

	(1) CapEx	(2) CapEx	(3) CapEx	(4) CapEx	(5) CapEx	(6) CapEx
H1B use × Post	-0.065**	-0.088***	-0.087***	-0.108***	-0.086***	-0.109***
	[0.029]	[0.028]	[0.029]	[0.029]	[0.029]	[0.029]
Tobin's Q			0.002***	0.002***	0.002***	0.002***
			[0.000]	[0.000]	[0.000]	[0.000]
Cash Flow			0.006*	0.006*	0.006*	0.006*
			[0.003]	[0.003]	[0.003]	[0.003]
ln(Assets)			-0.001	-0.001	-0.001	-0.001
			[0.001]	[0.001]	[0.001]	[0.001]
Leverage					-0.003	-0.003*
					[0.002]	[0.002]
Cash Holdings					-0.002	-0.002
					[0.002]	[0.002]
Fixed Effects	F, T	F, I × T	F, T	F, I × T	F, T	F, I × T
Observations	9,905	9,905	9,905	9,905	9,905	9,905
Adjusted R-squared	0.007	0.013	0.025	0.031	0.026	0.032

Table V: Quarterly Investment Dynamics

This table reports the estimation results from OLS regression $CapEx_{it} = \alpha_i + \gamma_t + \sum \delta_t \cdot \mathit{H1B\ use}_i \cdot \tau_t + \delta \cdot \mathit{H1B\ use}_i \cdot Post_t + X_{it-1}\beta + \epsilon_{it}$. The sample is limited to the 2002Q1-2004Q4 interval, which includes the pre-treatment period (2002Q1-2002Q4), the legislative shift period (2003Q1-2003Q4), and the post-treatment period (2004Q1-2004Q4), for firms submitting at least one H-1B application during 2001. $CapEx_{it}$ denotes firm i's investment rate during quarter t, $\mathit{H1B\ use}_i$ denotes firm i's H-1B usage intensity during 2001, and τ_t denotes a dummy variable for quarter τ, where τ takes on values from 2002Q1 to 2004Q4 inclusive. X_{it-1} denotes the set of quarterly firm-level control variables, which are lagged by one quarter relative to the dependent variable $CapEx_{it}$. Detailed definitions for all variables can be found in Table I as well as Appendix A. Only δ and δ_t are reported to conserve space. F denotes firm fixed effects, T denotes year-quarter fixed effects, and $I \times T$ denotes industry-year-quarter fixed effects. Standard errors are corrected for heteroskedasticity and clustered at the firm level. Standard errors are in parentheses, with *, **, and *** denoting significance at the 10%, 5%, and 1% level, respectively.

	(1) CapEx	(2) CapEx
H1B use × 2002Q2 (pre-treatment)	-0.021	-0.022
	[0.029]	[0.028]
H1B use × 2002Q3 (pre-treatment)	0.020	0.008
	[0.052]	[0.052]
H1B use × 2002Q4 (pre-treatment)	-0.041	-0.051
	[0.044]	[0.044]
H1B use × 2003Q1 (legislative shift)	-0.005	-0.034
	[0.037]	[0.038]
H1B use × 2003Q2 (legislative shift)	-0.029	-0.062
	[0.041]	[0.043]
H1B use × 2003Q3 (legislative shift)	-0.066	-0.092**
	[0.041]	[0.041]
H1B use × 2003Q4 (legislative shift)	-0.102**	-0.120**
	[0.047]	[0.047]
H1B use × Post (post-treatment)	-0.092**	-0.117***
	[0.037]	[0.037]
Control Variables	Yes	Yes
Fixed Effects	F, T	F, I × T
Observations	14,789	14,789
Adjusted R-squared	0.024	0.027

Table VI: Long Run Effect of H-1B Cap Drop on Investment

This table reports the estimation results from OLS regression $CapEx_{it} = \alpha_i + \gamma_t + \sum_{k=-1}^{4} \delta_k \cdot \mathit{H1B\ use}_i \cdot Year\ k_t + X_{it}\beta + \epsilon_{it}$. The sample is limited to the 2001 to 2007 time interval, with $k = 0$ corresponding to the 2003 calendar year, for firms submitting at least one H-1B application during 2001. $CapEx_{it}$ denotes firm i's quarterly investment rate averaged over calendar year t, $\mathit{H1B\ use}_i$ denotes firm i's H-1B usage intensity during 2001, and $\mathit{Year}\ k_t$ denotes a year dummy variable for $k = 2003 + t$. X_{it} denotes the set of firm-level control variables, which are lagged by one quarter relative to the dependent variable $CapEx_{it}$ and then averaged over calendar year t. More detailed definitions for all variables can be found in Table I as well as Appendix A. Only coefficients δ_k are reported to conserve space. F denotes firm fixed effects, $Year$ denotes year fixed effects, and $I \times Year$ denotes industry-year fixed effects. Standard errors are corrected for heteroskedasticity and clustered at the firm level. Standard errors are in parentheses, with *, **, and *** denoting significance at the 10%, 5%, and 1% level, respectively.

	(1) CapEx	(2) CapEx
H1B use × Year -1	0.017	0.017
	[0.029]	[0.033]
H1B use × Year 0	-0.018	-0.040
	[0.033]	[0.035]
H1B use × Year 1	-0.070**	-0.095***
	[0.031]	[0.033]
H1B use × Year 2	-0.063**	-0.083**
	[0.031]	[0.033]
H1B use × Year 3	-0.107***	-0.120***
	[0.036]	[0.037]
H1B use × Year 4	-0.104***	-0.111***
	[0.039]	[0.040]
Control Variables	Yes	Yes
Fixed Effects	F, T	F, I × T
Observations	8,577	8,398
Adjusted R-squared	0.097	0.113

Table VII: Effect of the H-1B Cap Drop on Other Outcomes

The tables below report the estimation results from the OLS regression $Y_{it} = \alpha_i + \gamma_t + \delta \cdot \mathit{H1B\ use}_i \cdot \mathit{Post}_t + X_{it}\beta + \epsilon_{it}$ in which Y_{it} represents *H1B usage*, the time-varying quarterly H-1B usage intensity, in column (1), *H1B AvgWage*, the average wage across new H-1B hires, in column (2), *R&D*, R&D expeditures scaled by lagged assets, in column (3), *SG&A*, sales and general administration expenditures scaled by lagged assets, in column (4), and *Acquisition*, acquisitions expenditures scaled by lagged assets, in column (5). Only δ is reported in order to conserve space. In Panel A, the sample is limited to four quarters prior to the H-1B cap drop (2002Q1-2002Q4) and four quarters following the H-1B cap drop (2004Q1-2004Q4), for firms submitting at least one H-1B application during 2001. In Panel B, the sample is limited to four quarters prior to the H-1B cap drop (2002Q1-2002Q4) and 16 quarters following the H-1B cap drop (2004Q1-2007Q4), for firms submitting at least one H-1B application during 2001. $\mathit{H1B\ use}_i$ denotes firm i's H-1B usage intensity during 2001, and Post_t represents a dummy variable that takes on a value of 1 if quarter t is in the post-treatment period 2004Q1-2004Q4. X_{it} denotes the set of quarterly firm-level control variables, which are all lagged by one quarter relative to the dependent variable. Detailed definitions for all variables can be found in Table I as well as Appendix A. F denotes firm fixed effects, T denotes year-quarter fixed effects, and $I \times T$ denotes industry-year-quarter fixed effects. Standard errors are corrected for heteroskedasticity and clustered at the firm level. Standard errors are in parentheses, with *, **, and *** denoting significance at the 10%, 5%, and 1% level, respectively.

Panel A: Baseline Sample

	(1) H1B usage	(2) H1B AvgWage	(3) R&D	(4) SG&A	(5) Acquisitions
H1B use × Post	-0.093***	-0.213	-0.121	-0.058	-0.022
	[0.018]	[0.782]	[0.089]	[0.117]	[0.060]
Control Variables	Yes	Yes	Yes	Yes	Yes
Fixed Effects	F, I × T	F, I × T	F, I × T	F, I × T	F, I × T
Observations	9,578	4,129	6,439	8,858	9,477
Adjusted R-squared	0.050	0.013	0.167	0.361	0.010

Panel B: Extended Sample

	(1) H1B usage	(2) H1B AvgWage	(3) R&D	(4) SG&A	(5) Acquisitions
H1B use × Post	-0.065***	0.411	-0.161**	-0.181**	0.050
	[0.021]	[0.615]	[0.081]	[0.082]	[0.052]
Control Variables	Yes	Yes	Yes	Yes	Yes
Fixed Effects	F, I × T	F, I × T	F, I × T	F, I × T	F, I × T
Observations	21,600	7,985	14,533	20,252	21,363
Adjusted R-squared	0.477	0.044	0.123	0.303	0.011

Table VIII: Effect of the H-1B Cap Drop on Investment by Occupational Category

This table reports the estimation results from the OLS regression $CapEx_{it} = \alpha_i + \gamma_t + \sum \delta_j \cdot H1B\ use_{ij} \cdot Post_t + X_{it-1}\beta + \epsilon_{it}$. The sample is limited to four quarters prior to the H-1B cap drop (2002Q1-2002Q4) and four quarters following the H-1B cap drop (2004Q1-2004Q4), for firms submitting at least one H-1B application during 2001. Only coefficients δ_j are reported to conserve space. $CapEx_{it}$ denotes firm i's investment rate during quarter t, $H1B\ use_{ij}$ denotes firm i's H-1B usage intensity in hiring workers in occupation j (i.e. *Industrial*, *Engineer*, *Science*, *Knowledge*, *Computer*, *Admin*, or *Management*) during 2001, and $Post_t$ represents a dummy variable that takes on a value of 1 if quarter t is in the post-treatment period 2004Q1-2004Q4. X_{it-1} denotes the set of quarterly firm-level control variables, which are lagged by one quarter relative to the dependent variable $CapEx_{it}$: all specifications include *Tobin's Q*, *Cash Flow*, *ln(Size)*, *Cash Holdings*, and *Leverage* as controls. Detailed definitions for all variables can be found in Table I as well as Appendix A, and more detailed definitions for occupational categories can be found in Appendix B. F denotes firm fixed effects and $I \times T$ denotes industry-year-quarter fixed effects. Standard errors are corrected for heteroskedasticity and clustered at the firm level. Standard errors are in parentheses, with *, **, and *** denoting significance at the 10%, 5%, and 1% level, respectively.

	(1) CapEx	(2) CapEx	(3) CapEx	(4) CapEx	(5) CapEx	(6) CapEx	(7) CapEx
H1B use (Industrial) × Post	-0.495***						
	[0.117]						
H1B use (Engineer) × Post		-0.289**					
		[0.123]					
H1B use (Science) × Post			-0.598***				
			[0.213]				
H1B use (Knowledge) × Post				-0.062			
				[0.048]			
H1B use (Computer) × Post					-0.057		
					[0.050]		
H1B use (Admin) × Post						-0.759	
						[0.487]	
H1B use (Management) × Post							-1.390*
							[0.724]
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects	F, I × T	F, I × T	F, I × T	F, I × T	F, I × T	F, I × T	F, I × T
Observations	9,905	9,905	9,905	9,905	9,905	9,905	9,905
Adjusted R-squared	0.032	0.029	0.031	0.029	0.029	0.029	0.030

Table IX: Heterogeneity across Industries and H-1B Worker Replaceability Measures in the Effect of the H-1B Cap Drop on Investment

This table reports the estimation results from the OLS regression $CapEx_{it} = \alpha_i + \gamma_t + \delta \cdot H1B\ use_i \cdot Post_t + \theta \cdot W_i \cdot Post_t + \lambda \cdot H1B\ use_i \cdot W_i \cdot Post_i + X_{it}\beta + \epsilon_{it}$. Only coefficients δ and λ are reported in order to conserve space. The sample is limited to four quarters prior to the H-1B cap drop (2002Q1-2002Q4) and four quarters following the H-1B cap drop (2004Q1-2004Q4), for firms submitting at least one H-1B application during 2001. W_i represents $Manufacturing_i$, an indicator variable for whether firm i is in the manufacturing sector (SIC 2000-3999), in column (1), $Services_i$, an indicator variable for whether firm i is in the services sector (SIC 7000-8999), in column (2), $Wage\ Growth_i$, the annual wage growth in the pre-treatment period in firm i's commuting zone and 3-digit NAICS industry, in column (3), $State\ HQ_i$, the proportion of firm i's new H-1B hires in the pre-treatment period working in the same state as firm headquarters, in column (4), $Pct\ NAFTA_i$, the proportion of firm i's new H-1B hires in the pre-treatment period born in Canada or Mexico, in column (5), $ForeignSegment_i$, an indicator variable for whether firm i has a geographic segment located outside of the United States, in column (6), and $IndianSegment_i$, an indicator variable for whether firm i has a geographic segment located in India, in column (7). $CapEx_{it}$ denotes firm i's investment rate during quarter t, $H1B\ use_i$ denotes firm i's H-1B usage intensity during 2001, and $Post_t$ represents a dummy variable that takes on a value of 1 if quarter t is in the post-treatment period 2004Q1-2004Q4, X_{it-1} denotes the set of quarterly firm-level control variables which are lagged by one quarter relative to the dependent variable $CapEx_{it}$. All specifications include $Tobin's\ Q$, $Cash\ Flow$, $ln(Size)$, $Cash$, and $Leverage$ as controls. Detailed definitions for all variables can be found in Table I as well as Appendix A. F denotes firm fixed effects and $I \times T$ denotes industry-year-quarter fixed effects. Standard errors are corrected for heteroskedasticity and clustered at the firm level. Standard errors are in parentheses, with *, **, and *** denoting significance at the 10%, 5%, and 1% level, respectively.

	(1) CapEx	(2) CapEx	(3) CapEx	(4) CapEx	(5) CapEx	(6) CapEx	(7) CapEx
H1B use × Post	-0.044	-0.153***	-0.123***	0.048	-0.132***	-0.178***	-0.120***
	[0.043]	[0.037]	[0.029]	[0.070]	[0.034]	[0.064]	[0.028]
H1B use × Manufacturing × Post	-0.110*						
	[0.057]						
H1B use × Services × Post		0.116**					
		[0.058]					
H1B use × Wage Growth × Post			-0.620**				
			[0.300]				
H1B use × State HQ × Post				-0.201**			
				[0.086]			
H1B use × Pct NAFTA × Post					0.285*		
					[0.150]		
H1B use × Foreign Segment × Post						0.114	
						[0.072]	
H1B use × Indian Segment × Post							0.855***
							[0.172]
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects	F, I × T	F, I × T	F, I × T	F, I × T	F, I × T	F, I × T	F, I × T
Observations	9,905	9,905	9,315	8,207	8,363	9,905	9,905
Adjusted R-squared	0.032	0.032	0.032	0.034	0.035	0.034	0.034

Table X: Characteristics Associated with Political Lobbying and the Effect of the H-1B Cap Drop on Investment

This table reports the estimation results from the OLS regression $CapEx_{it} = \alpha_i + \gamma_t + \delta \cdot H1B\ use_i \cdot Post_t + \pi \cdot I_i \cdot Post_t = \kappa \cdot H1B\ use_i \cdot Post_t + X_{it}\beta + \epsilon_{it}$. Only coefficients δ and κ are reported in order to conserve space. The sample is limited to four quarters prior to the H-1B cap drop (2002Q1-2002Q4) and four quarters following the H-1B cap drop (2004Q1-2004Q4), for firms submitting at least one H-1B application in 2001. $CapEx_{it}$ denotes firm i's investment rate during quarter t, $H1B\ use_i$ denotes firm i's H-1B usage intensity during 2001, and $Post_t$ represents a dummy variable that takes on a value of 1 if quarter t is in the post-treatment period. In columns (1)-(2), I_i represents a dummy variable that take on a value of 1 if firm i is in the information technology sector ($I_i = IT_i$) and the "new economy" sector ($I_i = New\ Econ_i$). In columns (3)-(5), I_i represents a dummy variable that take on a value of 1 if firm i is in an above-median industry (2-digit SIC) in terms of average values for the following variables: $Tobin's\ Q$ ($I_i = High\ TQ_i$), *R&D* spending ($I_i = High\ RD_i$), and total assets ($I_i = High\ Size_i$). X_{it-1} denotes the set of quarterly firm-level control variables, which are lagged by one quarter relative to $CapEx_{it}$: all specifications include $Tobin's\ Q$, *Cash Flow*, $ln(Size)$, *Cash Holdings*, and *Leverage* as controls. Detailed definitions for all variables can be found in Table I as well as Appendix A. F denotes firm fixed effects and $I \times T$ denotes industry-year-quarter fixed effects. Standard errors are corrected for heteroskedasticity and clustered at the firm level. Standard errors are in parentheses, with *, **, and *** denoting significance at the 10%, 5%, and 1% level, respectively.

	(1) CapEx	(2) CapEx	(3) CapEx	(4) CapEx	(5) CapEx
H1B use × Post	-0.144*** [0.052]	-0.095** [0.038]	-0.120*** [0.039]	-0.038 [0.076]	-0.122** [0.057]
H1B use × IT × Post	0.043 [0.063]				
H1B use × New Econ × Post		-0.062 [0.057]			
H1B use × High TQ × Post			0.017 [0.052]		
H1B use × High RD × Post				-0.067 [0.083]	
H1B use × High Size × Post					0.019 [0.068]
Control Variables	Yes	Yes	Yes	Yes	Yes
Fixed Effects	F, I × T	F, I × T	F, I × T	F, I × T	F, I × T
Observations	9,905	9,905	9,903	7,431	9,905
Adjusted R-squared	0.032	0.032	0.032	0.030	0.031

Table XI: Historical Local Population Characteristics and the Effect of the H-1B Cap Drop on Investment

Panel A reports the results from the OLS regression $H1B\,use_i = \alpha_i + \pi \cdot PctASTEM_{county(i)} + \rho \cdot PctIndPop_{county(i)} + \epsilon_i$, where $PctASTEM_{county(i)}$ denotes the % of college students enrolled in the county of firm i's headquarters of Asian ethnicity and studying in a STEM discipline as of 2000, and $PctIndPop_{county(i)}$ denotes the % of residents in the county of firm i's headquarters who speak an Indic language reported by the 1990 U.S. Census. Panel B reports the results from the OLS regression $CapEx_{it} = \alpha_i + \lambda_t + \delta \cdot \widehat{H1B\,use}_i \cdot Post_t + X_{it-1}\beta + \epsilon_{it}$, where $\widehat{H1B\,use}_i$ denotes the predicted value of $H1B\,use_i$ from the regression described in Panel A. All specifications in Panel B include $Tobin's\ Q$, *Cash Flow*, $ln(Size)$, *Cash Holdings*, and *Leverage* as controls. In Panel B, the sample is limited to four quarters prior to the H-1B cap drop (2002Q1-2002Q4) and four quarters following the H-1B cap drop (2004Q1-2004Q4) for firms submitting at least one H-1B application in 2001, and further restricted to exclude firms with headquarters located in Silicon Valley (i.e. Alameda, San Francisco, San Mateo, and Santa Clara county) in columns (2) and (4). Detailed definitions for all variables can be found in Appendix A. F denotes firm fixed effects and $I \times T$ denotes industry-year-quarter fixed effects. Standard errors are corrected for heteroskedasticity and clustered at the firm HQ county level. Standard errors are in parentheses, with *, **, and *** denoting significance at the 10%, 5%, and 1% level, respectively.

Panel A: *H1B use* and Historical Local Population Characteristics

	(1) H1B use	(2) H1B use	(3) H1B use
PctASTEM	0.039***		0.027***
	[0.009]		[0.009]
PctIndPop		0.978***	0.575**
		[0.275]	[0.229]
F-Statistic	19.62	12.62	19.98
Cluster by	County (HQ)	County (HQ)	County (HQ)
Observations	1,316	1,235	1,235
Adjusted R-squared	0.114	0.101	0.136

Panel B: Investment and Predicted values of *H1B use*

	(1) CapEx	(2) CapEx	(3) CapEx	(4) CapEx
$\widehat{H1B\,use}$ (ASTEM) × Post	-0.150**	-0.297**		
	[0.068]	[0.122]		
$\widehat{H1B\,use}$ (Both) × Post			-0.134*	-0.264*
			[0.074]	[0.141]
Control Variables	Yes	Yes	Yes	Yes
Fixed Effects	F, I × T	F, I × T	F, I × T	F, I × T
Cluster by	County (HQ)	County (HQ)	County (HQ)	County (HQ)
Exclude Silicon Valley	No	Yes	No	Yes
Observations	9,858	8,248	9,502	7,892
Adjusted R-squared	0.514	0.544	0.516	0.549

Table XII: Effect of the H-1B Cap Drop on Investment Based on Unrestricted Sample of H-1B and Non-H-1B Firms

The tables below report the estimation results from the OLS regression $CapEx_{it} = \alpha_i + \gamma_t + \delta \cdot \mathit{H1B\ use}_i \cdot Post_t + X_{it-1}\beta + \epsilon_{it}$ in column (1), and $CapEx_{it} = \alpha_1 + \gamma_t + \eta \cdot \mathit{H1B}_i \cdot Post_t + \delta \cdot \mathit{H1B\ use}_i \cdot Post_t + X_{it-1}\beta + \epsilon_{it}$ in column (3). The sample is limited to four quarters prior to the H-1B cap drop (2002Q1-2002Q4) and four quarters following the H-1B cap drop (2004Q1-2004Q4) for all firms (including those that did not submit H-1B applications during 2001). $CapEx_{it}$ denotes firm i's investment rate during quarter t, $\mathit{H1B}_i$ denotes that firm i submitted at least one H-1B application during 2001, $\mathit{H1B\ use}_i$ denotes firm i's H-1B usage intensity during 2001, and $Post_t$ represents a dummy variable that takes on a value of 1 if quarter t is in the post-treatment period 2004Q1-2004Q4. X_{it} denotes the set of quarterly firm-level control variables, which are all lagged by one quarter relative to the dependent variable $CapEx_{it}$. Detailed definitions for all variables can be found in Table I as well as Appendix A. F denotes firm fixed effects, T denotes year-quarter fixed effects, and $I \times T$ denotes industry-year-quarter fixed effects. Standard errors are corrected for heteroskedasticity and clustered at the firm level. Standard errors are in parentheses, with *, **, and *** denoting significance at the 10%, 5%, and 1% level, respectively.

	(1) CapEx	(2) CapEx	(3) CapEx
H1B use × Post	-0.078***		-0.071**
	[0.029]		[0.030]
H1B × Post		-0.001	-0.000
		[0.000]	[0.000]
Control Variables	Yes	Yes	Yes
Fixed Effects	F, I × T	F, I × T	F, I × T
Observations	23,476	23,476	23,476
Adjusted R-squared	0.027	0.026	0.027

Table XIII: Effect of the H-1B Cap Drop on Investment Based on Alternative Definitions of H-1B Exposure

This table reports the estimation results from the OLS regression $CapEx_{it} = \alpha_i + \gamma_t + \delta \cdot H1B\ variable_i \cdot Post_t + X_{it-1}\beta + \epsilon_{it}$, where $H1B\ variable_i$ represents various alternative measures of firm i's H-1B usage intensity during 2001. The sample is limited to four quarters prior to the H-1B cap drop (2002Q1-2002Q4) and four quarters following the H-1B cap drop (2004Q1-2004Q4), for firms submitting at least one H-1B application during 2001. $CapEx_{it}$ denotes firm i's investment rate during quarter t and $Post_t$ represents a dummy variable that takes on a value of 1 if quarter t is in the post-treatment period 2004Q1-2004Q4. Column (1) uses the same definition of $H1B\ use_i$ as found in Table IV, column (2) uses the natural log of $H1B\ use_i$, and column (3) uses a non-parametric measure of whether $H1B\ use_i$ is above or below its cross-sectional sample median. Columns (4)-(6) apply analogous measures of H-1B usage intensity calculated based on the cumulative wages of H-1B workers per firm rather than the number of hires per firm. X_{it-1} denotes the set of quarterly firm-level control variables, which are lagged by one quarter relative to the dependent variable $CapEx_{it}$: all specifications include $Tobin's\ Q$, $Cash\ Flow$, $ln(Size)$, $Cash\ Holdings$, and $Leverage$ as controls. Detailed definitions for all variables can be found in Table I as well as Appendix A. F denotes firm fixed effects and $I \times T$ denotes industry-year-quarter fixed effects. Standard errors are corrected for heteroskedasticity and clustered at the firm level. Standard errors are in parentheses, with *, **, and *** denoting significance at the 10%, 5%, and 1% level, respectively.

	(1) CapEx	(2) CapEx	(3) CapEx	(4) CapEx	(5) CapEx
ln(H1B usage) × Post	-0.111*** [0.029]				
High H1B usage × Post		-0.002*** [0.001]			
H1B wage × Post			-0.071*** [0.026]		
ln(H1B wage) × Post				-0.072*** [0.027]	
High H1B wage × Post					-0.002*** [0.001]
Control Variables	Yes	Yes	Yes	Yes	Yes
Fixed Effects	F, I × T	F, I × T	F, I × T	F, I × T	F, I × T
Observations	9,905	9,905	9,727	9,727	9,727
Adjusted R-squared	0.032	0.031	0.031	0.031	0.031

Appendix A Variable Definitions

CapEx: Quarterly capital expenditures (*capxy*) scaled by lagged quarter-end total assets (*atq*). Note Compustat variable *capxy* is year-to-date cumulative, so for fiscal quarter 2, 3, 4, the lagged *capxy* is subtracted from current *capxy* (Source: Compustat).

Tobin's Q: Market value of quarter-end total assets ($atq + prccq \times cshoq - ceqq - txditcq$) scaled by lagged quarter-end total assets (*atq*) (Source: Compustat).

$ln(Size)$: Natural log of lagged quarter-end total assets (*atq*) (Source: Compustat).

Cash Flow: Quarterly income before extraordinary items and depreciation ($ibq + dpq$) scaled by lagged quarter-end total assets (*atq*) (Source: Compustat).

Cash Holdings: Quarter-end cash holdings (*cheq*) scaled by lagged quarter-end total assets (*atq*). (Source: Compustat).

Leverage: Quarter-end long-term book value of debt (*dlttq*) scaled by lagged quarter-end total assets (*atq*). (Source: Compustat).

R&D: Quarter-end R&D expenditures (*xrdq*) scaled by lagged quarter-end total assets (*atq*). (Source: Compustat).

SG&A: Quarter-end SG&A expenditures (*xsga*) scaled by lagged quarter-end total assets (*atq*). (Source: Compustat).

Acquisitions: Quarter-end acquisitions spending (*aqcq*) scaled by lagged quarter-end total assets (*atq*). Note Compustat variable *aqcy* is year-to-date cumulative, so for fiscal quarter 2, 3, 4, the lagged *aqcy* is subtracted from current *aqcy* (Source: Compustat).

H1B use: The total number of H-1B initial petitions submitted to the USCIS during the 2001 calendar year, scaled by the average number of workers employed by the firm in 2001 (Source: USCIS petitions, Compustat).

ln(*H1B use*): The natural log of *H1B use* as defined above (Source: USCIS petitions, Compustat).

High H1B use: A dummy variable that takes a value of one if *H1B use*, as defined above, is above the sample median, and zero otherwise (Source: USCIS petitions, Compustat).

H1B use_j: The total number of H-1B initial petitions submitted to the USCIS during the 2001 calendar year for workers in occupational category j, scaled by the average number of workers employed by the firm in 2001 (Source: USCIS petitions, Compustat).

H1B: A dummy variable that takes on a value of one if the firm filed at least one H-1B initial petition to the USCIS during 2001, and zero otherwise (Source: USCIS petitions).

H1B wage: The sum of wages listed across H-1B initial petitions submitted to the USCIS during the 2001 calendar year, scaled by the product of the average number of workers employed by the firm in 2001 and the national industry average wage at the 3-digit NAICS level (Source: USCIS petitions, Compustat, BLS QCEW files).

ln(*H1B wage*): The natural log of *H1B wage* as defined above (Source: USCIS petitions, Compustat, BLS QCEW files).

High H1B wage: A dummy variable that takes a value of one if *H1B wage*, as defined above, is above the sample median, and zero otherwise (Source: USCIS petitions, Compustat, BLS QCEW files).

H1B usage: The total number of H-1B initial petitions submitted to the USCIS during a given quarter (annualized by multiplying by 4) by a given firm, scaled by the average number of workers employed by the firm during the same period (Source: USCIS petitions, Compustat).

H1B AvgWage: The natural log of the average wage across all new H-1B workers hired by a given firm in a given period (Source: USCIS petitions, Compustat).

Manufacturing: A dummy variable that takes on a value of one if the firm SIC classification is between 2000 and 3999, and zero otherwise (Source: Compustat).

Services: A dummy variable that takes on a value of one if the firm SIC classification is between 7000 and 8999, and zero otherwise (Source: Compustat).

Wage Growth: The average wage growth corresponding to the industry and region of a given firm, where region is defined as the commuting zone of firm headquarters and industry is defined at the 3-digit NAICS level (Source: BLS Quarterly Census of Employment and Wages, Compustat).

State HQ: The proportion of H-1B workers hired by a firm in 2001 listed to be working in the same state as the location of firm headquarters (Source: DOL LCA files, Compustat).

Pct NAFA: The proportion of H-1B workers hired by a firm in 2001 listed to be born in Canada or Mexico (Source: DOL LCA files, Compustat).

Foreign Segment: A dummy variable that takes on a value of one if the firm reports a geographic segment located outside of the U.S. in 2001 (Source: Compustat Segments).

Foreign Segment: A dummy variable that takes on a value of one if the firm reports a geographic segment located in India in 2001 (Source: Compustat Segments).

IT: A dummy variable that takes on a value of one if the firm SIC classification is 3341, 3342, 3343, 3344, 3345, 3346, 5111, 5112, 5161, 5181, 5182, 5191, or 5415, and zero otherwise (Source: Compustat).

$New\ Econ$: A dummy variable that takes on a value of one if the firm SIC classification is between 35, 36, 48 (2-digit), or 873 (3-digit), and zero otherwise (Source: Compustat).

$High\,TQ$: A dummy variable that takes a value of one if the pre-treatment (2002) industry average $Tobin's\ Q$ at the 2-digit SIC level is above the sample median, and zero otherwise (Source: Compustat).

$High\ Size$: A dummy variable that takes a value of one if the pre-treatment (2002) industry average $ln(Size)$ at the 2-digit SIC level is above the sample median, and zero otherwise (Source: Compustat).

$High\ RD$: A dummy variable that takes a value of one if the pre-treatment (2002) industry average R&D expenditures scaled by assets at the 2-digit SIC level is above the sample median, and zero otherwise (Source: Compustat).

$PctASTEM$: The proportion of post-secondary students enrolled in a given county who are reported to be of Asian/Pacific Islander ethnicity and studying in a field related to science, technology, engineering, and mathematics as of 1998 (Source: Integrated Post-Secondary Education Data System).

$PctIndPop$: The proportion of residents residing in a given county who report speaking an Indic language (Census code 662–678) at home as of 1990 (Source: 1990 U.S. Census Bureau Summary File 3).

Notes: Compustat data comes from the Compustat Fundamentals Annual (annual) and Compustat Fundamentals Quarterly files (quarterly). USCIS data comes from the United States Citizenship and Immigration Services via a Freedom of Information Act (FOIA) request. DOL LCA data comes from the Department of Labor's website at www.foreignlaborcert.doleta.gov/performancedata.cfm. BLS QCEW data comes from www.bls.gov/cew/. BLS OES data comes from www.bls.gov/oes/. IPEDS data comes from https://nces.ed.gov/ipeds/Home/UseTheData. Population Census data comes from https://www.census.gov/.

Appendix B Occupation Definitions

<u>Architecture, Engineering, And Surveying (Engineering)</u>

001 Architectural Occupations

002 Aeronautical Engineering Occupations

003 Electrical/Electronics Engineering Occupations

005 Civil Engineering Occupations

006 Ceramic Engineering Occupations

007 Mechanical Engineering Occupations

008 Chemical Engineering Occupations

010 Mining And Petroleum Engineering Occupations

011 Metallurgy And Metallurgical Engineering Occupations

012 Industrial Engineering Occupations

013 Agricultural Engineering Occupations

014 Marine Engineering Occupations

015 Nuclear Engineering Occupations

017 Drafters, N.E.C.

018 Surveying/Cartographic Occupations

019 Occupations In Architecture, Engineering, And Surveying, N.E.C.

<u>Mathematics And Physical Sciences (Combined under Sciences)</u>

020 Occupations In Mathematics

021 Occupations In Astronomy

022 Occupations In Chemistry

023 Occupations In Physics

024 Occupations In Geology

025 Occupations In Meteorology

029 Occupations In Mathematics And Physical Sciences, N.E.C.

<u>Computer-Related Occupations (Computers)</u>

030 Occupations In Systems Analysis And Programming

031 Occupations In Data Communications And Networks

032 Occupations In Computer Systems User Support

033 Occupations In Computer Systems Technical Support

039 Computer-Related Occupations, N.E.C.

<u>Life Sciences (Combined under Sciences)</u>

040 Occupations In Agricultural Sciences

041 Occupations In Biological Sciences

045 Occupations In Psychology

049 Occupations In Life Sciences, N.E.C.

<u>Administrative Specializations (Admin)</u>

160 Accountants, Auditors, And Related Occupations

161 Budget And Management Systems Analysis Occupations
162 Purchasing Management Occupations
163 Sales And Distribution Management Occupations
164 Advertising Management Occupations
165 Public Relations Management Occupations
166 Personnel Administration Occupations
168 Inspectors And Investigators, Managerial And Public Service
169 Occupations In Administrative Specializations, N.E.C.

Managers And Officials, N.E.C. (Management)
180 Agriculture, Forestry, And Fishing Industry Managers And Officials
181 Mining Industry Managers And Officials
182 Construction Industry Managers And Officials
183 Manufacturing Industry Managers And Officials
184 Transportation, Communication, And Utilities Industry Managers And Officials
185 Wholesale And Retail Trade Managers And Officials
186 Finance, Insurance, And Real Estate Managers And Officials
187 Service Industry Managers And Officials
188 Public Administration Managers And Officials
189 Miscellaneous Managers And Officials, N.E.C.