Economic Inquiry

TRANSITION OF INTERNATIONAL SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS STUDENTS TO THE U.S. LABOR MARKET: THE ROLE OF VISA POLICY

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I analyze how visa policies affect international students' transition to the U.S. labor market. The Optional Practical Training (OPT) program permits international students to work via a student visa for a limited period after graduation before obtaining a work visa—an uncertain process due to the binding visa cap. I find that the extension in the length of OPT terms for students in science, technology, engineering, and mathematics (STEM) increases their likelihood of initially staying in the United States and using OPT. This result suggests that uncertainties about obtaining work visas hinder international STEM students' participation in the U.S. labor market. (*JEL* J61, K37, I23).

I. INTRODUCTION

Visa policies for immigrants are of significant economic and policy interest because the process governments use to select immigrants to their country may impact the value of immigrants' contributions to the host country. Since foreign graduates of the host country's STEM programs have significant potential to contribute to that country's economy as shown in the literature, facilitating their transition to the host country's labor market might be an effective way to improve the characteristics of admitted immigrants.[1] In fact, implementing such selective immigration policies became quite feasible over the last decade as the number of international students pursuing postsecondary degrees has rapidly increased in major host countries (OECD 2017). In particular, the enrollment of international students in bachelor's- and master's-level programs of U.S. colleges and universities almost doubled over the last decade,

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1. Studies in the literature show that immigrants who enter on student visas and later transfer to work visas after attending school in the host country perform better in the labor market compared to immigrants who enter via other channels (Bound et al. 2015a; Bratsberg and Ragan Jr. 2002; Hunt 2011; Sweetman and Warman 2014). In addition, immigrants in science, technology, engineering, and mathematics (STEM) fields are found to contribute significantly to innovation activities in host countries (Chellaraj, Maskus, and Mattoo 2008; Hunt and Gauthier-Loiselle 2010; Kerr and Lincoln 2010; Moser, Voena, and Waldinger 2014; Stuen, Mobarak, and Maskus 2012).

ABBREVIATIONS

ACS: American Community Survey
BEA: Bureau of Economic Analysis
BLS: Bureau of Labor Statistics
CIP: Classification of Instructional Programs
CPT: Curricular Practical Training
DHS: Department of Homeland Security
FOIA: Freedom of Information Act
GDP: Gross Domestic Product
IPEDS: Integrated Postsecondary Education Data System
LCA: Labor Condition Application
NSCG: National Survey of College Graduates
OPT: Optional Practical Training
SAT: Scholastic Assessment Test
SEVIS: Student and Exchange Visitor Information System
STEM: Science, Technology, Engineering, and Mathematics

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with about a third of international students majoring in STEM fields.[2]

Yet, international graduates of U.S. colleges and universities have few visa opportunities to stay in the United States unless an employer sponsors them for a work visa, which is a costly and uncertain process due to the binding visa cap. Difficulties in obtaining permission to work in the United States may encourage talented students to return to their countries of origin or accept job offers from firms in other countries, and the loss of this talent might threaten U.S. leadership in STEM fields. Some U.S. policymakers have recently proposed altering the allocation of permanent work visas to make it easier to retain this U.S.-educated STEM workforce.[3] Proponents of these bills highlight the importance of STEM majors as a boost to innovation and growth. Meanwhile, there is an ongoing debate about whether increases in the supply of foreign workers might harm employment and earnings opportunities for natives.[4] In this study, I examine whether and how visa policies affect the transition of international students to the U.S. labor market. In particular, I analyze the effects of the increase in the allowable length of employment via the Optional Practical Training (OPT) program for students in STEM fields.

The OPT program provides a critical bridge for international students to access the U.S. labor market. It extends student visas for 12 months, allowing students to gain work experience in U.S. firms after graduation without holding a work visa. Because the H-1B visa—the most common type of temporary work visa for highly skilled immigrants—requires time-intensive and costly employer sponsorship with restrictive quotas, many international students benefit from OPT to start working in the United States. For instance, over the last decade, 83% of international students of U.S. bachelor's- and advanced-level programs who initially stayed in the United States obtained OPT and used their student visas to continue staying for at least six more months after their graduation and 67% did so for 12 months (see Section III). In 2008, the U.S. government extended OPT work permission from 12 to 29 months for degree recipients in most STEM fields. I employ this unique variation in the visa policy to address whether and how extended OPT terms affect the participation of international STEM students in the U.S. labor market.

The extension of OPT duration might potentially result in more students initially staying in the United States and participating in the U.S. labor market via OPT for several reasons. First, the OPT extension might increase the potential benefits of initially staying in the United States by providing a certainty of longer payoff streams (at least 29 months) and by increasing the probability of success in H-1B visa applications (because students can apply for it in multiple application cycles). Second, the extension might provide a longer screening or training period; therefore, a better opportunity for firms to train recently graduated international students and assess their ability before initiating a costly sponsorship for an H-1B visa. Third, the extension might change the composition of international students who attend U.S. colleges and universities by increasing the enrollment in STEM programs of students with greater intentions of entering the U.S. labor market after graduation.

In the empirical analysis, I use administrative data obtained from the U.S. government through a Freedom of Information Act (FOIA) request. This new dataset provides unique evidence on the postgraduation placement of international students, along with their educational

2. The population of international students enrolled in a higher education program abroad has increased from about 3 million in 2005 to 4.6 million in 2015 worldwide (OECD 2017). As of 2015, the United States was the largest destination country by hosting about 907,000 international students, followed by the United Kingdom (431,000 students), Australia (294,000), France (239,000), Germany (229,000), and Canada (172,000). In 2015, about 33% of international students in OECD countries majored in STEM fields compared to 21% of domestic students on average. According to the Integrated Postsecondary Education Data System (IPEDS) data, the enrollment of international students in U.S. higher education has increased from about 564,000 in 2005 to 951,000 students in 2015, with their share among all students increased from 2.1% to 3.6% at the undergraduate level programs and from 13.6% to 17.6% at the graduate level programs. See Section II for a discussion of trends by field of study.

3. For example, the SKILLS Visa Act of 2013 (H.R. 2131) proposes to allocate up to 55,000 permanent residency cards to STEM graduates of U.S. universities at the master's and doctoral levels, while the 2013 Border Security, Economic Opportunity, and Immigration Modernization Act (S. 744) proposes no cap for STEM doctorates and allocates up to 40% of permanent residency cards for STEM master's degree holders.

4. A large strand of literature explores the relationship between the supply of college-educated foreign workers and the labor market outcomes of native counterparts. The empirical evidence is mixed. Researchers that define labor markets by geography (e.g., Kerr, Kerr, and Lincoln 2015; Kerr and Lincoln 2010; Peri, Shih, and Sparber 2015) find negligible effects on natives' employment and earnings, whereas researchers that define labor markets by field of study (e.g., Borjas 2009; Borjas and Doran 2012; Demirci 2019; Lan 2013) and researches that rely on structural modeling (e.g., Bound et al. 2015b; Demirci 2017) find some adverse effects.

records. Students must either transfer to another status or apply for OPT within 60 days after their graduation. In the data, I observe whether students do not take any of these actions and leave the United States after completing their studies, or whether they take any of these actions and continue staying in the United States. I use this binary outcome as the main variable of interest by referring it throughout the paper as "initially staying in the United States," and I use it interchangeably with "participating in the U.S. labor market." For students who initially stayed, I also observe how long they use their student visas after their graduation over the course of the OPT period, but I do not observe visa status after the termination of their student visas.

I adopt a difference-in-differences (DD) strategy to estimate the effect of the OPT extension on eligible STEM students' likelihood of initially staying in the United States. Students in noneligible fields serve as a control group to capture patterns that would be observed for eligible STEM students in the absence of the OPT extension. I find that extended OPT terms increase eligible STEM students' likelihood of initially staying in the United States after they complete their studies. In particular, I find the largest estimates for STEM students at the master's level, indicating a 7.1% increase in their likelihood of initially staying, whereas it increases by 5.2% and 2.4% at the bachelor's and doctorate levels, respectively. I also analyze the effect of the OPT extension on the likelihood of using student visas over a range of postgraduation intervals (from 3 to 27 months) with a similar DD strategy. I find positive effects at all intervals, which shows that eligible STEM students' likelihood of using OPT to continue staying in the United States increases after the OPT extension takes effect.

The estimated positive effect of the OPT extension on the likelihood of initially staying suggests that some firms and international students need the certainty of a longer employment period to compensate them for the fixed costs of hiring and to achieve better training and screening before the costly sponsorship of work visas. The insurance mechanism provided by the OPT extension decreases the risk of employment termination due to the H-1B cap at the end of the first year. The regression results show that this reduced uncertainty makes both firms and students more likely to initiate employment at the first stage, even though the OPT extension does not change the work permission for initial employment. In other words, the results suggest that uncertainty about obtaining a work visa discourages the participation of international STEM students in the U.S. labor market. The loss of these talented students might undermine U.S. leadership in STEM fields and negatively impact growth rate in the U.S. economy, especially to the degree that the initial placement of international students is a good predictor of long-term patterns of staying in the United States. (It is shown to be the case for doctoral-level students in Finn 2014.)

Changes in labor demand conditions might be concerning in interpreting the estimated effect as a causal relationship. In particular, the Great Recession hit the U.S. economy and probably affected the labor demand adversely in the post-policy period. If the recession affected the labor demand in STEM fields less adversely, then the estimated positive effect of the OPT extension on the likelihood of initially staying might have been driven by the recession. Two pieces of evidence might mitigate these concerns. First, the results are robust even after controlling for time-varying labor market conditions. Second, when I estimate a triple difference model in which students from countries with alternative work visas are used as a control group, I find that the OPT extension increases the likelihood of staying more for STEM students without alternative visas than for STEM students with them. Given this evidence, labor demand conditions remain concerning for causality only if they differed across students in STEM fields and those in non-STEM fields in an unobservable way and if they differed within STEM fields across students with alternative visas and those without them.

Next, I explore the heterogeneity of the estimated effect across subgroups of students. I find that the impact of the OPT extension on the likelihood of initially staying in the United States after graduation is larger for STEM students with lower earnings opportunities in their home country (as measured by gross domestic product [GDP] per capita), who attend less selective institutions in the United States (as measured by Scholastic Assessment Test [SAT] scores of students in the institution attended), and who have a noisier signal of their ability (as measured by the interquartile range of SAT scores). Differences in potential benefits from staying in the United States, due to the wage gap across countries, might explain the results with respect to the GDP per capita, whereas differences in the necessary amount of training and screening across students might explain the results with respect to SAT measures. Earlier literature shows

that immigrants who come from a country providing lower-quality education earn less in the host country (Bratsberg and Terrell 2002; Ferrer and Riddell 2008; Li and Sweetman 2013). My findings contribute to that literature by showing that immigrants' educational credentials attained even in the host country affect their likelihood of employment and their chances to continue staying in the host country.

Finally, I analyze the impact of the OPT extension on the likelihood of transition to work visas. I use data from the National Survey of College Graduates (NSCG) for that analysis because the administrative data do not provide the visa status after student visas as mentioned above. But sample sizes in the NSCG are small so that I can only compare aggregate statistics between international students in STEM and non-STEM fields. I show that the population and the percentage of international students who transition to work visas became larger in STEM fields after the OPT extension, whereas they remained similar in non-STEM fields. As a result, the share of international STEM graduates of U.S. colleges and universities among all work-visa holders rose by about a half after the OPT extension, suggesting the role of the OPT extension in improving characteristics of admitted immigrants in the long term. I also find that annual earnings of international students observed in the NSCG data did not differ in STEM fields after the OPT extension took effect, suggesting no adverse effect of the visa policy on the average productivity of international STEM students who continued to stay in the United States after their graduation.

The paper proceeds in six sections, including the introduction. The next section provides a brief overview of the relevant literature, describes current visa policy, and discusses theoretical implications of the OPT extension. Section III introduces the unique administrative data employed in this analysis. Section IV lays out the estimation strategy, and Section V provides regression results and a discussion of the effect on transition to work visas. Section VI concludes.

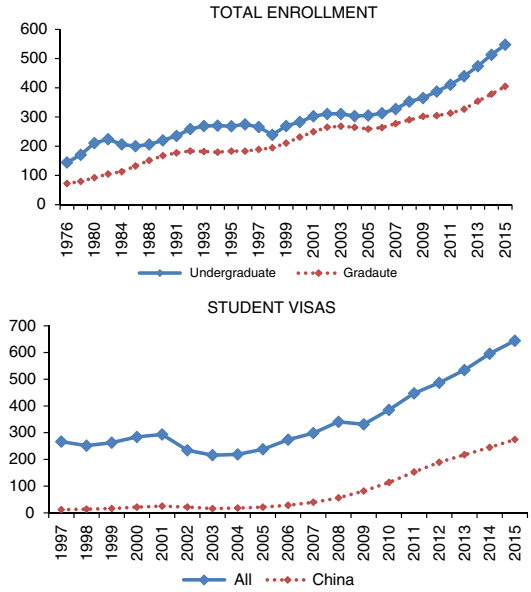
II. RESEARCH BACKGROUND AND THEORETICAL FRAMEWORK

A. Trends in Enrollment of International Students in the United States

The total enrollment of international students in both undergraduate and graduate programs of U.S. colleges and universities has grown substantially over the last four decades (Figure 1A), except for a few periods associated with contracting economic opportunities and stringent visa requirements related to national security concerns (Lowell and Khadka 2011). Since 2006, the increase has been particularly marked, with a distinctly faster growth at the undergraduate level (6.4% annually) than at the graduate level (4.9%), whereas the changes at the graduate level were concentrated in master's programs. Visa statistics from the U.S. Department of State show that students from China have been the driving force of this growth (Figure 1B). In 2006, Chinese students held only 10% of student visas; but, in 2015, they held 43%.

In turn, the number of degrees awarded to international students has grown at all levels, particularly in bachelor's and master's programs it seems repetitive. (Figure S1, Supporting

FIGURE 1
The Stock and Flows of International Students in the United States



Notes: The enrollment series denoted in thousands display the total number of enrolled students with temporary visas in undergraduate programs (only the bachelor's level) and graduate programs (combining the master's and the doctorates level). The student visas series denoted in thousands display the total number of new F visas (the primary type of student visa) issued each year.

Source: IPEDS 1976–2015, Enrollment Surveys in Figure 1A; and Department of State, Nonimmigrant Visa Issuances by Visa Class and by Nationality in Figure 1B.

Information). As a result, the share of degrees awarded to international students increased from 2.1% to 3.6% at the bachelor's level and from 13.6% to 17.6% at the master's level over the last decade. Since international students were more likely to study in STEM fields compared to domestic students, their share was much higher in STEM programs than their overall share. In particular, international students obtained 8.1% of STEM bachelor's degrees and 50.2% of STEM master's degrees granted by U.S. universities and colleges in 2015.

B. Related Literature

A strand of the literature explores determinants of international student mobility. The "school-constrained" and the "migration" model are two theoretical approaches used in the literature to explain student flows (Rosenzweig 2006). The school-constrained model emphasizes home country supply constraints in postsecondary options as a driving motive, whereas the migration model focuses on the motive to find high-paying jobs in the destination country after graduation. The empirical evidence in the U.S. context provides support for both hypotheses. Some researchers find that both the increased competition for college enrollment in the home country and the increased ability to pay U.S. tuition raise demand for a U.S. education (Bird and Turner 2014); some studies find that international students' enrollment responds to changing job prospects in the U.S. labor market, proxied by variation in visa caps or demand shocks in specific industries (Bound et al. 2013; Kato and Sparber 2013; Shih 2016).

Although the latter studies provide some evidence for the migration model, the principal tenant of this model is that international students enroll in U.S. schools to obtain U.S. employment. But, at what levels international students transition to the U.S. labor market is noticeably absent in the literature, perhaps because of data limitations, except for a few studies at the doctoral level. In particular, relying on the data for doctoral degree recipients from U.S. universities and colleges, Grogger and Hanson (2015) find that foreign doctoral students' intention to stay in the United States is positively related to their academic ability. Merging the survey data with administrative tax records, Finn (2014) presents high levels of stay rates for foreign recipients of doctoral degrees, with 68% of them staying in the United States 5 years after graduation on average, 65% staying 10 years, and 61% staying 16 years. Unlike the earlier literature, this study analyzes the likelihood of initially staying in the United States after graduation for students at all degree levels, including students at the bachelor's and master's level, and relies on a new administrative dataset.

This study also relates to the literature that explores determinants of return migration (e.g., Aydemir and Robinson 2008; Borjas and Bratsberg 1996; Constant and Massey 2003). In the context of immigration in the United States, Depew, Norlander, and Sørensen (2017) study the likelihood of job transition and return migration for a group of college-educated immigrants who hold temporary work visas. They show that deteriorating labor market conditions in the United States increases the likelihood of return migration. My paper contributes to this literature by analyzing how visa policy affects international students' likelihood of initially staying in the United States after their graduation (i.e., the opposite of the likelihood of leaving the United States). Also, in a related study, Amuedo-Dorantes and Furtado (2017) find that foreign graduates of U.S. universities and colleges, particularly bachelor's degree holders, are more likely to work in universities and research institutions that are exempt from the H-1B cap in periods when the cap is binding. My paper complements this study by analyzing how the restrictiveness of visa policies affects international students' likelihood of initially staying in the United States and participating in the U.S. labor market.

C. Student Visas and the OPT Program

There are three types of student visas: M visas for vocational study, J visas for cultural exchange programs, and F visas for academic study. Among them, F visas are the most prevalent type as 94% of universities sponsor their international students under the F visa program (Student Exchange and Visitor Program 2014). Because there is no cap on the number of student visas that can be issued per year, the capacity to finance and academic preparedness compose the two main conditions to be eligible for an F visa. Although admission to any program requires both conditions for each level of study, capacity to finance is binding particularly at the bachelor's and master's levels because doctoral students generally get stipends. F visas provide a limited period during which newly graduated students may work at U.S. firms

before needing sponsorship via another type of work authorization. This period is known as OPT.[5]

The value of the postgraduation employment opportunity via OPT becomes more apparent when it is compared with other entry channels to the U.S. labor market. H-1B visas, the most popular work visa category for the employment of college-educated foreign workers, provide work permission for up to 3 years with the potential for a 3-year extension.[6] However, the number of H-1B visas is subject to a restrictive cap at 65,000 per year, and only employees of universities and other research institutions are exempt from the quota. The number of applications has exceeded the cap each year since 2004 such that some firms must wait for the next year to be able to sponsor their foreign employees. Congress authorized an extra 20,000 H-1B visas per year in 2005 for workers holding advanced degrees from U.S. universities, but that number has been considerably less than the annual population of new graduates of advanced programs. As a result, this extended cap has been binding each year since its inception. (See Table S1.) Indeed, a comparison of the total flows of international graduates to the H-1B cap suggests that not every U.S.-educated student can be sponsored under the H-1B program because of the H-1B cap even if U.S. firms would be willing to hire them.[7]

In sum, the transition to the U.S. labor market with student visas (via OPT) after postsecondary study provides a window of opportunity for most students to obtain long-term employment in U.S. firms. In 2008, the U.S. government extended the OPT from 12 to 29 months for graduates of most STEM fields. As a result, international students in computer sciences, mathematics, engineering, and biological and physical sciences became eligible to stay in the United States up to 29 months after graduation by holding their student visa status.[8] In 2011 and 2012, eligibility was further expanded to students in pharmaceutical, agricultural, and environmental sciences.[9] (See the Appendix for further discussion of fields.) In the next section, I discuss potential implications of this extension policy on international students' likelihood of initially staying in the United States after their graduation.

D. Theoretical Framework

The sign of the effects of the OPT extension on the likelihood of staying is expected to be positive. The overall magnitude of the impact is an empirical question, and it might be a function of effects realized due to three different reasons. First, the extension in OPT terms provides a certainty of longer payoff streams (at least 29 months rather than 12) and increases the likelihood of success in H-1B applications. In particular, international students who are unable to transfer to a work visa because of the exhaustion of H-1B visas can continue to work in their current employment up to 29 months after the

5. F-visa students may also work part-time up to 20 hours even during schooling, which is known as Curricular Practical Training (CPT). The time employed on CPT counts toward the total limit in the OPT period, yet only 1% of students use CPT (Wasem 2012).

6. There are a few other visa opportunities for college-educated foreign workers, such as permanent visas and L visas, but they are either not common nor feasible for international students. In particular, permanent visas have a restrictive cap and only 3.3% of those visas were issued to students in 2001 as of the most recent year when these statistics were released (U.S. Immigration and Naturalization Service 2002). L visas require work experience abroad in the prior year to application, which makes them not feasible for international students.

7. In recent years, about 15,000 international students at the doctoral level and 60,000 at the master's level graduate from U.S. colleges and universities per year (see Figure S1). Thus, the allocated 20,000 visas for advanced degree holders are significantly less than the flow of new graduates. Although the rest of the advanced degree holders might be subject to regular quota of 65,000 visas, this process is quite competitive because an additional 50,000 new graduates at the bachelor's level and immigrants from abroad might apply for these visas.

8. All students with a degree in eligible STEM fields can use the 17-month extension after completing the initial 12 months of their OPT. Although the law requires employers to register on the E-verify system, which is a federal system designated to check employees' eligibility to work legally in the United States, firms can easily enroll to the system online and there is no evidence for firms' hiring decision affected by the E-verify requirement, with the exceptions for immigrants who are likely to be unauthorized (Amuedo-Dorantes and Cynthia 2012; Bohn, Lofstrom, and Raphael 2014). Moreover, the 2008 regulations set the unemployment limit at 120 days for those on the OPT extension period, while it was kept at 90 days for all other students. Also, student visas of those with a properly filed and approved H-1B petition were automatically extended up to 6 months after the extension, regardless of the field of study.

9. The Washington Alliance of Technology Workers sued the U.S. Department of Homeland Security (DHS) over the OPT extension policy, claiming that the policy harmed native workers' employment opportunities, and that the statutorily mandated notice-and-comment period was not followed by the DHS. On November 21, 2014, the U.S. District Court for the District of Columbia invalidated the existing policy on the grounds that the DHS had not followed the proper administrative process in implementing the rule. In response, the DHS proposed a new rule on the OPT extension, considering the proper notice-and-comment period. The new rule, which took effect on May 10, 2016, sets the extension period to 24 months and mandates that participants fulfill the Mentoring and Training Plan form (Form I-983).

extension in the OPT duration. Also, college students graduating in May used to have only one chance to apply for an H-1B visa (about 10 to 11 months after graduation) because H-1B permits have usually been exhausted by the first week of April. With the OPT extension, students in eligible STEM fields have two chances to apply (once after 10 to 11 months and again 22 to 23 months later if the first attempt fails). This reduced uncertainty of obtaining an H-1B visa along with longer payoff streams increases the benefits of staying, and these benefits likely compensate for the fixed costs of staying, such as the costs of moving between states and expenses associated with job-related training.

Second, firms might use employment on OPT as a training or screening period during which they try to learn the quality of international students before the sponsorship decision for an H-1B visa. The theory suggests that the option value of reassessment in decisions with uncertain payoffs increases the realization of risky behaviors, such as the dropout option increasing the value of college attendance (Eisenhauer, Heckman, and Mosso 2015; Lee, Shin, and Lee 2015; Stange 2012). In this context, the OPT extension provides a reassessing opportunity before initiating a costly sponsorship for work visas.[10] Also, the extension provides a longer training period, therefore a better opportunity to develop firm-specific skills before the H-1B sponsorship. By providing opportunity for enhanced training and screening, the OPT extension might encourage firms to consider hiring international students with lower ability or those sending a noisier signal about their ability.

Third, the OPT extension might increase the likelihood of staying because it might increase the enrollment in STEM programs of international students with a strong intention to initially stay and participate in the U.S. labor market after graduation. Indeed, earlier studies show that international students' enrollment responds to changes in job prospects in the U.S. labor market (Bound et al. 2013; Kato and Sparber 2013; Shih 2016). But, as described in the next section, most students analyzed in this study probably made their enrollment decision before the extension policy was announced. Thus, the effects realized due to the enrollment channel are not likely to be captured in this study.

In sum, the impact of the OPT extension is expected to be positive, and its magnitude might vary across students. In particular, the effect is expected to be larger for students whose transfer to a work visa is bound by the H-1B cap, those for whom staying longer in the United States implies larger benefits, and those who need a longer training and screening period before the H-1B sponsorship. In the empirical analysis, I examine both the overall impact of the OPT extension and its heterogeneity with respect to student characteristics.

III. DATA

A. Administrative Data Source for International Students: SEVIS

I use administrative data obtained from the student and exchange visitor information system (SEVIS) through a FOIA request. The dataset is an individual-level census of F-visa students who either adjusted to another visa or departed the United States any time between January 1, 2004 and June 26, 2014. I observe exact dates of when a student started and completed postsecondary study along with when his or her F-visa status terminated. In terms of educational records, I observe the intended degree, field of study, and the name of the institution attended. As such, I can identify whether the student was eligible for the OPT extension by virtue of the field and the date of school completion. I also observe some demographic characteristics of students including country of origin, year of birth, and gender.

The length of the period between school completion and F-visa status termination provides some insights about postgraduation residency. The law requires students either to transfer to another visa or to apply for OPT within 60 days after graduation. Visas of students who have not taken either action are revoked at the end of this "grace period." The date of F-visa status termination is exactly 60 days after school end date for about one-third of all students in the data. Therefore, I identify those observations (i.e., those with visa termination exactly 60 days after school end date) as the students who left the country right after the completion of their studies. I treat all other observations as the students who initially stayed in the United States. A

10. Employment on H-1B visas is likely to be costlier compared to employment on OPT for several reasons. First, H-1B visas have more expensive application fees and more burdensome paperwork. Second, firms must attest to pay the prevailing wage and compensate workers' losses in case of layoff under the H-1B program. Third, firms must pay Social Security and Medicare taxes for H-1B workers.

small group of students who initially stayed terminated their student visas within 60 days after the completion of their studies (3.6% of all observations). These students probably transferred to other visas in that period and continued to stay in the United States without using their OPT. On the other hand, all other students who initially stayed used their student visas more than 60 days after the completion of their studies, and these students must have used their OPT.[11]

Although I observe the length of a student visa used after the completion of schooling in the SEVIS data as mentioned above, I do not employ it as another measure of stay because it cannot be interpreted as "the length of stay" in the United States. The concern is that students who rely on student visas for a short period to stay after the completion of their studies might actually transfer to a work visa sooner and stay in the United States longer compared to students who rely on student visas for a longer period.

The SEVIS administrative data have some limitations. First, I do not observe visa status after the termination of student visas. Once their visas expire, students might leave the country or transfer to another visa, including an employment-based visa or a family-related visa by marrying a native or permanent resident. Therefore, I cannot explore whether and how the OPT extension affects the likelihood of long-term attachment to the United States with the SEVIS data. Second, I do not know whether students obtained the degree pursued or dropped out of their programs. Indeed, for some of my observations, the period between the school start date and school end date does not seem long enough to obtain the degree pursued. Nonetheless, I include these students in the empirical analysis below, as they might still have stayed in the United States via other channels. But I also show that the results are not sensitive to these students' inclusion (see Appendix). Third, the data do not have a longitudinal feature. For instance, if a student obtains a bachelor's degree in May from a U.S. institution and then starts a doctorate program in August in the United States, I observe them as separate entries without any person-specific identifier.

11. In practice, SEVIS asks school officials to enter each student's school end date accurately because SEVIS automatically terminates the student's record 60 days after his or her school end date unless the student takes an action of applying for OPT or transferring to another visa in that period. SEVIS also allows school officials to terminate the student's record manually within 60 days by warning that this option should be used only if school officials are completely sure that the student will not apply for OPT (SEVP, Training for Designated School Officials, Module 6). Due to potential risks of early termination in case of students changing their decision to apply for OPT, it is plausible to assume that school officials do not exercise that option often for students who will leave the United States before the 60-day deadline. So, I treat students whose student visa termination date is shorter than 60 days after their graduation as transferring to another visa status and initially staying in the United States. Nonetheless, only about 3.6% of international students in the data have their student visas terminated within 60 days after graduation, and the regression results are robust even if I treat them as leaving the United States as shown in the Appendix (Table A1).

B. Sample Statistics of International Students in SEVIS

I restrict the sample to students who completed their schooling between January 1, 2004 and June 30, 2011 so that every student in the sample should have run out his or her F-visa status as of the last day observed in the data (June 26, 2014). In addition, I drop students who adjusted their visa status before the school end date from the sample (about 5% of all observations), as they likely obtained a family related visa before completing their schooling and they would not benefit from the OPT extension. But the results are not sensitive to their exclusion from the sample as discussed in the Appendix.

Table 1 reports summary statistics for international students in the sample, differentiating students by their level of study and eligibility status of their field of study for the OPT extension. Students in the eligible fields (i.e., STEM) are more likely to be male and slightly younger than are students in noneligible fields at all degree levels. The predominance of Indian students in eligible fields at the master's level (61% of all the students in eligible master's programs) and Chinese students in eligible fields at the doctorate level (36%) is also noteworthy. Moreover, students in eligible fields are more likely to study computer sciences and engineering at all degree levels, whereas almost half of those in noneligible fields major in business programs at the bachelor's and master's level.

About 72% of students in the sample initially stayed in the United States after completing their studies, and this figure is even higher for students in eligible STEM fields and for students in graduate-level programs. In particular, 89% of students in eligible STEM fields at the master's level and 85% of those at the doctoral level stayed initially in the United States. While this high level of initial stay rate observed in the SEVIS data for doctoral students is consistent with corresponding figures in the literature (Finn

TABLE 1
Summary Statistics of International Students, SEVIS Data

Eligibility for the OPT extension	Bachelor's		Master's		Doctorates	
	Eligible	Noneligible	Eligible	Noneligible	Eligible	Noneligible
Number of observations	51,740	181,611	145,787	238,571	67,571	42,391
% Female	31.6	55.1	28.8	51.5	28.3	48.9
Mean age at school completion	23.8	24.1	25.7	28.9	30.9	33.2
(St. Dev.)	(3.3)	(3.9)	(3.4)	(5.4)	(3.9)	(6.4)
% China	3.3	3.6	11.4	12.8	35.9	14.9
% India	9.6	3.5	60.6	13.1	17.4	8.2
% South Korea	8.7	10.9	2.8	8.5	10.0	15.1
% Computer Sciences	28.7	—	35.4	—	14.8	—
% Engineering	41.9	—	54.0	—	42.6	—
% Physical and Biological Sciences	21.0	—	6.8	—	38.3	—
% Management	—	40.7	—	47.6	—	7.9
% Social Sciences	—	11.7	—	5.0	—	16.2
% Stayed initially in the United States	66.1	62.0	88.5	68.0	85.3	63.6
% Stayers who used student visas 6 months after graduation	80.5	77.4	88.2	84.0	84.0	77.4
% Stayers who used student visas 12 months after graduation	69.7	69.2	65.6	71.1	58.8	58.3
% Stayers who used student visas 18 months, conditional on graduating after the OPT extension	18.1	1.7	37.7	1.9	17.8	1.2
% Stayers who used student visas 29 months, conditional on graduating after the OPT extension	10.8	0.2	18.3	0.2	10.2	0.5

Notes: The statistics are based on SEVIS data. The sample includes students who completed their school between January 1, 2004 and June 30, 2011. Students who adjusted their visa status before they completed their schooling are excluded from the sample. Statistics are reported by level of study and eligibility status of fields for the OPT extension. Eligible fields include most STEM fields. See the supporting information for a detailed discussion of eligible fields. The age refers to the age at school completion. The percentage of stayers who used student visas 18 months or 29 months after graduation is calculated only for students who completed their schooling after the OPT extension policy was enacted.

2014; Grogger and Hanson 2015), the SEVIS data additionally reveal that the initial stay rate for master's-level students in STEM fields is at par and even slightly higher than that of doctoral students.[12] (See Table A2 in the Appendix for the observed stay rates in the SEVIS data for more detailed subgroups of students.)

Conditional on initially staying in the United States, most students in the sample benefited from OPT. For instance, 88% of students who completed master's-level programs in eligible STEM fields and initially stayed in the United States used their student visas for at least 6 months after completing their studies. The corresponding figures do not vary so much across students in different fields and levels. Overall, 83% of all students who initially stayed in the United States used their student visas for at least 6 months after the completion of their studies, whereas 67% of them continued to do so for 12 months. Restricting the sample of interest to students who completed their studies in eligible STEM fields and initially stayed in the United States after the OPT extension was enacted, I observe that 38% of them at the master's level used their student visas for 18 months after the completion of their studies, and about 18% did so for 29 months; whereas the corresponding figures for bachelor's- and doctorate-level students are about half of those for master's-level students.

However, I should note that these percentages are calculated based on the observed length of student visas used after school end date, and they

12. Grogger and Hanson (2015) shows that 80% of STEM doctoral students who graduated in the early 2000s intended to stay in the United States (my calculations combining the data in Figure 1 and Figure 3), while Finn (2014) shows that 78% of those in the 2006 graduation cohort stayed in the United States a year after their graduation (my calculations from the data in Table 5). These figures are slightly smaller than the stay rate observed for doctorate-level STEM students in the SEVIS data. This small discrepancy might result from the fact that the sample of international students in the other studies include J-visa holders (a small sample of all international students) and these students are required by visa regulations to return to their country of origin after graduation.

TABLE 2

The Impact of the OPT Extension on Initial Stay Rates, Difference in Differences (DD), Unconditional on Covariates

Level of Study	Before	After	Difference
Bachelor's			
Noneligible fields	0.662	0.575	−0.087
	(0.0016)	(0.0016)	(0.0023)
N	93,944	87,667	
Eligible fields	0.689	0.624	−0.065
	(0.0028)	(0.0032)	(0.0043)
N	29,811	21,929	
DD result			0.022
			(0.0048)
Master's			
Noneligible fields	0.696	0.665	−0.032
	(0.0012)	(0.0012)	(0.0017)
N	119,058	119,513	
Eligible fields	0.868	0.902	0.034
	(0.0015)	(0.0015)	(0.0021)
N	73,111	72,676	
DD result			0.066
			(0.0027)
Doctorates			
Noneligible fields	0.653	0.618	−0.035
	(0.0028)	(0.0028)	(0.0039)
N	21,844	20,547	
Eligible fields	0.854	0.852	−0.002
	(0.0021)	(0.0023)	(0.0032)
N	37,784	29,787	
DD result			0.033
			(0.0051)

Notes: "After" refers to the period after the OPT extension takes effect. The statistics in the "After" cells are calculated for students who completed school after April 8, 2008 (after May 11, 2011 for those in fields that became eligible in the second cycle) and for those who were on student visa status when the extension was enacted but having graduated in the last 60 days before then. "Before" period refers to all other cases. Standard errors associated with the differences are reported in parenthesis. *N* denotes the number of observations in each cell.

might not be precise due to a potential measurement error. The concern is that students might apply for OPT with the intention of using it for a certain period, but then leave the country before their OPT expires without updating the U.S. government about their current situation. Nonetheless, this issue might be less concerning for the statistics of 18-month use of student visas, which might be interpreted as a proxy for obtaining the OPT extension. It is less concerning because obtaining work permission via the OPT extension depends on the successful completion of the regular OPT period, which requires students to have been in the United States and have worked in a job during that period.[13]

13. Student visas can technically be 4 months longer than the allowable length of work permission via OPT because the OPT term can start on the last day of the grace period (2 months after the completion of school) and another grace period (2 months) is provided after the termination of OPT. Overstayers are not reported in the data, but I infer them as observations whose student visa terminates after the length of allowable OPT plus 4 months. Overstayers make up only about 3% of the sample. Low rates of overstaying exist possibly for two reasons. First, students have strong incentives to keep their status legal because any noncompliance might jeopardize their visa applications in future. Second, schools are in charge of monitoring their students. In practice, most schools have an office designated for that purpose, and these offices regularly inform their students to comply with student visas. Also, schools are required to terminate students' visa status once they observe noncompliance, such as students being outside of the country more than 5 months or exhausting the allowable length of unemployment on OPT.

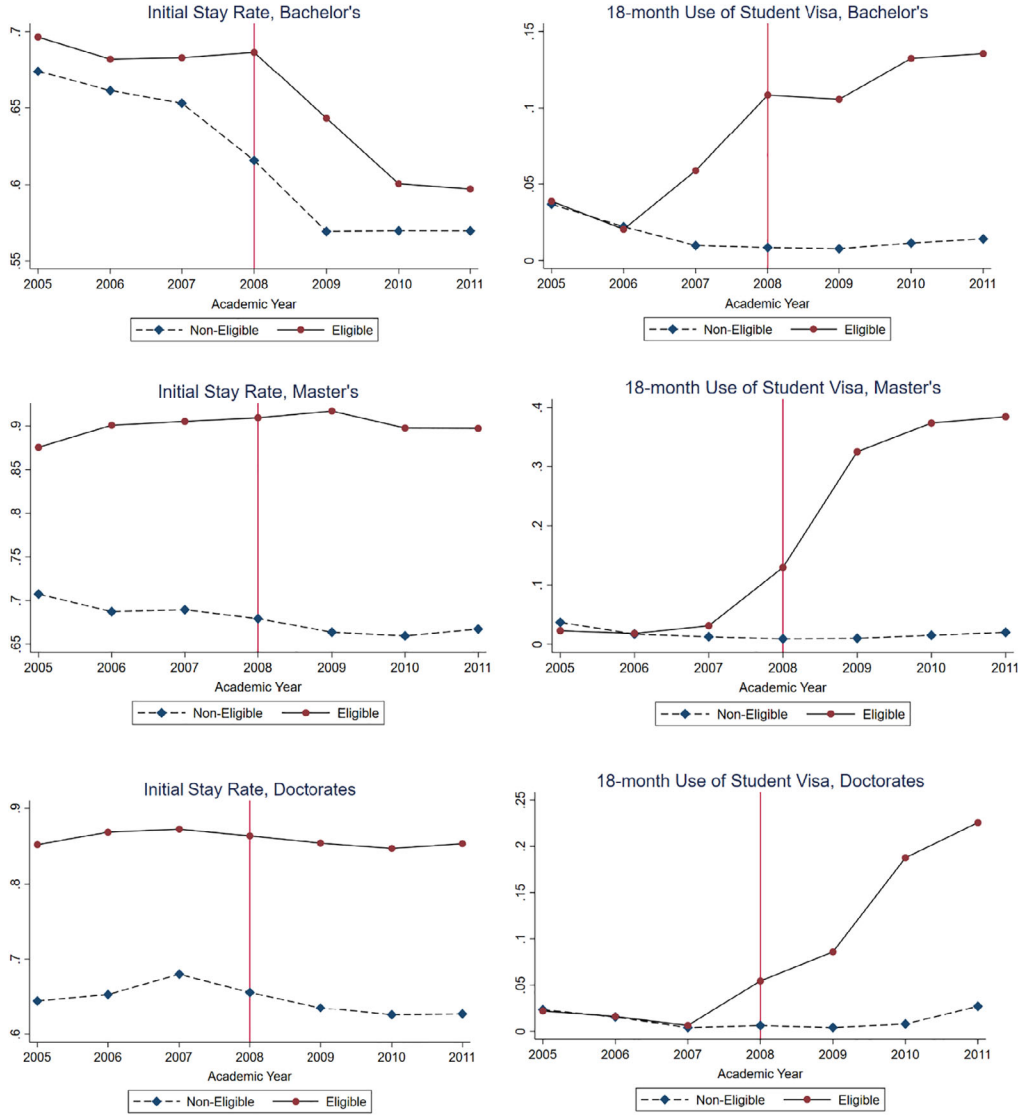
IV. EMPIRICAL STRATEGY

To estimate the impact of the OPT extension on international students' likelihood of initially staying in the United States after their graduation, I use a DD approach that compares international students in fields eligible for the OPT extension (i.e., STEM fields) with students in noneligible fields (i.e., non-STEM fields, with business majors comprising a large fraction of students in this group in the data). The key identifying assumption behind the empirical methodology is that the pattern in the likelihood of initially staying for noneligible students proxies the pattern that would have occurred for eligible students in the absence of the OPT extension. A potential violation of the assumption of parallel trends would arise if time-varying factors (such as changing labor demand conditions) affect the initial stay rate for eligible students differently than the initial stay rate for noneligible students. I provide robustness checks to address this concern in the next section.

Table 2 reports the average initial stay rate (and the standard errors in parentheses) at each level of study. Columns report outcomes for students who completed study before the policy versus after, along with their difference. Rows report those outcomes separately for students in fields that are eligible versus noneligible for the OPT extension. Figure 2 illustrates the similar statistics for each year over the sample period. Initial stay rates fell during the postpolicy period at most fields and levels. It is not surprising to observe such a drop, as the postpolicy period coincides with a weak job market due to the Great Recession. Despite the economic slowdown, the initial stay rate rose in eligible STEM fields at the master's level. Comparison of differences implies a positive impact of the OPT extension on the likelihood of initially staying between 2.2 to 6.6 percentage points (equivalently, between 3.1% to

FIGURE 2

The Initial Stay Rate of International Students, by Field and Level



Notes: Graphs on the left display the fraction of students in each graduation class who initially stayed in the United States after completing their schooling. Graphs on the right display the fraction of students in each graduation class who initially stayed and used their student visas 18 months after completing their schooling. The vertical line shows the year when the OPT extension policy was enacted. Since all students in eligible fields who were already in the United States when the policy was announced were eligible for the extension after using regular OPT for 12 months, the policy might affect the 18-month use of the visa for students in the 2007 graduation cohort.

Source: SEVIS data.

7.6%), with the largest effect observed at the master's level.

Regression analysis addresses concerns about possible compositional changes in the characteristics of international students over the sample period, such as country of origin and type of institutions attended. I estimate the DD linear model

$$Y_{i_{fsct}} = \beta_0 + \beta_1 OPT_{ft} + \beta_2 X_{i_{fsct}} + \delta_f + \delta_t + \delta_s + \delta_c + \varepsilon_{i_{fsct}} \quad (1)$$

TABLE 3
Baseline Results, the Impact of the OPT Extension on the Likelihood of Initially Staying in the United States after Graduation

	(1)	(2)	(3)
Bachelor's	0.039***	0.039***	0.036***
	(0.008)	(0.007)	(0.007)
R-squared	0.06	0.16	0.19
		($N = 233{,}351$ Mean Dep. Var. = 0.629)	
Master's	0.055***	0.059***	0.062***
	(0.009)	(0.008)	(0.008)
R-squared	0.15	0.21	0.25
		($N = 384{,}358$ Mean = 0.757)	
Doctorates	0.014**	0.014**	0.021***
	(0.006)	(0.006)	(0.006)
R-squared	0.11	0.16	0.20
		($N = 109{,}962$ Mean = 0.769)	
Year fixed effects	X	X	X
Field fixed effects	X	X	X
School fixed effects		X	X
Country fixed effects			X

Notes: See notes to Table 1 for the sample restrictions. Each cell is a separate regression that controls for demographics (age and gender) in addition to fixed effects specified on the table. Coefficients are for the binary variable of the OPT policy. Robust standard errors clustered at school-and-field level are reported in parenthesis. Sample size (N) and the mean of the dependent variable by level of study (calculated for all fields throughout the sample period) are provided at the bottom of each panel.
***Significant at 1%, **significant at 5%, *significant at 10%.

where i indexes individuals in the group of students from country c who completed postsecondary study in field f and school s at time t. $Y_{i_{fsct}}$ represents a dichotomous measure of initial stay in the United States after graduation. The key independent variable OPT_{ft} is a binary indicator of eligibility for the OPT extension after the extension takes effect.[14] Field fixed effects, δ_f, control for permanent differences across fields, such as the high prevalence of foreign workers in computer-related occupations. Time fixed effects, δ_t, associated with the timing of school completion control for the impact of events common across all fields, such as recessions. School fixed effects, δ_s, control for the possibility that graduates of some colleges might have consistently high or low stay rates, perhaps because of the colleges' quality or proximity to business areas. Country of origin fixed effects, δ_c, control the impact of permanent differences across countries, such as wage levels. $X_{i_{fsct}}$ denotes a vector of student i's demographic characteristics, which includes age at school completion and gender.

14. The policy took effect on April 8, 2008, whereas a few fields became eligible on May 11, 2011 and May 12, 2012. I count students of eligible fields who completed school in the 60 days before the policy took effect but who were holding student visa status by the policy announced as eligible for the OPT extension, because they could apply for OPT during this "grace" period.

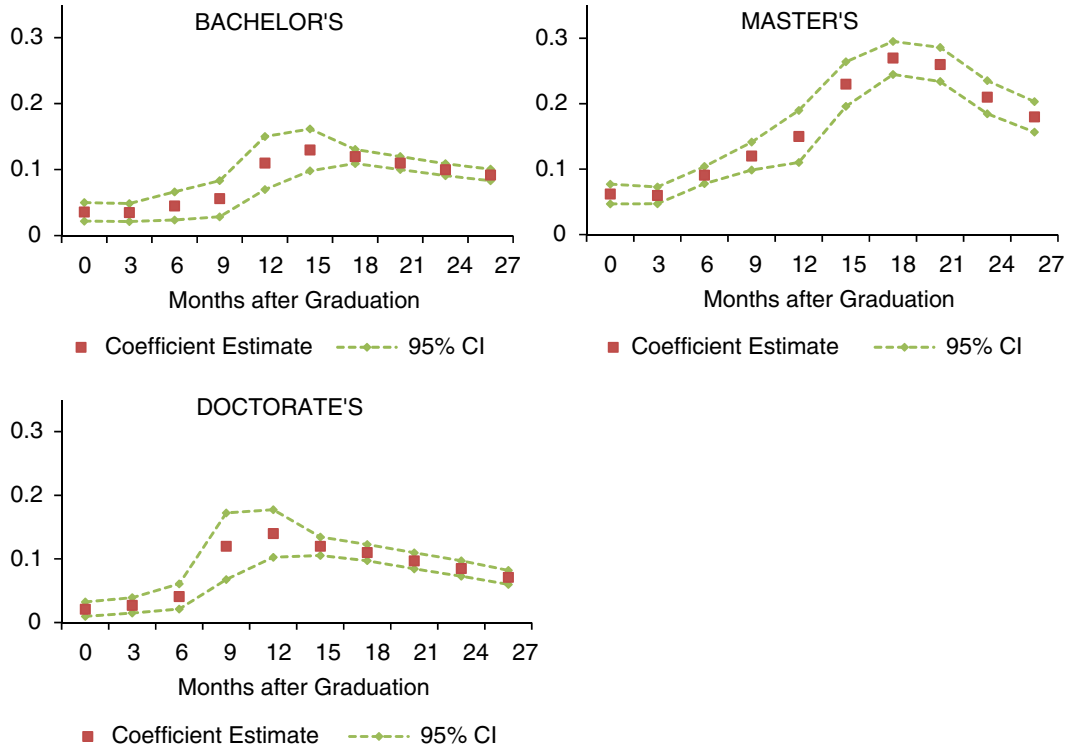
V. RESULTS

A. *Baseline Regression Results*

Table 3 presents the key regression results. Each cell reports the coefficient estimate for the variable OPT_{ft} along with the robust standard errors clustered at the school-and-field level. The coefficients in each column measure the marginal increase in the likelihood of initially staying in the United States after graduation for eligible STEM students once the OPT extension became available.

The estimates are positive and statistically significant for all specifications at each level of study. The baseline specification has only field and year fixed effects and results in slightly larger point estimates than does the nonparametric DD approach (Table 2). Adding school fixed effects and country of origin fixed effects has little effect on the point estimates. This finding is consistent with the observation that demographic characteristics of students do not differ noticeably before and after the policy within STEM and non-STEM fields (Table A3). The regressions with the full set of control variables in column 3 imply that the OPT extension increases the likelihood of initially staying in the United States for eligible STEM students by 3.6 percentage points at the bachelor's level, 6.2 points at the master's level, and 2.1 points at the doctorate level.

FIGURE 3
The Impact of OPT Extension on the Likelihood of Using Student Visas over the Course of the OPT Period



Notes: Each point is a coefficient estimate for the binary indicator of the OPT extension and comes from a separate regression in which the dependent variable is the likelihood of using student visas for 3 to 27 months after graduation (with 3-month increments). All regressions include year, field, school and country of origin fixed effects, and demographic characteristics (age and gender). The dashed lines represent the 95% confidence interval associated with each estimate.
Source: SEVIS data.

Comparing these percentage point estimates to the sample mean of initial stay rates of eligible STEM students in the prepolicy period, I find that the OPT extension increases the likelihood of staying by 5.2% at the bachelor's level, 7.1% at the master's level, and 2.4% at the doctorate level.

I also consider the effect of the OPT extension on the likelihood of using student visas over a range of postgraduation intervals from 3 to 27 months (with 3-month increments) in additional regressions. Figure 3 displays the coefficient estimates of the OPT dummy taken from regressions that are run on the sample of students in all fields with the full set of control variables. Students must have obtained their OPT to use their student visas in these postgraduation periods so that the estimated coefficients in these regressions capture the effect of the OPT extension on the likelihood of using OPT in the specified postgraduation period. In one extreme, if the OPT extension makes some eligible students initially stay in the United States, but if all these students transfer to other visas shortly after their graduation without using their OPT for three or more months, then the coefficient estimates in these regressions would be zero. However, the coefficient estimates for all months up to 27 are positive and statistically different than zero. This finding shows that the OPT extension does not only increase the likelihood of initially staying in the United States (as shown in the earlier regressions) but it also increases the likelihood of using OPT to be able to stay in the United States for a certain period after graduation.

Moreover, the coefficient estimates for the likelihood of using student visas for the months before 12 in the postgraduation period are considerably smaller than the estimates for the months beyond 12. For instance, the OPT extension increases eligible students' likelihood of using students visas during the first 12 months following their graduation by only 6 to 11 percentage points at the master's level, whereas it increases their likelihood of 18-month use of student visas after graduation by 27 percentage points (from virtually zero levels, as using student visas that long after graduation was not possible before the policy). The likelihood of 18-month use of student visas (i.e., a proxy for using the OPT extension) would increase by 100 percentage points if all eligible students stay initially and use their OPT extension fully. So, the estimated impact of 27 percentage points shows that not all but a non-negligible share of master's-level international students benefits from the OPT extension.

Lastly, the comparison of coefficient estimates for the months before 12 with those for the months beyond 12 allows us to identify the existence of two different groups of students that are affected from the policy. In particular, if the OPT extension affects only the group of students who would not stay in the United States in the absence of the OPT extension by making them to stay initially and if these students use their OPT extension fully, then the pattern in the coefficient estimates would be flat over all months over the course of the OPT period. However, the estimates for the months beyond 12 are larger. Thus, it can be inferred that the OPT extension affects also the group of students who would stay anyway by just extending their length of stay with student visas to the period beyond 12 months after graduation.

B. Robustness

The validity of the estimates depends on the assumption of parallel trends between the likelihood of initially staying for students who are eligible for the OPT extension and that for noneligible students. In the context of the OPT policy, a major concern is changing labor market conditions due to the Great Recession. To the degree that the recession affected labor demand in STEM fields less adversely, the estimated relative increase in eligible students' likelihood of staying might be driven by the recession. In addition, the recession might have affected the economy of home countries differently, and the variation in the severity of the recession across countries might confound the effect of the OPT policy. A related concern is that strong demand conditions might have arisen in STEM fields after 2008, and these conditions might have encouraged the STEM industry to lobby for the passage of the OPT extension, which makes the policy endogenous to labor demand conditions in the United States.[15] In this section, I show the robustness of the baseline results by presenting evidence from alternative estimation strategies to address concerns about the confounding role of labor demand-side factors. As another concern, students might have adjusted their graduation timing in response to the recession such that changes in their composition might drive the results. In Appendix, I provide robustness checks to address concerns about compositional changes and sample restriction criteria.[16]

In the first robustness check, I add new control variables to the baseline specification. I first add school-and-year fixed effects and country-and-year fixed effects to control for time-varying local and home-country conditions in the labor market. Next, I include some state- or field-specific variables to capture the severity of the recession across the United States and control for associated changes in labor demand conditions. In particular, I use state-specific monthly unemployment rates for the state the student attends college and for the month the student completes his or her studies.[17] I also construct a field-specific production variable, using the

15. Although the lobbying activities of the industry are well known in the literature (Kerr, Lincoln, and Mishra 2014), the institutional details suggest time-invariant firm preferences for hiring foreign STEM workers. In particular, the employment of foreign workers under the H-1B visa has been rationed every year since 2004 due to the H-1B cap, and field fixed effects should control for such preferences.

16. In the Appendix (Table A1), I show that the results are robust to the arrangement of the data by entry classes, excluding students who started their study after the OPT extension, excluding possible dropouts, and using a narrower set of fields as a control group.

17. Ruiz (2014) shows that 45% of international students work in the city where their university is located. To the extent that the students' field concentration varies across states, the unemployment rate would control differences in the likelihood of staying across fields due to the variation in local labor markets conditions. Figure S2 shows quite a bit variation across states in terms of the share of STEM students, yet there is no correlation between the share of STEM students and the increase in unemployment in the same area. Unfortunately, since the unemployment rates by college major are not available throughout the sample period, I cannot do the same analysis using a potentially more relevant measure of unemployment.

industry-specific aggregate production data and a cross-walk between field of study and industry choices.[18] For instance, if the recession affected the construction sector more adversely and architecture majors are more likely to find jobs in construction, then their prospects of staying in the United States would be more deteriorated and this field-specific production variable can capture such a mechanism. Last, I construct a measure of labor demand specific to foreign workers since the recession might impact demand for them differently than for native workers. In particular, I calculate the total number of new hires in each occupation and year from the publicly available database of the labor condition application (LCA) and use it as a measure of the demand for foreign workers, associating occupations with field of studies. However, because firms do not have to fill the position specified in an LCA petition, this measure of the labor demand might be a noisy measure of the actual demand. (See the Appendix for details of the construction of these variables.)

Table 4 reports the estimates of the OPT dummy after adding these variables to the regression analysis. Adding school-and-year fixed effects has little impact on the estimates but adding country-and-year fixed effects in addition to school-and-year fixed effects results in a decline in the impact of the OPT extension on the likelihood of initially staying in the United States after graduation, from 0.042 to 0.027 percentage points at the bachelor's level and from 0.058 to 0.032 points at the master's level. Adding other control variables described above has no bearing either on the estimated positive effect nor on its magnitude, and most of these control variables are themselves statistically significant determinants of the initial stay rate in an expected way. I also run the regression, including the interaction of the unemployment rate with the OPT extension dummy, to analyze how the effect of the OPT extension differs with local labor demand conditions. The interaction term is found to be negative and statistically significant only at the bachelor's level, but its magnitude is small (i.e., one standard deviation increase in the unemployment rate results in about a 0.9 percentage points decline in the effect of likelihood of staying).

As another robustness check, I estimate a triple difference regression in which students from countries with alternative work visas serve as an additional control group within eligible fields. Citizens of certain countries (Canada, Chile, Mexico, Singapore, and Australia) have access to less restrictive alternative visas in addition to H-1B visas due to existing trade treaty agreements. Therefore, the OPT extension would not affect the staying prospects of students from those countries as much as it affects students from nontreaty countries.[19] Estimates of this alternative strategy show that the OPT extension increases the likelihood of initially staying and the likelihood of using student visas for 18 months (as a proxy for using the OPT extension) for eligible STEM students from nontreaty countries compared to those for eligible STEM students from treaty countries (Panel A in Table 5). These positive results would not be obtained if unobserved labor demand conditions favoring eligible fields were the main factor behind the estimated relative increase in initial stay rates. I also estimate an alternative DD model, restricting the control group to students only in business fields. Because college graduates in highly paid majors are affected less from recessions (Altonji, Kahn, and Speer 2016), business majors might serve as a better control group satisfying the assumption of parallel trends with STEM fields. Nonetheless, I find that the OPT extension increases the likelihood of staying for eligible STEM students even when they are

18. In particular, I calculate this variable for a student who completed to study in field f in year t as

$$\text{Production}_{ft} = \sum_{n=1}^{N} GDP_{nt} \cdot \frac{E_{fn}}{Ef}$$

where GDP_{nt} denotes the gross domestic product in the industry n in year t, Efn denotes the total employment of natives and immigrants with degree in field f in industry n, and Ef is the total employment of degree holders of all fields in industry n. The GDP term on the right-hand side captures the performance of the industry n in year t, and the ratio captures the degree to which the students of field f are supposed to be affected from the performance of industry n. I obtain the annual industrial production data from the Bureau of Economic Analysis (BEA) and calculate the employment dependencies from the 2009 to 2013 ACS (Steven et al. 2010), using both native- and foreign-born workers. After I calculate the weighed sum of industrial production in each field, I demean and detrend its natural logarithm as a measure of the percentage deviation from the long-run average in each field. See the Appendix for a full list of industries used in the construction of this variable.

19. The governments of Canada (TN visas), Mexico (TN visas), Singapore (H-1B1 visas), Chile (H-1B1 visas), and Australia (E-3 visas) have special trade treaty agreements with the U.S. government such that their college-educated citizens can temporarily work in the United States without being subject to the H-1B cap. Kato and Sparber (2013), Shih (2016), and Amuedo-Dorantes and Furtado (2017) use the same identification strategy.

TABLE 4
Robustness, Controlling for Labor Market Conditions

	(1)	(2)	(3)	(4)
Bachelor's				
OPT extension	0.042***	0.027***	0.027***	0.059***
	(0.007)	(0.006)	(0.006)	(0.015)
Unemployment rate			0.096	0.15
			(0.13)	(0.14)
Field-specific GDP			0.34***	0.34***
			(0.10)	(0.10)
Demand for foreign labor			0.023***	0.022***
			(0.008)	(0.008)
OPT × Unemployment rate				−0.38**
				(0.18)
Master's				
OPT extension	0.058***	0.032***	0.038***	0.022**
	(0.009)	(0.006)	(0.006)	(0.011)
Unemployment rate			0.49***	0.43***
			(0.09)	(0.10)
Field-specific GDP			0.55***	0.55***
			(0.08)	(0.08)
Demand for foreign labor			0.0079	0.0082
			(0.0054)	(0.0055)
OPT × Unemployment rate				0.19
				(0.13)
Doctorates				
OPT extension	0.015**	0.014**	0.019***	0.015
	(0.006)	(0.006)	(0.006)	(0.014)
Unemployment rate			−0.32***	−0.34**
			(0.12)	(0.15)
Field-specific GDP			0.23**	0.23**
			(0.11)	(0.11)
Demand for foreign labor			−0.0064	−0.0064
			(0.0080)	(0.0080)
OPT × Unemployment rate				0.045
				(0.17)
School × Year fixed effects	X	X	X	X
Country × Year fixed effects		X	X	X

Notes: Each cell is a separate regression. Robust standard errors clustered at school-and-field level are reported in parenthesis. All regressions control for field fixed effects and demographics (age and gender). Labor market variables include the state-specific unemployment rate in the month of graduation and the state of the university attended, the field-specific GDP in the graduation year, and the measure of demand for foreign labor in the graduation year. One standard deviation is equal to 0.024 for the variable of unemployment rate, 0.029 for field-specific GDP, and 0.23 for demand for foreign labor.

***Significant at 1%, **significant at 5%, *significant at 10%.

compared to students in business fields (Panel B in Table 5).

C. Heterogeneity by Subgroups

By observing the full census of the international student population, I can explore heterogeneity in the responsiveness to extended OPT terms across subgroups of students. For that purpose, I initially run regressions by interacting the *OPT* variable with dummy variables for each subgroup of interest defined in terms of country of origin, type of the university attended, gender, and graduation age. I find heterogeneous effects across most subgroups at the bachelor's and master's level (as shown in Table A4). In particular, Indian students are found to be the most affected subgroup compared to those from other countries, and students from master's/comprehensive or baccalaureate colleges (i.e., institutions with research activities at lower intensity) are more affected than are students from top research universities. On the other hand, both genders are similarly affected from the OPT extension at the master's level, whereas males are affected more at the bachelor's level.

What might explain the heterogeneity across international students? As discussed before, the OPT extension is supposed to increase the likelihood of initially staying in the United States after graduation more for students who have larger benefits from sustaining a longer U.S.

TABLE 5
Robustness, Using Different Control Groups

	Bachelor's	Master's	Doctorates
Panel A: Triple difference estimates, using students from trade treaty countries			
Likelihood of initially staying	0.014	0.044***	0.016*
	(0.010)	(0.009)	(0.009)
18-month use of student visas after graduation	0.091***	0.13***	0.037***
	(0.010)	(0.007)	(0.005)
Panel B: DD estimates, using only business majors in the control group			
Likelihood of initially staying	0.032***	0.057***	0.0047
	(0.007)	(0.008)	(0.006)
18-month use of student visas after graduation	0.12***	0.26***	0.061***
	(0.006)	(0.017)	(0.006)

Notes: Each cell is a separate regression. Coefficients in Panel A are for the interaction of the binary indicator of the OPT policy with the binary variable indicating nontreaty countries of trade agreements. Canada, Mexico, Chile, Singapore, and Australia (after May 11, 2005) compose treaty countries. Regressions in this panel include field-year, school-year and country-year fixed effects, demographics (age and gender), and labor market controls introduced in Table 4. In Panel B, the control group is restricted to business majors. Reported coefficients are for the binary indicator of the OPT policy. Regressions in this panel include field, school-year and country-year fixed effects, demographics (age and gender), and labor market controls introduced in Table 4. Robust standard errors clustered at school-and-field level are reported in parenthesis in both panels.

***Significant at 1%, **significant at 5%, *significant at 10%.

employment and for students whose H-1B sponsorship decision requires a longer training or screening period. To test theses hypotheses, I estimate regressions, including the interaction term of the OPT variable with a proxy measure for potential benefits and for necessary training or screening. In particular, I use the GDP per capita of home countries to capture potential benefits. I assume that students from countries with a lower GDP per capita benefit more from staying longer in the United States due to the larger wage gap (Clemens 2013). I use the 25th percentile of SAT math scores of first-year students and the interquartile range of SAT math scores (i.e., the difference between the 75th and 25th percentile) in each institution as proxy variables for necessary screening or training. I assume that the sponsorship decision of students from less selective institutions and from institutions with a wider interquartile range of SAT scores requires a longer screening or training period.[20]

Table 6 presents coefficient estimates of the interaction terms. As displayed in the first column, the effect of the OPT extension on the likelihood of initially staying is found to be 0.21 and 0.18 percentage points larger respectively for bachelor's- and master's-level students who come from countries with a $1,000 lower GDP per capita (about one-seventeenth of the standard deviation of GDP per capita in the data). Since I assume lower GDP per capita means larger benefits from staying, finding a negative coefficient estimate for the interaction term of the GDP per capita is consistent with the explanation of the heterogeneity based on the variation in potential benefits.

The estimates in the second column of the table show that the effect of the OPT extension on the likelihood of initially staying in the United States is 0.13 and 0.17 percentage points larger for bachelor's- and master's-level students from institutions that admit students with 10 points lower SAT scores on average (about one-seventh of the standard deviation in the SAT scores in the data). This finding supports the other explanation of the heterogeneity that students whose sponsorship decision requires a longer screening or training period are affected more by the OPT extension (i.e., those who have credentials from less selective schools).

I also explore how the effects of the OPT extension change with respect to the uncertainty

20. I obtain the GDP data from the Penn World Trade tables (Feenstra, Inklaar, and Timmer 2015) and match it to observations in the SEVIS data using country of origin and year of school completion. During the sample period, the average GDP per capita was $17,956 and its standard deviation was $17,519. I obtain the SAT scores from the IPEDS Admissions and Test Scores modules. I use the average SAT-math scores over the 2004–2011 period as a measure of the quality, but the regression results are not sensitive when I use the other test scores, such as the 25th percentile of SAT-verbal scores and the 25th percentile of the ACT composite scores. The average of the 25th percentile SAT-math scores is 485 with the standard deviation of 71 across institutions. The average of the interquartile range (the difference between the 75th and 25 percentiles of the SAT-math scores) is 110 with the standard deviation of 20 in the sample.

TABLE 6
Impact of OPT Extension on the Likelihood of Initially Staying, Heterogeneity

	(1)	(2)	(3)	(4)
Bachelor's				
OPT	0.063***	0.14***	−0.060*	−0.075
	(0.012)	(0.035)	(0.032)	(0.063)
OPT × GDP per capita	−0.0021***	−0.0022***	−0.0023***	−0.0023***
	(0.00028)	(0.00030)	(0.00030)	(0.00031)
OPT × SAT Math Perc25		−0.0013*		0.0002
		(0.0007)		(0.0008)
OPT × SAT Math Diff 75−25			0.012***	0.012***
			(0.0026)	(0.0030)
Master's				
OPT	0.11***	0.20***	0.044***	0.16***
	(0.008)	(0.024)	(0.015)	(0.032)
OPT × GDP per capita	−0.0018***	−0.0015***	−0.0017***	−0.0015***
	(0.00033)	(0.00032)	(0.00033)	(0.00032)
OPT × SAT Math Perc25		−0.0017***		−0.0014***
		(0.0004)		(0.0004)
OPT × SAT Math Diff 75−25			0.0057***	0.0021*
			(0.0013)	(0.0012)

Notes: Each column in each panel is a separate regression. Coefficients are for the binary variable of the OPT policy and its interaction with the GDP per capita at home countries (denoted in $1,000), the 25th percentile of SAT math scores of admitted students in the institution attended (denoted in 10 points), and the difference between the 75th and 25th percentile of SAT math scores (denoted in 10 points). Robust standard errors clustered at school-and-field level are reported in parenthesis. Regressions include field, school-year and country-year fixed effects, demographics (age and gender), and labor market controls introduced in Table 4.

***Significant at 1%, **significant at 5%, *significant at 10%.

about students' ability to test the explanation based on the variation in necessary screening or training time. I use the interquartile range of SAT math scores in the institution attended as a proxy for the uncertainty about the ability of students graduating from that institution. Estimates show that the effect of the OPT extension on the likelihood of initially staying is 1.2 and 0.57 percentage points larger for bachelor's- and master's-level students graduating from institutions that admit students from a 10-point wider interquartile SAT range (about a half of the standard deviation of the interquartile range observed in the data). The initial stay rate is expected to increase as a result of the OPT extension especially for students whose ability is highly uncertain (i.e., those graduating from institutions with a wider interquartile range) because the extension allows employers to evaluate the ability of students for a longer period before offering H-1B visa sponsorship. The empirical estimates are consistent with this expectation, and the same result holds even after controlling for the quality of the attended college with the 25th percentile of SAT scores (as shown in the fourth column of Table 6).

D. Transition to Work Visas

In this section, I analyze whether the OPT extension affects international STEM students' likelihood of transition to work visas. To make this analysis, I use the NSCG—a nationally representative survey of college-educated people residing in the United States—because I do not observe visa status after the OPT period in the SEVIS data. In the NSCG data, I observe visa status and educational attainment, including the type of the current visa and entry visa as well as the level, year and field of each postsecondary degree attained, and the location of the institution awarding the degree. But the NSCG is a survey and collects information from a random sample of college graduates residing in the United States at the time of the survey, whereas the SEVIS data provide information for the full population of international students. Thus, the NSCG has small sample sizes for international students, and I cannot use it to make a regression analysis of long-term stay rates at a detailed level of field classification. Instead, I use it to compare some aggregate measures of staying between students in two broad field categories: STEM versus non-STEM.

To calculate aggregate statistics, I first restrict the NSCG data to foreign-born observations who entered the United States on student visas and graduated from a U.S. college or university between 2004 and 2007 in the 2010 wave of NSCG and those who graduated between 2009 and 2012 in the 2015 NSCG. These groups

TABLE 7
Transition to Work Visas, NSCG Data

	All Levels		Master's	
	2010	**2015**	**2010**	**2015**
The population of the international students residing in the United States in 3 to 6 years after their graduation				
Non-STEM	80,531	84,797	55,753	60,980
STEM	64,904	95,939	31,944	60,427
The population of work visa holders who have recently graduated from foreign universities				
Non-STEM	122,156	116,644	40,913	25,907
STEM	84,505	50,626	26,106	19,881
The stay rates for the international students				
Non-STEM (%)	32.1	28.9	44.8	40.9
STEM (%)	46.8	66.5	44.8	77.5
The share of the international students among all work visa holders				
Non-STEM (%)	5.1	5.6	3.5	4.0
STEM (%)	4.1	6.3	2.0	4.0
The average salary of the international students (in 2010 prices)				
Non-STEM	62.0	71.9	57.5	73.7
(St. Dev.)	(20.9)	(25.9)	(21.2)	(25.9)
STEM	76.4	79.5	78.0	83.6
(St. Dev.)	(21.9)	(23.4)	(17.2)	(20.2)

Notes: These statistics are based on the 2010 and 2015 NSCG data. The sample of international students includes immigrants who entered the United States via a student visa and graduated from a U.S. college or university between 2004 and 2007 in the 2010 NSCG and between 2009 and 2012 in the 2015 NSCG. Recently, graduated immigrants from foreign universities include those who graduated after 2004 in the 2010 NSCG and after 2009 in the 2015 NSCG. The population statistics are calculated by using person weights provided in the NSCG data. The stay rate shows the percentage of international students who obtained a work visa and reside in the United States at the time of the survey for each graduation cohort of interest. In the calculation of this stay rate, the population of all international students in each graduation cohort is obtained from the SEVIS data.

of immigrants correspond to the cohorts of international students observed in the SEVIS data.[21] Since I allow at least 3 years to have passed after the graduation in each wave of the NSCG, students in the selected graduation cohorts must have completed their OPT and transferred to another visa status by the survey time. Only those with STEM degrees in the 2015 wave were eligible for the OPT extension in the sample.

I present the population of recently graduated international students who were still staying in the United States by the time of the NSCG survey in the top panel of Table 7, calculating the population statistics as the sum of person weights provided by the NSCG data. A total of 64,904 international STEM students from the 2004 to 2007 graduation cohorts transferred to a work visa as of 2010, whereas 95,939 international STEM students from the 2009 to 2012 graduation cohorts did so as of 2015. On the other hand, the population of those in non-STEM fields who transferred to a work visa remained almost the same in that period. This different pattern between STEM and non-STEM students indicates the role of the OPT extension on their likelihood of transition to work visas. Moreover, as displayed at the right panel of the table, the population of students that transferred to a work visa with a STEM master's degree increased considerably, which is consistent with my earlier findings on the likelihood of initially staying.

The next row in the table shows the population of work-visa holders who are in the same graduation cohorts but graduated from a non-U.S. university. The population of this group of immigrants with STEM degrees decreased from 2010 to 2015 (with most of the decline observed at the bachelor's level) in contrast to the increasing population of their foreign peers with STEM degrees obtained from U.S. universities. Since these two groups of immigrants are likely to be subject to the same labor demand conditions, differential patterns in their population with respect to where they earned their degrees might be attributed to the OPT extension.

21. In total, the 2010 NSCG includes 77,188 observations and the 2015 NSCG includes 91,000 observations. After I restrict the sample of observations to international students of the 2004–2007 graduation cohorts in the 2010 NSCG and the 2009–2012 graduation cohorts in the 2015 NSCG, the number of observations drops to 388 and 942 in each wave, respectively.

To convert the population statistics to stay rates, I divide the population of stayers in each cohort to the population of all international students in that cohort, including even those who did not initially stay in the United States (as taken from the SEVIS data). As shown in the third row, the 3- to 6-year stay rate after graduation for international students in STEM fields increased from 46% in 2010 to 66% in 2015, whereas that of non-STEM students even slightly declined from 32% to 29%. The increase in the stay rate is specifically noteworthy for master's-level STEM students. Of those, 44% of the 2004–2007 graduation cohorts stayed in the United States as of 2010, whereas 77% of the 2009–2012 cohorts stayed as of 2015. As discussed before, the initial stay rates for master's-level students were about 90% for both graduation cohorts (Table 2). The NSCG data reveal that most master's-level students in eligible STEM fields were able to transfer to a work visa after the OPT extension (77% out of 90%), whereas only about a half of them were able to do so before then (44% out of 90%).

I also find that the percentage share of international STEM students among all work-visa holders increased, from 4.1% in 2010 to 6.3% in 2015. This shift in the composition of work-visa holders can be considered as an improvement in the selection of immigrants because the earlier literature shows that immigrants who obtain a postsecondary degree in the United States earn more and contribute more to innovation activities than other immigrants (Bound et al. 2015a; Hunt 2011).

Finally, I compare the average annual real earnings of international students who stayed in the United States 3 to 6 years after their graduation to assess whether and how their productivity changed over time. I find that the average real earnings of stayers in both STEM and non-STEM fields increased over time, with a smaller increase observed for those in STEM fields. However, I do not find a statistically significant change associated with the OPT extension in the regression of the natural logarithm of earnings on a dummy variable denoting eligibility for the OPT extension (controlling for potential experience, level of study, gender, and field- and year-fixed effects as well). In sum, the analysis in this section provides some evidence that the OPT extension increased STEM students' likelihood of transition to work visas, without resulting in a decrease in the productivity of those who made that transition.

VI. CONCLUSION

In recent years, the postgraduation placement choices of international students have become a matter of global interest because the number of international students has increased rapidly in major destination countries. For instance, U.S. policymakers discuss giving international STEM graduates of their universities priority in permanent visa applications in the hope that they will stay in the United States and boost innovation activities. Some provinces in Canada have already granted priority to graduates of Canadian universities under Provincial Nominee Programs (Baglay 2012). This study shows that work permissions tied to student visas can be used effectively to increase international STEM students' likelihood of staying initially in the host country and their transition to work visas, even without changing the total number of available work visas. Since immigrants who obtain a degree in the host country are more productive in the labor market and those in STEM fields also contribute to innovation activities, these findings can be interpreted as an improvement in the selection of immigrants.

In the end, this study offers a starting point in analyzing the role of visa policies in international students' transition to the host country's labor market. The study emphasizes the effects on the likelihood of initially staying after graduation for students who were already in the host country at the time when visa policies extended the length of work permission via student visas. Such policies might change international students' university enrollment patterns, and these adjustments might have further effects on domestic peers. I hope that future work continues to discern how behavioral changes induced by modifications in work permission programs on student visas affect other relevant outcomes of international and domestic students.

APPENDIX A: CODES FOR FIELD OF STUDY

The field of study in the SEVIS data is reported with the Classification of Instructional Programs (CIP) codes. This coding scheme was developed by the National Center for Education Statistics to maintain education statistics consistently across federal agencies. Since the designation of eligibility for the OPT extension is also reported with the CIP codes, I identify eligible fields in this analysis without using any approximation.

While the two-digit CIP series (with 48 groups) represent the most general groupings of related programs and the four-digit CIP series (with 420 groups) at the intermediate level, the six-digit CIP series (with about 1,730 groups) represent

specific instructional programs. Although the designation for the eligibility was made with the six-digit CIP codes and they seem ideal to capture field-specific effects, there were only a few or even no foreign students in some fields. Thus, I collapse the six-digit CIP series into 185 fields. In doing so, I ensure that every field within the same aggregated category has the same eligibility status and follows a similar growth trend and that the aggregate category contains a sizable number of observations. The crosswalk from the six-digit CIP series into my aggregation, along with the OPT eligibility status of each field, is available upon request from the author.

APPENDIX B: CONSTRUCTION OF VARIABLES FOR LABOR MARKET CONDITIONS

I use unemployment rates from the Bureau of Labor Statistics (BLS) as a measure of local economic activity. To construct the field-specific production variable, I employ the annual industrial production records from the Bureau of Economic Analysis (BEA). The data are provided with the following 19 industry groups: agriculture, forestry, fishing, and hunting; mining; utilities; construction; manufacturing; wholesale trade; retail trade; transportation and warehousing; information; finance and insurance; real estate and rental and leasing; professional and technical services; management of companies and enterprises; administrative and waste services; educational services; health care and social assistance; arts, entertainment, and recreation; accommodation and food services; and other services except government.

I create a field-specific production measure as the weighed sum of industrial production where the weights are the employment dependency of each major on industries. The employment dependencies are calculated based on the 2009–2013 American Community Survey (ACS) data. The ACS reports the field of study with its own classification. These are about 200 codes which are different from the CIP codes. I further collapse fields into 44 categories to merge with the SEVIS data because the sample sizes otherwise were fairly small and subject to measurement error in case they are used at the most detailed level. To address concerns over an endogenous change in the industrial composition, I use total employment of individuals (both natives and immigrants) aged between 35 and 50, a group whose labor market performance is likely not to be affected by the OPT extension. Once the field-specific production is obtained, I demean and detrend the natural logarithm of this variable to convert it to a measure of the percentage deviation from the long-run average in each field.

To measure the labor demand for foreign workers, I employ the U.S. Department of Labor LCA database, which provides the occupation of each foreign hiring under the H-1B status. I create a national-level control variable for foreign labor demand out of this dataset. I aggregate applications by occupation at the national level. I use the following 10 aggregate occupations: architects, teachers and professors, computer scientists, engineers, physical scientists, biological scientists, social scientists, health occupations, managerial occupations, and all other occupations. Once the total number of applications by year and occupation is obtained, I demean the natural logarithm of this variable to convert it to a measure of the percentage deviation from the long-run average in each field.

APPENDIX C: ROBUSTNESS TO SAMPLE RESTRICTIONS

Table A1 presents the robustness of results to a number of alternative sample restrictions. The first row displays the benchmark regression results taken from Table 3 for comparison reasons. The second row provides estimates by treating students who terminated student visas within 60 days after school end date as leaving the United States rather than initially staying. The third row provides estimates by including those who adjusted their visa status before the school completion date and treating them as initially staying in the United States. The fourth row addresses concerns over endogenous time to degree and right censoring due to the sample restrictions by graduation classes. I arrange the data by entry class and restrict the sample by the duration of program completion. More specifically, I restrict the bachelor's sample to students from the 2000 to 2007 entry class who completed study in 6 years, the master's sample to those from the 2002 to 2010 class who completed study in 3 years, and the doctorate sample to those from the 1999 to 2006 class who completed study in 6 years. The fifth row drops those who finished a bachelor's or doctoral program in less than 2 years and a master's program in less than 180 days from the sample because those might be the possible dropouts from the school without earning a degree. The sixth row excludes those who started school after the policy announcement, allowing a one-year application delay to address concerns about the compositional changes of new students, as those students might have larger intention to initially stay in the United States after graduation. Namely, I exclude those who started in the 2010 academic year and later in the sixth row. Finally, the seventh row addresses the concern over the control group's selection. I restrict the sample to science, engineering, and health-related fields in line with the NSF's sampling frame for their science and engineering statistics.

TABLE A1
Robustness, Alternative Sample Restrictions

Level of Study	Bachelor's	Master's	Doctorates
Baseline results in Table 3	0.036***	0.062***	0.021***
	(0.007)	(0.008)	(0.006)
Treating those who terminate student visas within 60 days after school end date as leaving the United States	0.030***	0.058***	0.021***
	(0.007)	(0.008)	(0.006)
Including whose visa status update date earlier than school end date	0.014**	0.060***	0.009
	(0.007)	(0.008)	(0.006)
Restrictions by entry class	0.022***	0.057***	0.015**
	(0.008)	(0.008)	(0.007)
Excluding possible "drop-outs" from the sample	0.035***	0.064***	0.019***
	(0.007)	(0.007)	(0.005)
Excluding those started school after the policy	0.030***	0.055***	0.016***
	(0.007)	(0.008)	(0.006)
Restricting the sample to science, engineering, and health fields	0.034***	0.048***	0.016**
	(0.009)	(0.009)	(0.008)

Notes: Each cell is a separate regression. Coefficients are for the binary variable of the OPT policy. Robust standard errors clustered at school and field level are reported in parenthesis. Regressions control for year, field, school, and county fixed effects, and demographics (age and gender). See notes to Table 1 for the sample restrictions.
***Significant at 1%, **significant at 5%, *significant at 10%.

TABLE A2
The Initial Stay Rate of International Students, by Subgroups

	Bachelor's		Master's		Doctorates	
By Country (or Region) of Origin	***N***	**Stay Rate**	***N***	**Stay Rate**	***N***	**Stay Rate**
China	8,336	67	47,205	84	30,588	90
India	11,276	79	119,596	94	15,234	90
South Korea	24,360	60	24,258	63	13,179	71
Taiwan	6,576	68	29,214	71	5,554	68
Turkey	4,078	61	6,177	73	3,011	74
Western Europe	22,754	49	19,879	59	4,828	62
Rest of Europe	16,092	67	17,887	69	8,262	73
Canada	20,414	44	24,537	35	6,601	50
Mexico	6,246	61	6,091	58	1,147	60
All other countries	113,219	67	89,514	70	21,558	70
	Bachelor's		**Master's**		**Doctorates**	
By Field of Study	***N***	**Stay Rate**	***N***	**Stay Rate**	***N***	**Stay Rate**
Computer Sciences	12,769	74	47,374	91	5,396	85
Engineering	22,647	64	81,773	89	29,563	87
Physical Sciences/Mathematics	5,812	61	9,906	81	19,791	84
Biological/Medical Sciences	15,994	64	19,388	73	21,039	79
Social Sciences	21,258	62	11,945	66	6,873	60
Business	76,136	67	116,362	72	3,542	69
Education	6,519	44	23,770	41	3,521	58
Psychology	6,229	61	3,125	67	2,015	67
Arts	17,325	72	11,944	75	1,888	61
All other fields	48,662	53	58,771	69	16,334	61

Notes: The statistics are based on SEVIS data. Stay rate statistics display the percentage of international students who initially stayed in the United States in each subgroup of interest. The Western Europe countries include Belgium, Denmark, Finland, France, Germany, Netherlands, Norway, Sweden, Switzerland, and United Kingdom.

TABLE A3
Demographic Characteristics, SEVIS Data

	Eligible		Noneligible	
	Before	**After**	**Before**	**After**
Bachelor's				
% Female	31.9	31.2	55.0	55.1
Mean age at graduation	24.0	23.6	24.3	23.8
% China	2.6	4.3	2.4	5.0
% India	8.8	10.6	3.7	3.3
% South Korea	6.8	11.3	8.9	13.1
% Computer Sciences	31.1	25.3	—	—
% Engineering	38.7	46.3	—	—
% Natural Sciences	17.0	26.5	—	—
% Management	—	—	41.5	39.7
% Social Sciences	—	—	10.9	12.6
Master's				
% Female	28.9	28.7	50.5	52.5
Mean age at graduation	26.2	25.3	29.2	28.7
% China	10.4	12.5	9.5	16.0
% India	57.1	64.0	12.3	13.9
% South Korea	3.2	2.3	8.6	8.4
% Computer Sciences	34.0	36.8	—	—
% Engineering	52.6	55.4	—	—
% Natural Sciences	6.4	7.1	—	—
% Management	—	—	46.8	48.4
% Social Sciences	—	—	5.1	4.9
Doctorates				
% Female	28.0	28.7	47.3	50.5
Mean age at graduation	31.0	30.8	33.1	33.2
% China	37.8	33.6	15.9	13.9
% India	15.9	19.2	7.6	8.9
% South Korea	10.4	9.6	14.7	15.6
% Computer Sciences	14.3	15.4	—	—
% Engineering	41.8	43.7	—	—
% Natural Sciences	36.2	40.9	—	—
% Management	—	—	8.7	7.0
% Social Sciences	—	—	16.3	16.2

Notes: Statistics are reported for two time periods, differentiating students by the level of their study and eligibility status of their field for the OPT extension. The "After" period refers to statistics for students who completed their studies after the OPT extension took effect.

TABLE A4
The Impact of OPT Extension on the Likelihood of Initially Staying, Heterogeneity by Subgroups

	Bachelor's	**Master's**	**Doctorates**
By country of origin			
China	0.060***	0.15***	0.16***
	(0.021)	(0.010)	(0.013)
India	0.093***	0.079***	0.085***
	(0.018)	(0.006)	(0.011)
Europe	0.051***	−0.0036	0.13***
	(0.018)	(0.015)	(0.015)
Other	0.0016	0.059***	0.12***
	(0.011)	(0.008)	(0.012)
By university type			
Research	0.013	0.075***	0.12***
	(0.012)	(0.007)	(0.011)
Master's/ comprehensive	0.015	0.091***	0.10***
	(0.012)	(0.007)	(0.020)
Baccalaureate and other	0.024**	0.088***	0.14***
	(0.012)	(0.007)	(0.012)
By gender			
Female	0.0048	0.075***	0.12***
	(0.012)	(0.007)	(0.011)
Male	0.023**	0.091***	0.13***
	(0.011)	(0.007)	(0.012)
By graduation age			
Below the median age	0.015	0.075***	0.11***
	(0.011)	(0.006)	(0.011)
Above the median age	0.014	0.096***	0.13***
	(0.012)	(0.007)	(0.012)

Notes: Each column in each panel is a separate regression. Coefficients are for the interaction of the binary variable of the OPT policy with the binary variable of the subgroup of interest. Robust standard errors clustered at school-and-field level are reported in parenthesis. Regressions include field, school-year and country-year fixed effects, demographic characteristics (age and gender), and labor market controls introduced in Table 4. University types are categorized based on the Carnegie classification.

***Significant at 1%, **significant at 5%, *significant at 10%.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Figure S1. TRENDS in Degrees Conferred to International Students, by Field and Level

Figure S2. The Labor Market Conditions, STEM vs. Non-STEM Fields

Table S1. The Date When the H-1B Visa Cap Was Reached