A GENDERED ANALYSIS OF THE ROLE OF US STUDENT VISA POLICY

by

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Abstract

In this paper I estimate the gendered responses to a US student visa policy, the 17-month extension of Optional Practical Training (OPT) program for foreign students in Science, Technology, Engineering and Mathematics (STEM) fields. This policy allows longer terms of stay in the US for foreign STEM students and thus becomes an important pathway to gain access to US labor market. Using an individual-level census data of foreign students, I model the differences in males and females' immigration responses to OPT extension[1]. I find that females are inherently more likely to stay in the US but OPT extension favors males, possibly due to their preferences to STEM majors compared to females. I then use another "push" factor, the ratio of women's rights in the US over in origin countries (the women's rights gap), to explain females' immigration decisions. The model predicts a nonlinear relationship between women's rights gap and females' responses to OPT extension. More specifically, if the females' origin countries have very low level of women's rights, decreases in the rights gap, or increases in women's rights, will increase their possibility to stay in the US. However, if women in origin countries enjoy relatively high status, increases in the rights gap will make females more likely to stay in the US.

[1] The policy will be referred to as STEM OPT extension or OPT extension in the following passages.

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I. Introduction

High-skilled females have played an increasingly significant role in global immigration flow, having exceeded the emigration rate of high-skilled male by 17% (Docquier, Lowell and Marfouk, 2009). Especially in developing countries where women have limited access to tertiary education and labor market, there is disproportionate high-skilled female emigration. The loss of high-skilled females can result in negative impacts on developing economies. For example, Dumont, Martin and Spievogel demonstrate high-skilled female emigration leads to higher infant mortality and under-5 mortality as well as lower secondary school enrollment rate of female compared to male students. Thus, the previously overlooked gender aspect of brain drain has started to catch more attention in immigration studies. As Africa and Asia experienced the largest growth of high-skilled female emigration, the potential role of gender inequalities and labor market challenges in origin countries as "push factors" of female emigration is worth further exploration. (Kerr et al., 2016) In my research, I will use a US immigration policy as a natural experiment to see how female and male students respond differently depending on their origin country backgrounds.

Foreign students under F-1 visa who pursue Bachelor, Master or PhD degrees are entitled to enter the US labor market for a 12-month period after degree attainment. This is referred to as the Optional Practical Training (OPT) program, which offers students an opportunity to work in the US without changing their visa status. The transition to H-1B work visa is required if the immigrant wants to pursue longer term employment. However, the number of H-1B visas is subject to a restrictive cap at 65,000 per year, which can no longer satisfy the huge amount of applicants. Thus OPT program provides an increasingly important pathway for foreign students to gain access to

the US labor market. (Bound et al., 2015) In 2008, there was an important policy change regarding the OPT program. The U.S. government extended the OPT term from 12 to 29 months for graduates of most Science, Technology, Engineering and Mathematics (STEM) fields. STEM OPT extension significantly increases the appeal of STEM fields to foreign students and research has shown that indeed not only more foreign students choose STEM majors, but they tend to stay in the US longer following the change. (Amuedo-Dorantes, Furtado and Xu, 2019; Demirci, 2019) In my research, I will analyze foreign students' immigration responses to STEM OPT extension from a gendered perspective and understand how push factors of female emigration in origin countries can lead to differential outcomes by gender.

Murat Demirci's 2019 study shows that STEM OPT extension increases foreign students' initial stay rate as well as length of employment. The result is most significant at the master's level, indicating a 6.2 percentage point increase in the likelihood of staying and a 153-day extension in employment spells. In this paper, I will include the data source used by Murat Demirci, which is administrative data from the Student and Exchange Visitor Information System (SEVIS) obtained through a Freedom of Information Act (FOIA) request. (Demirci, 2019) This data set provides individual foreign student's education record, status change after graduation and demographic information such as gender and origin country. I will evaluate students' stay rate and length of stay in the US in relation to their eligibility to OPT extension. In addition, to measure the push factor regarding women's social and economic status in origin countries, I will use the women's rights indices from Cingranelli-Richards (CIRI) Human Rights Data Project (Nejad and Young, 2012) and combine it with the SEVIS data set to form the basis of my core analysis. Specifically, I will

create a measurement of women's rights gap between origin countries and the United States to assess the intensity of the push factor. (Nejad and Young, 2012)

I will perform two estimation models. The first one measures the differential immigration responses of male and female foreign students to OPT extension. The second one looks into how two important factors, women's rights gap and OPT extension eligibility, influence females' immigration responses. I find that females[2] are inherently more likely to stay in the US after graduation; however, their greater tendency to stay is partially offset by males' more positive response to OPT extension. Both women's rights gap and OPT extension eligibility have a significant impact on females' immigration decision. In particular, I estimate a statistically significant non-linear relationship between the women's rights gap and females' tendency to stay in the US. Women's rights gap has a more significant impact on females' initial likelihood to stay, while OPT extension eligibility plays a more critical role in whether females stay for the longer term.

The paper is structured as follows. In Section II, I will provide a brief overview of the current literature as well as research background. Section III will be devoted to description of the data and methods of measurement as well as the empirical methodology. Section IV presents the estimation results with interpretations, followed by robustness checks in Section V. Section VI concludes.

[2] I will use "females/women" as short for "female foreign students" in the following passages, similarly for males/men.

II. Research Background and Literature Review

A. Optional Practical Training (OPT) Program and Outcomes of the OPT Extension

The core framework for immigration studies was developed by John Hicks (1932), which indicates that differences in wages are the main reason for immigration. (Kerr et al., 2016) In other words, the ability to access developed markets can be a main driver for emigration from developing countries. In the US, the most popular employment-based work visa is H-1B visa. However, the number of H-1B visas has been subject to a restrictive cap at 65,000 each year. The number of applications has exceeded the cap each year since 2004. Although Congress introduced an extra 20,000 H-1B visas per year in 2005 for graduate students from U.S. universities and colleges, this extended cap has been binding each year since its inception. (Demirci, 2019) Due to the limited access to the US labor market through H-1B work visa, gaining higher education degrees from US institutions has started to become a more important pathway to access the US labor market. (Bound et al., 2015) For foreign students studying in US institutions using F visas, they are able to work in the US after graduation through the OPT program.

F visa is the most popular student visa used by foreign students to enroll in US institutions. Foreign students pursuing Bachelor, Master and PhD degrees using F visas are eligible to work in the US for 12 months after graduation. This period is granted by the Optional Practical Training (OPT) program. During the OPT program, the employers can sponsor the immigrants for applications of H-1B work visas if they want to pursue a longer term of employment. In order words, OPT program serves as a smooth transition from being a foreign student to the US labor market. In 2008, the U.S. government extended the OPT term from 12 to 29 months for graduates of most STEM

fields. As a result, foreign students with STEM degrees such as 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. This policy change definitely makes STEM majors more appealing to foreign students who want to enter the US labor market from graduation.

Research on the consequences of OPT extension has been limited so far. A 2018 study by Amuedo-Dorantes, Furtado and Xu indicate that OPT extension indeed drives more foreign students to major in STEM fields. Using data from the 2003 through 2015 National Survey of College Graduates, they find that foreign-born students who first came to the United States on student visas became 18 percent more likely to major in STEM following the OPT policy change. The result is most significant at the Master's level, where the likelihood of choosing a STEM field rose by 33 percent. A second major in STEM fields is more popular as well as pursuing a Master's degree in STEM fields with a non-STEM Bachelor's major. The study by Demirci in 2019 shows that being eligible for OPT extension will increase foreign students' likelihood of staying in the US after graduation as well as their length of employment. The result at Master's level is again most significant with 6.2 points increase in initial stay rate and 153 days longer employment spell on student visa. (Demirci, 2019) In particular, being eligible for OPT extension not only drives more students to stay initially after graduation, but also extends the length of stay for those students who originally intend to stay. These two results thus indicate that OPT extension has a significant impact on foreign students' choice of majors and decision to stay in the US.

B. Female Brain Drain

There are limited literatures dedicated to understand the causes and effects of female brain drain due to high skilled female emigration. Researchers have pointed out significant trends in high skilled female migration. Docquier, Lowell and Marfouk (2009) build an extension dataset based on information relating to 195 countries to improve understanding of the role of women in highly skilled international migration. They find that the share of women in the highly skilled emigration population increased in almost all OECD destination countries between 1990 and 2000. This trend is also reflected in the study by Dumont, Martin and Spievogel (2007) using the OECD international migration database. In fact, high skilled migration is now gender balanced, if not skewed towards females. Considering female's disadvantages in tertiary education in many less developed countries, this suggests that high skilled women must migrate at a much higher rate than high skilled men. Docquier, Lowell and Marfouk (2009) indeed show that on average, women's highly skilled emigration rate is 17 percent above men's.

High skilled female emigration can result in negative impacts on the economies of less developed countries. Many studies demonstrate that women's education is positively associated with investments in children's education and thus has pronounced effects on the human capital of future generations (Docquier, Lowell and Marfouk 2009; World Bank 2007). Mothers with higher levels of education will provide better guidance to their children and are willing to dedicate more resources to the children's growth and development. Dumont, Martin and Spievogel (2007) demonstrates that high skilled female emigration is closely related to higher infant mortality and under-5 mortality rates as well as lower female secondary enrollment rates compared to that of male. Thus, losing high skilled females in migration can be potentially very harmful to the less

developed economies, which will experience slower growth and reduced incomes. It is thus crucial to understand the drivers for high skilled female emigration. Given that female emigrants may respond differently to push factors from male emigrants, further studies are devoted to understand what drives high skilled females to migrate.

Docquier, Lohest and Marfouk (2009) demonstrate that the overall emigration rate in origin countries increases with country smallness, natives' human capital, political instability, colonial links, and geographic proximity to major OECD countries. A follow-up study by Docquier et al. (2012) find that women and men do not respond in the same way to traditional push factors. For example, female emigration increases with an origin country's average human capital level, while male brain drain decreases. This discrepancy reflects some kind of gender discrimination related to the labor market of the origin countries. Females face greater difficulties in finding a good job in their origin countries even with higher education, which results in higher emigration rate for high skilled females than males. Dumont, Martin and Spievogel (2007) also find that less developed origin countries face greater high skilled female emigration rates, pointing to economic conditions in the origin countries as a potential push factor for high skilled female emigration. Since females and males respond differently to characteristics of origin countries, more research tends to focus on gender inequality in evaluating the push factors.

The measurement of gender inequality is a key point in research. Baudassé and Baziller (2014) focus on measuring gender inequality in education and the labor market and use principal component analysis (PCA) on multiple variables, such as the tertiary education ratio, the labor force participation for women and the income ratio of males vs. females, to build the indices for

gender inequality. They propose two hypotheses for the effect of gender equality: (i) gender inequality is a push factor for female emigration due to the low opportunity cost for women; and (ii) gender prejudice creates a selection process which favors male emigration instead of female. The two hypotheses predict opposite outcomes of the effect of gender equality on female emigration. The authors find that improving gender equality will increase high skilled female emigration but decrease low skilled male emigration, which validates the selection process hypothesis instead of the push factor hypothesis. They also demonstrate that a reduction in gender bias increases the general skill level of migrants.

However, Nejad and Young's (2012) findings suggest a different story. They build a model on how women´s rights affect the costs and benefits of female migration decisions relative to those of males and derives a non-linear relationship between gender inequality and relative female migration rates. In addition, since both papers measure migration flow using dataset from Docquier et al. (2009), the difference in their results can also be attributed to the measurement of gender inequality. Nejad and Young criticize Baudassé and Baziller's (2014) choice of variables because these variables can be interpreted as outcomes rather than institutional opportunities for high skilled females. Instead, they utilize CIRI women's rights indices to define women's rights gap between destination and origin countries and estimate the impact of gender inequality on female brain drain ratio. The women's rights gap is broken down into three components: economic, political and social rights gaps. Using a cross section of over 3,000 bilateral migration flows across OECD and non-OECD countries, Nejad and Young (2012) find a nonlinear relationship between the women's rights gap and the gender gap in high-skilled migration flows. On the one hand, when the rights gap is low, or the origin countries have high levels of women's rights, the relationship between women's rights gap and female brain drain is positive. As women's rights gap increases,

more females tend to leave the origin countries and migrate to another destination country. On the other hand, when starting from high values of the rights gap, or origin countries have really low women's rights, decreases in the gap can be associated with increases in the female brain drain ratio. In other words, improving gender equality gives women more opportunities to migrate to other countries. This part of the story corresponds to Baudassé and Baziller's results.

Nejad and Young's results complete the story on both push factor and selection process hypotheses as proposed by Baudassé and Baziller. In my research, I plan to follow Nejad and Young's approach and use the women's rights gap from CIRI Women's Rights indices to measure gender inequality in origin countries. Alternatively I will use the Women's Economic Rights as a robustness check on my methodology since the attractiveness of employment opportunities provided by OPT extension is likely to depend on females' economic rights in their home countries. My research will serve as another testament on the effect of gender inequality in a specific case of foreign students' responses to US student visa policy.

III. Data

There are two major components in my data set. The first one comprises individual level information of foreign students who graduate from a US institution. It is obtained through a FOIA request from the Student and Exchange Visitor Information System (SEVIS) and used by Demirci (2019) in his study[3]. The data set is a census of over 1 million F-visa students who have graduated and updated whether they continue to stay in the US using OPT between January 1, 2004, and June 26, 2014. There are roughly 54% of male and 46% of female foreign students who come from 246 different origin countries. On average, male students tend to major in STEM fields more than female students on all degree levels. The second data set comes from Cingranelli-Richards (CIRI) Human Rights Data Project[4], which contains standards-based quantitative measurement for 15 internationally recognized human rights for 202 countries, annually from 1981-2011. The indicators of interest in this study are the three women's rights indices: Women's Social Rights, Women's Economic Rights, and Women's Political Rights. I combine these two data sets by country and year to generate my master data.

I made some adjustments on the SEVIS data similar to what Demirci did. First of all, I restrict the sample to students who completed study 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. In addition, since I am interested in the use of student visa after graduation, I exclude those who adjusted their visa status before completing their schooling (about 5 percent). There are two major outcomes from the SEVIS data that I am interested in studying—stay rate and length of stay

[3] I am very grateful to Murat Demirci for making this data available.
[4] This data set can be accessed from http://www.humanrightsdata.com/p/data-documentation.html

under OPT. I measure whether the individual stay in the US given certain period of time using when the status update occurs after school ends. Status update means that the student stops using student visa at that date, either continuing to stay using another visa status or having left the US. For example, if the status update happens 180 days after school ends, then the student must have stayed 6 months in the US using student visa after graduation. Stay rate is a dummy variable of 1 if the student stays and 0 otherwise. I calculate stay rate at 6 months intervals starting from right after graduation until the upper limit of 29 months provided by OPT extension. Similarly, length of stay can be found through the difference between status update and school end dates, given that school end date is before status update. One thing to note is that there is a 60-day grace period after graduation before which foreign students need to make a decision on whether to continue staying using OPT. If they haven't applied for OPT before the grace period, the default state is that their student visas expire at the 60-day deadline. Thus, if the status update time is at exactly 60 days after college completion, the student most likely leaves the United States without using OPT to enter the job market.

I then calculate the women's rights gap between the US and origin countries using the three women's rights indices from Cingranelli-Richards (CIRI) Human Rights Data Project (Nejad and Young, 2012). This variable serves as a testament for one of the widely proposed push factors of females' emigration, using females' response to OPT extension as the outcomes. According to Nejad and Young's results, I can expect a nonlinear relationship between women's rights gap and their willingness to stay.

Women's Economic Rights index takes into account a number of criteria, including (i) the right to get and choose a job without a husband or male relative's consent; (ii) non-discrimination by employers and equalities in workplace hiring, pay, promotion, and job securities; (iii) lawful protection from sexual harassment in the workplace; and (iv) the rights to work at night, in dangerous conditions, and in military and police forces. (Nejad and Young, 2014) Women's Political Rights include the right to vote, to run for political office, to hold elected and appointed government positions, to join political parties, and to petition government officials. Women's Social Rights[5] take into account rights to equal inheritance, to equal status in marriage, to an education and to choose where to go and live as well as freedom from genital mutilation and forced sterilization. The index contains 4 levels with values from 0 to 3. At level 0, there are no lawful protection of women's rights and the government tolerates a high level of discrimination against women. As the value increases, the mechanism of women's rights protection is more fully implemented and widely acknowledged. At level 3, all or nearly all of women's rights are guaranteed by law and the government fully and vigorously enforces these laws. Thus the women's rights gap between an origin country, i, and the US can be calculated from the formula below:

(1) Women's rights gap_i =

$$\frac{Women's\ Economic\ Rights_{us} + Women's\ Political\ Rights_{us} + Women's\ Social\ Rights_{us}}{Women's\ Economic\ Rights_i + Women's\ Political\ Rights_i + Women's\ Social\ Rights_i}$$

In order to avoid the denominators from being zero, I add one to each component so that each indicator now varies between one and four. Both the numerator and denominator of (1) can vary from 3 to 12. (Nejad and Young, 2012) The range of the ratio is from 0.75 to 3.33 with the mean at around 1.33. When the women's rights gap increases, it means that women have worse status in

[5] Women's Social Rights contain lots of missing data. I used a R package called mice to impute the missing data.

their origin countries compared to the US. Women's rights gap comprises a key variable to evaluate the female's immigration response to OPT extension.

I then combine these two data sets by matching country and year of graduation. The CIRI Human Rights Dataset contains annual measurement from 1981 to 2011, which covers the years 2004 to 2011 in the sample from SEVIS data. **Table 1** displays summary statistics on the data. I break down both male and female students by whether they are eligible for OPT extension. Male students have almost equal numbers of eligible and non-eligible majors, while the number of non-eligible female students are more than two times higher than that of eligible ones. Country is also an important variation to consider in my analysis. The top six countries that supply most students to the US account for about 60% of total observations. Except from India and China, non-eligible students surpasses eligible students for both male and female students. Nonetheless, the number of eligible STEM students from India and China largely overweighs that of the other countries. This indicates heterogeneity across countries, and countries with large exports of international students may have a significant influence on the overall results. The cumulative percentage suggests that all six countries together account for more than 70 percent of both eligible male and female students. Eligible students are highly concentrated in top countries, which indicates that it is worth looking into specific countries.

More undergraduate students tend to choose non-eligible majors for both males and females. The opposite case is true for PhD students. At the Master's level, a larger proportion of male students are eligible for OPT extension while non-eligible female students outnumber eligible ones. About 72% of the students in the sample initially stayed in the US after graduation, and the figure is even

higher for males and females eligible for OPT extension. Over 80% of eligible students chose to stay initially after graduation. The stay rates of eligible students continue to outnumber those of non-eligible students in the following periods. I restrict the sample to students who graduated after

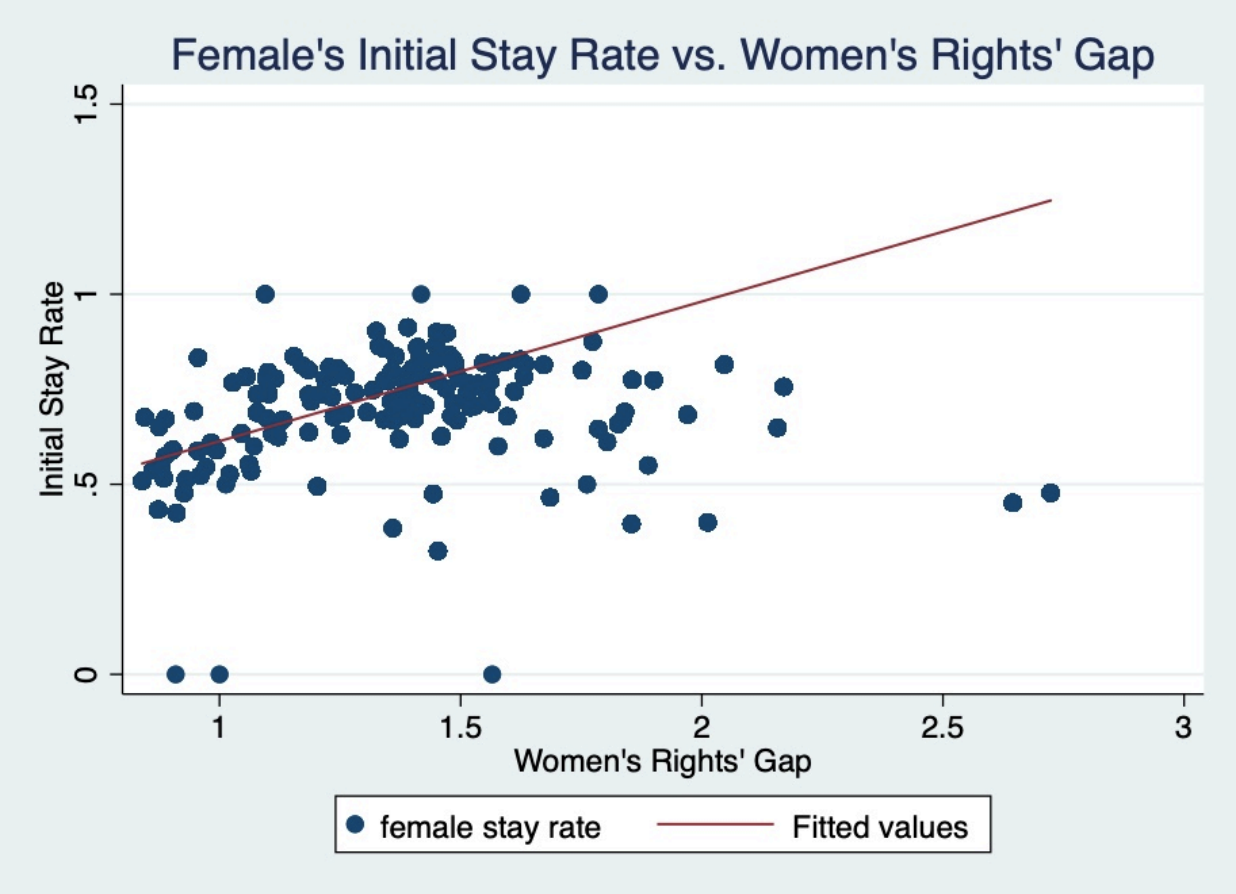
Table 1 – Summary Statistics of Male & Female Foreign Students

	Male		Female	
	Eligible	**Non-eligible**	**Eligible**	**Non-eligible**
Number of Observations	174,198	175,447	73,951	188,070
% of Total	*28.48*	*28.68*	*12.09*	*30.75*
Country (start from largest obs.)				
India	81,260	23,063	28,162	15,601
China	27,902	14,258	18,266	27,828
Canada	5,065	19,821	2,808	27,852
Japan	3,142	13,383	1,919	19,783
Turkey	3,600	5,439	1,295	3,643
Thailand	2,327	3,843	1,213	5,657
Mexico	2,757	4,865	842	3,745
Cum. percent	*72.37*	*48.26*	*73.7*	*55.41*
Degree Level				
Bachelor's Degree	32,372	69,010	14,480	79,524
Master's Degree	100,119	91,259	41,162	93,789
PhD Degree	41,707	15,178	18,309	14,757
Stay Rate				
% Stayed initially in the United States	85.14	65.89	84.53	67.84
% Stayers who used student visas 6 months after graduation	70.47	47.14	69.94	51.17
% Stayers who used student visas 12 months after graduation	51.68	39.79	53.44	44.14
% Stayers who used student visas 18 months, conditional on graduating after the OPT extension	26.72	0.91	23.11	0.96
% Stayers who used student visas 24 months, conditional on graduating after the OPT extension	21.92	0.20	19.56	0.19
% Stayers who used student visas 29 months, conditional on graduating after the OPT extension	13.42	0.11	12.95	0.11

Source: The statistics are based on SEVIS data.

the OPT extension was enacted when calculating the stay rates over 12 months after graduation. The stay rates of non-eligible students become close to 0. Over 20% of eligible students stayed 18 months using student visa and over 10% continued to use up all time allowed by student visa. One thing to notice is that overall, a higher percentage of females tend to stay than males within 12 months after graduation. This is not that case if additional time allowed by OPT extension is taken into consideration.

Figure 1. Female's Initial Stay Rate VS. Women's Rights Gap, By Country

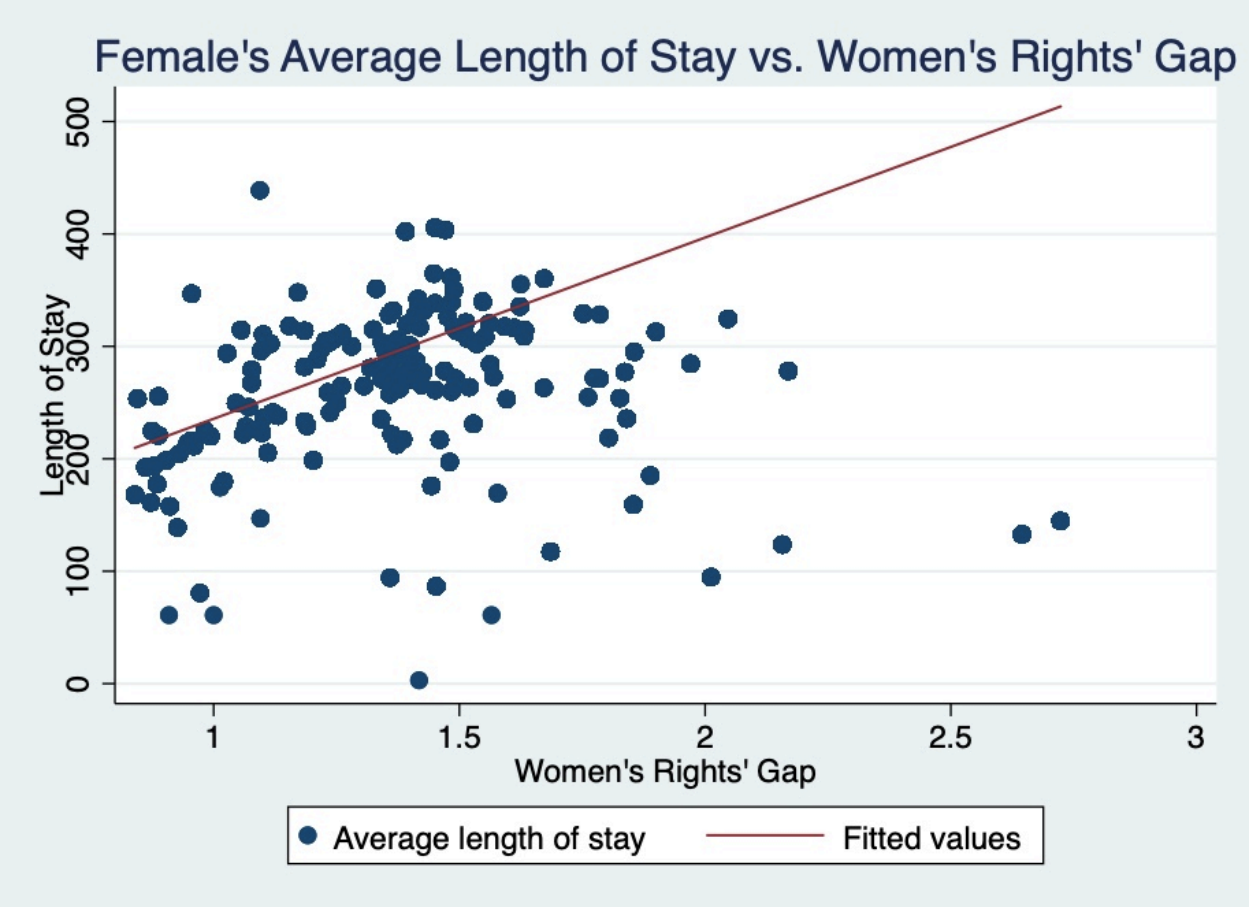


Note: The data points represent average initial stay rates and women's rights gap by country.

Figure 1 demonstrates a positive relationship between female's initial stay rate and women's rights gap by country. As the average women's rights gap increases between US and the origin countries,

females are more likely to stay initially in the US. This suggests that insufficient protection of women's rights in origin countries can be one of the push facts for women's immigration decisions. A similar pattern can be seen in **Figure 2**, which indicates that female students increase their length of stay if their origin countries have relatively low level of women's rights compared to the US.

Figure 2. Female's Length of Stay VS. Women's Rights Gap, By Country



Note: The data points represent average length of stay and women's rights gap by country.

IV. Empirical Methodology

To empirically estimate the differential impact of OPT extension on male and females' immigration responses and how women's rights gap influence females' responses to OPT extension, I establish two regression models.

(2) $$Y_{ifst} = \beta_0 + \beta_1 OPT_{ft} + \beta_2 \text{Gender}_{ifst} + \beta_3 \text{Gender}_{ifst} * OPT_{ft} + \beta_4 X_{ifst} + \delta_f + \delta_t + \delta_s + \epsilon_{ifst}$$

(3) $$Y^{f}_{ifst} = \beta_0 + \beta_1 OPT_{ft} + \beta_2 \text{Rights Gap}_{ifst} + \beta_3 (\text{Rights Gap}_{ifst})^2 + \beta_4 \text{Rights Gap}_{ifst} * OPT_{ft} + \beta_5 Z_{ifst} + \beta_6 X_{ifst} + \delta_f + \delta_t + \delta_s + \epsilon_{ifst}$$

Y_{ifcst} in the first model represents (i) a dummy variable of whether the individual i of field f and school s with graduation date t initially stays in the US under OPT after graduation; (ii) a dummy variable measuring whether the student continues to stay using student visa for 18 months after graduation; (iii) the number of days that the student stays in the United States via OPT, including all students[6]. Y^{f}_{ifst} in the second model refers to the same three outcomes, except only for a sample of female students.

In the first estimation equation, there are two key variables, OPT_{ft} and Gender_{ifst}. The first variable OPT_{ft} is a binary indicator of eligibility for the OPT extension after the year when the extension takes effect. The second variable Gender_{ifst} is a dummy variable with value 1 indicating female and 0 indicating male. The interaction term $\text{Gender}_{ifst} * OPT_{ft}$ estimates how OPT extension eligibility results in differential change in male and female foreign students' immigration

[6] For convenience, the three dependent variables will be referred to as Initial Stay Rate, 18-Month Stay Rate and Length of Stay in the following passages.

decisions. Key variables in the second equation are OPT_{ft} and Rights Gap$_{ifst}$, where Rights Gap$_{ifst}$ is a continuous variable of the ratio of women's rights in the origin country over in the US. I assume a nonlinear relationship between Rights Gap and the outcome variables based on results from Nejad and Young's study (2014). Thus, (Rights Gap$_{ifst}$)^2 is included to rapture any nonlinearity. The interaction term Rights Gap$_{ifst}$ $*OPT_{ft}$ measures how the impact of OPT extension eligibility changes in relation to women's rights gap. I essentially want to use women's rights gap to explain the females' immigration responses to OPT extension.

I also include multiple control variables in the second regression represented by Z_{ifst}. The first group are country specific characteristics including GDP per capita, unemployment rate and political stability of origin countries in a given year.[7] These variables can exclude any general economic trends in the origin countries that explain foreign students' decisions to stay in the US. According to research, good economic and social conditions in home countries tend to attract foreign students to return. (Docquier et al. 2012; Nejad and Young 2012) Excluding these other potential "push" or "pull" factors for females' immigration responses increases the validity of women's rights gap. The second group has several other geographic characteristics of origin countries and the US from the CEPII[8]. I include bilateral dummies indicating whether the two countries are contiguous, share a common language and have had a common colonizer after 1945, as well as a measurement of the population weighted distance between two countries. (Feyrer, 2009) In addition, Demographic characteristics X_{ifst} is another control variable that accounts for the student i's age at school completion. (Demirci 2019)

[7] The data comes from the World Bank DataBank files: https://databank.worldbank.org/home.aspx.
[8] The data can be found at: http://www.cepii.fr/anglaisgraph/bdd/distances.htm. Similar data was used by Feyrer 2009.

Field fixed effects, δ_f, control for permanent differences across fields, such as the increasing roles filled by foreign workers in computer science related fields. Year fixed effects associated with the timing of school completion, δ_t, control for the impact of common events in each year that affect everyone, such as the Great Recessions in 2008. Excluding time trends is necessary to identify the exact impact of OPT extension. I use school fixed effects, δ_s, to control for the possibility that graduates of some colleges might have consistently high or low stay rates, due to quality of education, locations and school culture. (Demirci 2019)

V. Results

Table 2 reports the empirical results from the first regression model. The three panels in **Table 2** sequentially reports OLS estimates based on Initial Stay Rate, 18-Month Stay Rate, Length of Stay (including all students) as the dependent variables. The outcomes are measured separately for three degree levels to rapture any different trends. I will mainly focus on the results in regressions with full set of controls as shown in Columns 2, 4 & 6. Panel A. shows that being eligible for OPT extension will increase foreign students' likelihood to stay initially in the US after graduation by 5 percentage points at the Bachelor's level, 6.5 points at the Master's level and 2.2 points at the PhD level. In addition, the significant coefficients of Gender variable indicate different behavior patterns of males and females in staying initially in the US. Female foreign students are 4.2 percentage points more likely to stay initially in the US at the Bachelor's and 3.5 points at the Master's level. Although females are inherently more likely to stay than males, their responses to OPT extension is not as positive as males'. The interaction term of Gender and OPT extension eligibility has negative coefficients, which suggests that females eligible for OPT extension are 3 percentage points less likely to stay initially compared to their male counterparts at the Master's level and 2.3 points less at the PhD level. In other words, OPT extension eligibility has a less positive effect on females than on males. Overall, at the Master's level, the tendency to stay initially is similar for males and females following OPT extension. At the Bachelor's level, eligible females are still more likely to stay initially than eligible males, while it is the opposite case at the PhD level.

The impact of Gender is much smaller in 18-Month Stay Rate. The only significant result is found at the Master's level, where female students are 0.24 percentage points less likely to stay for 18

Table 2 – The Gendered Responses to OPT Extension

	Bachelor's Level		**Master's Level**		**PhD level**	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. Dependent variable: The Likelihood of Initially Staying in the United States Using Student Visa						
OPT Extension Eligibility	0.055***	0.050***	0.062***	0.065***	0.024***	0.022***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Gender	0.049***	0.042***	0.042***	0.035***	0.00018	-0.0063
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Gender x OPT	-0.0051	0.00094	-0.037***	-0.030***	-0.029***	-0.023***
	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)	(0.01)
R-squared	0.06	0.18	0.17	0.24	0.11	0.16
Panel B. Dependent Variable: The 18-Month Stay Rate Using Student Visa						
OPT Extension Eligibility	0.14***	0.14***	0.31***	0.29***	0.11***	0.11***
	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)
Gender	0.00074	-0.00018	-0.0017*	-0.0024***	-0.00046	-0.00066
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Gender x OPT	-0.016***	-0.015**	-0.026***	-0.017***	-0.0042	-0.004
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
R-squared	0.06	0.08	0.23	0.29	0.09	0.11
Panel C. Dependent Variable: The Length of Stay Using Student Visa, including all students (in days)						
OPT Extension Eligibility	120.1***	112.1***	189.7***	178.6***	104.0***	102.7***
	(9.31)	(8.81)	(7.47)	(7.51)	(8.12)	(8.00)
Gender	22.1***	19.9***	20.9***	17.6***	6.26***	3.43*
	(1.44)	(1.31)	(1.61)	(1.16)	(2.01)	(1.86)
Gender x OPT	-15.7**	-14.7***	-28.1***	-20.0***	-8.03*	-6.04
	(6.29)	(5.67)	(4.26)	(3.63)	(4.36)	(4.23)
R-squared	0.09	0.19	0.19	0.26	0.10	0.13
Year Fixed Effects	x	x	x	x	x	x
Field Fixed Effects	x	x	x	x	x	x
School Fixed Effects		x		x		x
Observations	179,247	179,247	317,149	317,149	85,723	85,723

Note: Standard errors in parentheses; * p < 0.10, ** p < 0.05, *** p < .01

months using student visa. Nonetheless, OPT extension eligibility has a more significant effect on the 18-Month Stay Rate. Students eligible for OPT Extension are 14 percentage points more likely to stay 18 months after graduation at the Bachelor's level, and 29 points and 11 points more likely at the Master's and PhD levels respectively. This implies that OPT Extension plays an important role in promoting eligible students to stay longer in the US. In addition, since the interaction term is significantly negative at Bachelor's and Master's levels, males eligible for OPT extension are more likely to stay for 18-Month than eligible females.

In terms of Length of Stay, students eligible for OPT extension tend to stay 112 days longer in the US at the Bachelor's level, and 179 days and 103 days longer at the Master's and PhD levels respectively. Female students are also more likely to stay longer than male students, by 20 days at the Bachelor's level and 18 days at the Master's level. The impact of Gender is much less significant in magnitude than OPT extension eligibility. More importantly, a common trend similar to the other two outcomes is that females are less likely to stay longer when they are eligible for OPT extension. Females eligible for OPT extension stay 15 days and 20 days fewer than male counterparts at the Bachelor's and Master's levels respectively. In general, females' inherent tendency to stay in the US is partially or nearly offset by males' greater responses to OPT extension eligibility. One hypothesis for such discrepancy is that females are more willing to choose non-STEM majors out of free will. Although OPT extension makes STEM majors more appealing to foreign students, it may be a higher incentive to males who originally lean more towards STEM majors than females.

To better understand females' immigration choices, I restrict the sample to only females and

Table 3 – The Impact of Women's Rights Gap and OPT Extension Eligibility on Females' Immigration Responses

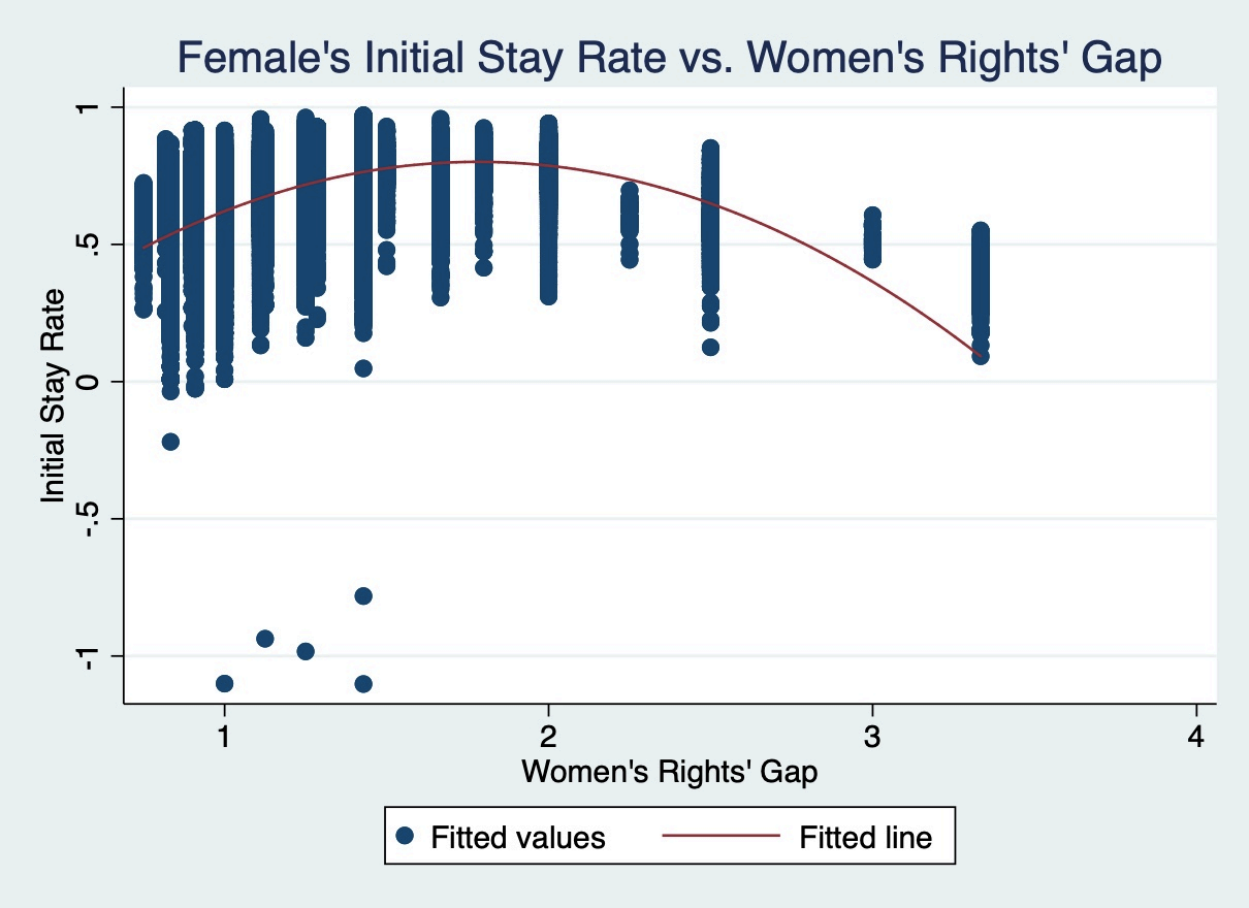
	Initial Stay Rate		18-Month Stay Rate		Length of Stay	
	(1)	(2)	(3)	(4)	(5)	(6)
Women's Rights Gap	0.29***	0.18***	-0.050***	-0.053***	48.4***	54.4***
	(0.04)	(0.03)	(0.01)	(0.01)	(15.10)	(12.50)
(Women's Rights Gap)^2	-0.10***	-0.069***	0.0076*	0.0095**	-25.1***	-26.4***
	(0.01)	(0.01)	(0.00)	(0.00)	(4.22)	(3.56)
OPT Extension Eligibility	0.10***	0.047*	0.31***	0.30***	196.6***	181.3***
	(0.03)	(0.03)	(0.03)	(0.03)	(21.60)	(19.90)
Women's Rights Gap x OPT	-0.038*	-0.00018	-0.072***	-0.071***	-44.5***	-38.3***
	(0.02)	(0.02)	(0.02)	(0.02)	(13.60)	(12.40)
GDP per capita	-4.1×10^{-6}***	-3.9×10^{-6}***	-2.1×10^{-7}***	-2.7×10^{-7}***	-0.0015***	-0.0015***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Political Stability	-0.0096**	-0.0078**	-0.0097***	-0.0076***	-12.7***	-8.16***
	(0.00)	(0.00)	(0.00)	(0.00)	(1.86)	(1.48)
Unemployment Rate	-0.0024***	-0.0023***	-0.00025	-0.0002	-1.14***	-0.98***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.21)	(0.18)
Continuity	-0.17***	-0.073***	-0.014***	-0.013***	-50.1***	-30.0***
	(0.02)	(0.01)	(0.00)	(0.00)	(4.17)	(3.17)
Common Language	0.049***	0.042***	0.022***	0.019***	22.8***	20.8***
	(0.00)	(0.00)	(0.00)	(0.00)	(2.73)	(1.97)
Ever in Colonial Relationship	-0.034***	-0.020***	-0.015***	-0.011***	-16.3***	-8.92***
	(0.01)	(0.01)	(0.00)	(0.00)	(3.26)	(2.70)
Population Weighted Distance from US	-4.3×10^{-6}***	-1.9×10^{-6}***	-8.2×10^{-7}***	-4.3×10^{-7}**	-3.6×10^{-6}	-0.00050**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Constant	0.42***	0.54***	0.099***	0.11***	206.6***	255.4***
	(0.06)	(0.05)	(0.02)	(0.02)	(28.30)	(19.90)
Year Fixed Effects	x	x	x	x	x	x
Field Fixed Effects	x	x	x	x	x	x
School Fixed Effects		x		x		x
Observations	244,950	244,950	244,950	244,950	244,950	244,950
R^2	0.17	0.24	0.16	0.19	0.17	0.23

Note: Standard errors in parentheses; * p < 0.10, ** p < 0.05, *** p < .01

estimate the impact of women's rights gap and OPT extension eligibility on their decisions. **Table 3** shows the overall results on all three outcomes of females' immigration responses, regardless of degree levels. For Initial Stay Rate and Length of Stay, women's rights gap enters positively and significantly at the 1% level, while its squared value has significant negative coefficients, which indicates a nonlinear relationship. The coefficients for 18-Month Stay Rate has opposite signs for these two variables. Thus Initial Stay Rate has a peak value of women's rights gap at about 1.30 and Length of Stay at about 1.03, both slightly smaller than the sample mean of 1.33. Nonetheless, 18-Month Stay Rate has a trough value of women's rights gap at about 2.79, which is close to the maximum value of 3.33. For most observations, there is a monotonic relationship between women's rights gap and 18-Month Stay Rate.

For an origin country with women's rights gap smaller than 1.30, increases in women's rights, or decreases in the rights gap will decrease females' likelihood to stay initially in the US after graduation. In other words, relatively low women's rights in origin countries are indeed push factors for high-skilled female immigration. However, it is another story for countries with women's rights gap larger than 1.30. These countries have such low women's rights that increase in the rights gap will actually decrease women's likelihood to stay initially in the US. This can be understood as women don't have basic financial support to stay in the US due to extremely poor conditions in home countries. Similar conclusions can be drawn for Length of Stay with the distinguishing threshold being 1.03. For 18-Month Stay Rate, since the relationship is negative for most countries, increase in women's rights gap will decrease women's likelihood of staying for 18 months in the US. Figures 3-5 demonstrate the estimation results between women's rights gap and the three outcome variables respectively.

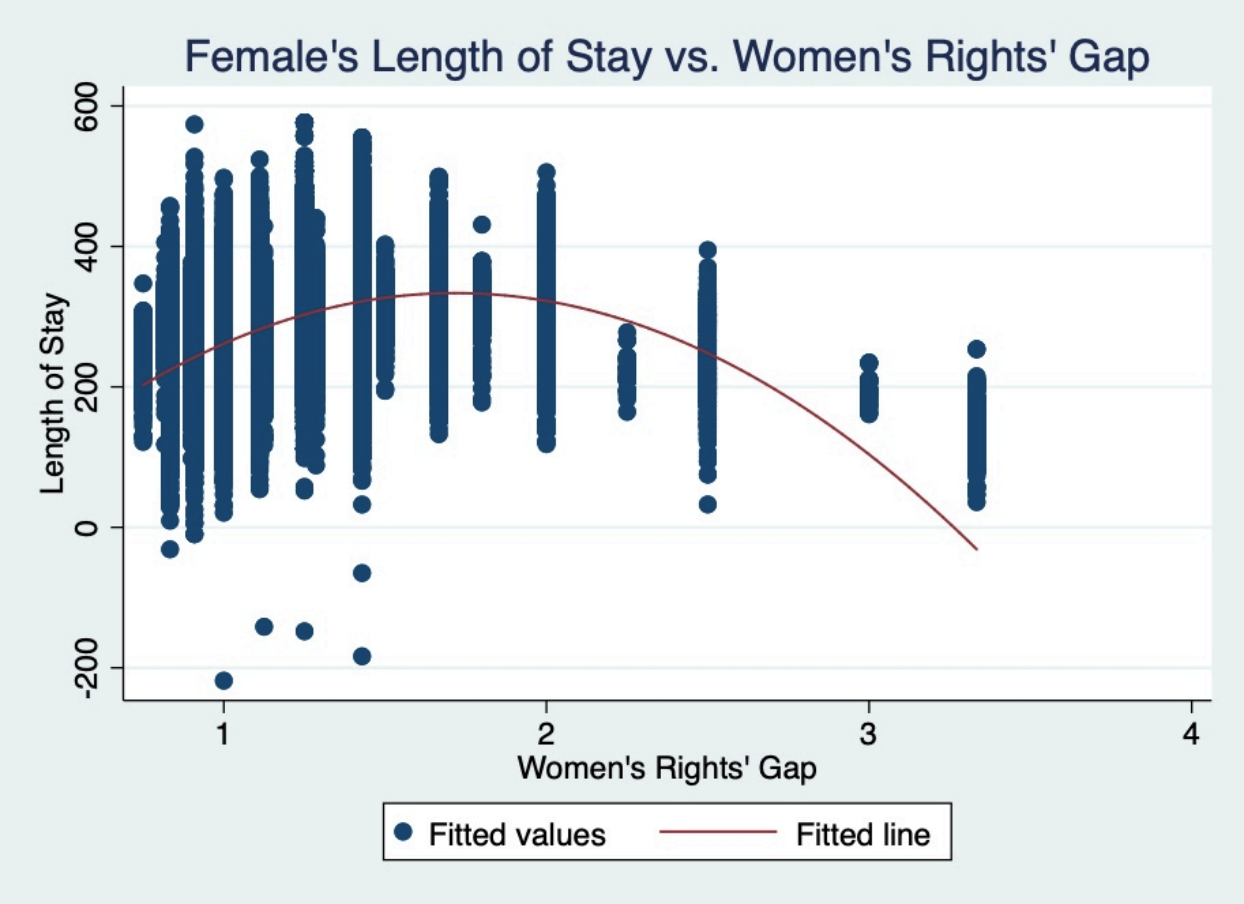
Figure 3. Fitted Values of Initial Stay Rate vs. Women's Rights Gap



Note: The data points represent fitted values from the second estimation outputs.

The fitted values display a clear U-shaped quadratic curve facing down in both **Figures 3** and **4**. Some countries on the left end of curve include Sweden, Denmark, Finland, Germany, Netherlands, Norway, and Canada. On the right end of the curve, there are countries like Saudi Arabia, Tonga, Afghanistan, Haiti, Nigeria, and Pakistan. Countries like China, Argentina, Belgium, Italy, and Portugal lie in the middle part of the curve. The quadratic shape is less obvious in **Figure 5**, which is consistent with my interpretation of regression outputs.

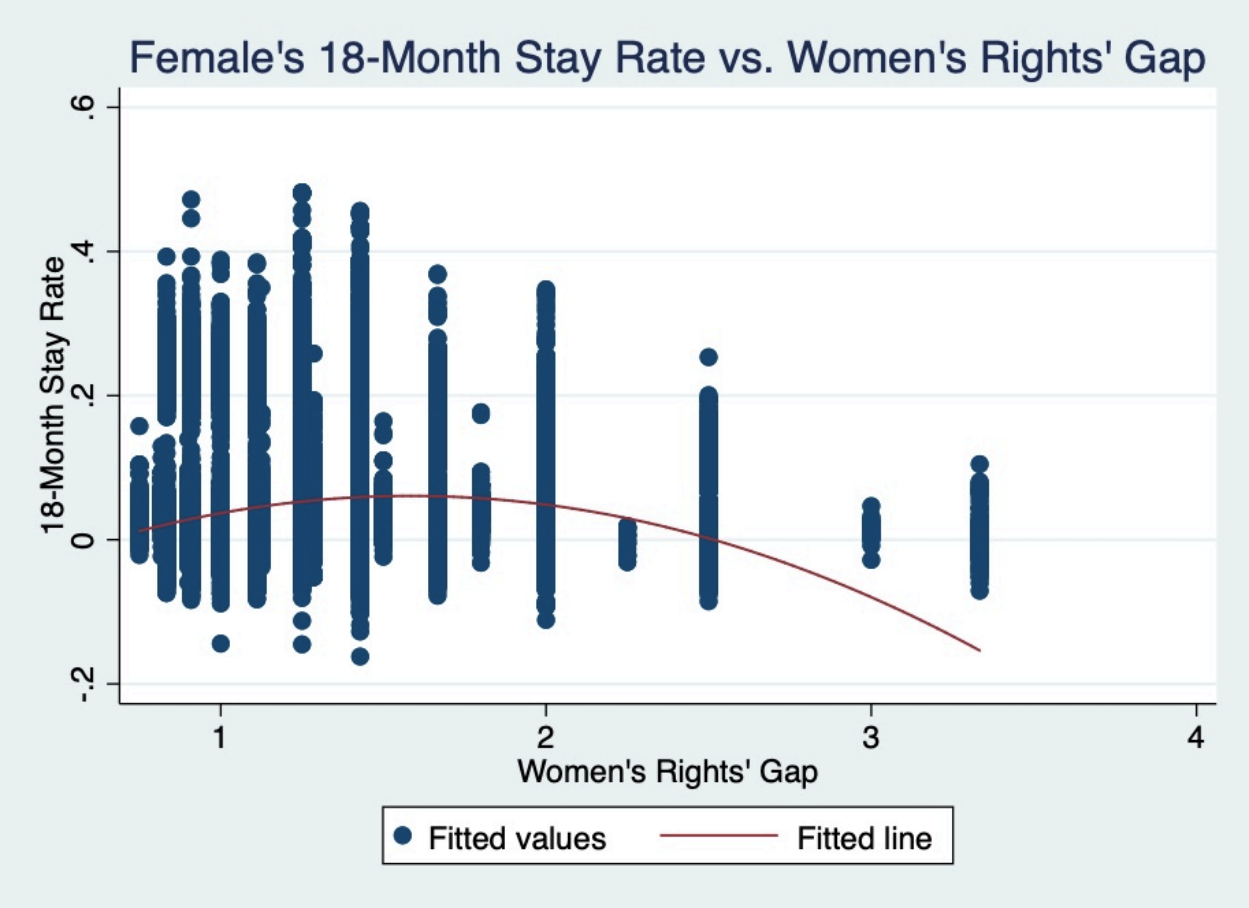
Figure 4. Fitted Values of Length of Stay vs. Women's Rights Gap



Note: The data points represent fitted values from the second estimation outputs.

Another important variable in my regression model is OPT extension eligibility, which measures the impact of being eligible for OPT extension on females' decision to stay in the US. Females eligible for OPT extension are 30 percentage points more likely to stay in the US for 18 months. They also tend to stay 181 days longer in the US than non-eligible females. However, being eligible for OPT extension doesn't have a significant impact on females' Initial Stay Rate at 5% level. This indicates that OPT extension can keep females stay longer in the US but doesn't very much influence whether they initially stay. Furthermore, the interaction terms between women's rights gap and OPT extension eligibility are found to be negatively significant for Length of Stay and 18-

Figure 5. Fitted Values of 18-Month Stay vs. Women's Rights Gap



Note: The data points represent fitted values from the second estimate outputs.

Month Stay Rate. With increasing women's rights gap, females eligible for OPT extension tend to have a shorter stay. For female eligible for OPT extension, coming from a country with low women's rights discourages them from staying for long in the US. For example, for origin countries with the largest women's rights gap 3.33, females are about 23 percentage points less likely to stay for 18 months, which nearly offsets the 30 percentage points positive impact of being eligible for OPT extension. Similar to the story in **Table 2**, OPT extension eligibility has a positive impact on females' Length of Stay and 18-Month Stay Rate. Nonetheless, increasing women's rights gap can offset a major part of the positive effects.

VI. Robustness

In the second estimation model, I used women's rights gap in origin countries and OPT extension eligibility to explain females' choices of whether and how long to stay in the US. To confirm on the results, it is important to assess whether women's rights gap properly represents the influential factors to consider in origin countries. In particular, since OPT extension mainly benefits foreign students by allowing longer access into the US labor market, the social and political rights measured in women's rights gap may not be very relevant to the outcomes. Thus, in **Table 4**, I rerun the regression model but this time change the women's rights gap to Women's Economic Rights. The results are mostly consistent with **Table 3**. The coefficients of all four key regressors are significant at 1% level. Women's Economic Rights have a nonlinear relationship with the all outcome variables. The impacts are all on the same direction as in **Table 3**, including the 18-Month Stay Rate, which was an outlier. The magnitude of the impacts, in general, are smaller than those in **Table 3**, except from the impact of OPT extension eligibility on Initial Stay Rate. OPT extension eligibility has a significant positive effect on Initial Stay Rate at the 1% level and its interaction term reports negative. Specifically, OPT extension eligibility increase females' likelihood to stay initially by 7.1 percentage points, but as Women's Economic Rights increases in origin countries, females eligible for OPT extension are 2.2 percentage points less likely to stay initially. Thus, both women's status conditions in origin countries and OPT extension eligibility are critical factors that influence females' immigration decisions.

Table 2 demonstrates differential trends in how OPT extension eligibility impacts male and females' immigration decisions. One major concern regarding the validity of OPT extension

Table 4 – The Impact of Women's Economic Rights and OPT Extension Eligibility on Females' Immigration Responses

	Initial Stay Rate		18-Month Stay Rate		Length of Stay	
	(1)	(2)	(3)	(4)	(5)	(6)
Women's Economic Rights	0.056***	0.056***	0.038***	0.034***	30.0***	28.8***
	(0.01)	(0.01)	(0.01)	(0.01)	(5.51)	(4.47)
(Women's Economic Rights)^2	-0.017***	-0.014***	-0.0083***	-0.0073***	-6.43***	-6.08***
	(0.00)	(0.00)	(0.00)	(0.00)	(1.46)	(1.17)
OPT Extension Eligibility	0.053***	0.071***	0.27***	0.26***	159.4***	152.3***
	(0.01)	(0.01)	(0.01)	(0.01)	(7.59)	(6.75)
Women's Econ Rights x OPT	-0.0049	-0.022***	-0.051***	-0.047***	-21.3***	-21.0***
	(0.01)	(0.01)	(0.00)	(0.00)	(4.21)	(3.90)
GDP per capita	-4.3×10^{-6}***	-4.0×10^{-6}***	-8.1×10^{-8}	-1.5×10^{-7}**	-0.0016***	-0.0016***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Political Stability	-0.0093**	-0.0075**	-0.0088***	-0.0070***	-11.6***	-7.22***
	(0.00)	(0.00)	(0.00)	(0.00)	(1.84)	(1.47)
Unemployment Rate	-0.0024***	-0.0024***	-0.000071	-0.000043	-1.07***	-0.94***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.20)	(0.18)
Continuity	-0.17***	-0.074***	-0.011***	-0.011***	-49.9***	-29.9***
	(0.02)	(0.01)	(0.00)	(0.00)	(4.20)	(3.23)
Common Language	0.051***	0.044***	0.024***	0.021***	24.7***	22.6***
	(0.00)	(0.00)	(0.00)	(0.00)	(2.88)	(2.10)
Ever in Colonial Relationship	-0.038***	-0.022***	-0.013***	-0.0092***	-15.6***	-8.48***
	(0.01)	(0.01)	(0.00)	(0.00)	(3.29)	(2.65)
Population Weighted Distance from US	-3.6×10^{-6}***	-1.5×10^{-6}***	-4.7×10^{-7}***	-1.1×10^{-7}	-0.000011	-0.00048**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Constant	0.58***	0.61***	0.021*	0.038***	203.6***	258.0***
	(0.06)	(0.04)	(0.01)	(0.01)	(25.60)	(17.50)
Year Fixed Effects	x	x	x	x	x	x
Field Fixed Effects	x	x	x	x	x	x
School Fixed Effects		x		x		x
Observations	244,950	244,950	244,950	244,950	244,950	244,950
R^2	0.17	0.24	0.16	0.19	0.17	0.23

Note: Standard errors in parentheses; * p < 0.10, ** p < 0.05, *** p < .01

eligibility is changing labor market conditions that might affect foreign students' employment prospects over time. Demirci addressed this concern in his paper by adding several control variables, including local unemployment rate, field specific GDP and labor demand for foreign students. These variables control for the economic conditions in the US and in specific fields, which might influence whether and how long foreign students are capable of working in the US. He finds that the impact of OPT extension eligibility is still significant after controlling for additional variations, although the effects on Bachelor's and Master's level are diminished. In addition, I performed the regression in **Table 2** on top origin countries individually to identify any potential heterogeneity. The results can be found in Appendix **Table A1**. The impact of OPT extension eligibility is consistently positive for all countries. Although females are found to be more likely to stay in some cases, following OPT extension the stay rates and length of stay tends to be similar for males and females, if not higher for males. Overall, OPT extension eligibility tends to be favoring males' emigration.

Another important constraint in my analysis is that, after all, the OPT program provides only relatively short term stay compared to more permanent immigration. The observations are foreign students who have studied in a US institution, and the results apply only to patterns within the realm of student visa. Although this is an increasing popular path of high-skilled immigration in the US, I admit that there are lots of other ways for high-skilled immigration. Thus, the conclusions may not hold true if I expand the samples to other groups of immigrants.

VII. Conclusion

I explore differential gendered responses to an important US student visa policy change, STEM OPT extension, and estimate critical factors that influence females' immigration decisions. To measure responses, I use stay rates and length of stay for each individual foreign student. I perform two estimation models on an individual-level SEVIS census of F visa students combined with women's rights indices from CIRI Human Rights Data Project. I estimate the gendered responses to OPT extension eligibility in the first model. Consistent with Demirci's (2019) results, I report a positive impact of OPT extension eligibility on foreign students' stay rates and length of stay. Females are inherently more likely to stay in the US regardless of OPT extension, but their tendency to stay is partially or nearly offset by males' more positive responses to the OPT extension. Thus, following OPT extension, there is not a significant difference between male and females' immigration responses.

The first model suggests that OPT extension does not have as huge impacts on females as on males. I look into other potential "push" factors that might influence females' immigration response. I use women's rights gap to measure the difference in women's status between origin countries and the US and estimate the impact of OPT extension eligibility and women's rights gap on females' immigration response. Suggested by results from Nejad and Young (2014), I assume a nonlinear relationship between women's rights gap and females' immigration responses. The nonlinear relationship is confirmed in the second model. For females coming from countries with high values of women's rights gap, increase in the gap, or decrease in women's status, will make females less likely to stay in the US. That may be due to insufficient financial support females can get from

origin countries, which prevent them from staying for long in the US. Countries like Saudi Arabia, Tonga, Afghanistan, Haiti, Nigeria, and Pakistan are at this end of the spectrum. On the other hand, when the home countries have relatively similar women's status to the US, increasing women's rights gap will increase the stay rate and length of stay of females in the US. In this case, decreasing women's status in origin countries indeed serves as push factors for female emigration.

As an implication for further studies, how to retain high-skilled females is a key question for countries with medium to high women's rights gap. Although improving women's status may give high-skilled females more opportunities to leave the country, high-skilled females are very crucial to child development and economic growth. (Dumont, Martin and Spievogel, 2007) Thus the government in these countries may want to think about policies that attract high-skilled females to return. In addition, STEM OPT extension as one of the most influential visa policies in recent years provides a very specific aspect in understanding gender differences in immigration flows. OPT extension only allows for up to three-year stay[9]. In future studies, I hope to look at patterns in the transition from student visa to more permanent stay.

[9] In 2016, US government issued a further STEM OPT extension, allowing 24 additional months of stay for STEM majors. Thus total time allowed by OPT for STEM majors sums up to three years.

Appendix

Table A1 – Gendered Responses to OPT Extension, Top Origin Countries

	Bachelor's Level			Master's Level		
	(1)	(2)	(3)	(1)	(2)	(3)
India						
OPT Extension Eligibility	0.077***	0.20***	153.6***	0.041***	0.32***	210.7***
	(0.02)	(0.01)	(12.70)	(0.01)	(0.02)	(9.50)
Gender	0.030***	-0.00037	15.3***	-0.0021	-0.0042**	2.4
	(0.01)	(0.00)	(4.45)	(0.00)	(0.00)	(1.87)
Gender x OPT	-0.023	-0.025	-18.4	-0.0077**	-0.018***	-8.52**
	(0.02)	(0.02)	(13.70)	(0.00)	(0.01)	(3.91)
R-squared	0.18	0.24	0.22	0.11	0.36	0.3
China						
OPT Extension Eligibility	0.021	0.071***	34.7*	0.054***	0.13***	83.2***
	(0.03)	(0.02)	(19.90)	(0.01)	(0.01)	(8.05)
Gender	0.053***	-0.0029	20.3***	0.020***	-0.00047	10.9***
	(0.01)	(0.00)	(5.77)	(0.01)	(0.00)	(2.42)
Gender x OPT	0.019	0.014	-2.98	-0.012	0.0037	-2.74
	(0.03)	(0.02)	(16.20)	(0.01)	(0.01)	(5.70)
R-squared	0.32	0.16	0.3	0.12	0.099	0.1
Canada						
OPT Extension Eligibility	0.044*	0.024***	46.3***	-0.0023	0.079***	59.2***
	(0.03)	(0.01)	(12.00)	(0.03)	(0.01)	(15.90)
Gender	0.048***	-0.00031	24.4***	0.018**	-0.0001	7.68**
	(0.01)	(0.00)	(2.98)	(0.01)	(0.00)	(3.06)
Gender x OPT	-0.0093	0.011	-7.37	0.067	0.01	19.5
	(0.03)	(0.01)	(13.30)	(0.04)	(0.02)	(22.20)
R-squared	0.24	0.14	0.27	0.39	0.14	0.36

Note: Column 1 represents Initial Stay Rate, colum 2 represents 18-Month Stay Rate; and column 3 represents Length of Stay.

Standard errors in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < .01$

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