THE ECONOMIC IMPACT OF INTERNATIONAL STUDENTS ON THEIR COUNTRIES OF ORIGIN

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Mantong Guo, B.A.

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Mantong Guo, B.A.

Thesis Advisor: Andrew Wise, Ph.D.

ABSTRACT

Although sending students overseas for post-secondary education is a common phenomenon, no previous research estimates the economic impact of international students on their home country. To address this gap in the literature, this paper uses cross-country panel data in a fixed effects model to estimate the lagged effects of international students on their home country’s GDP growth, while accounting for the unobserved heterogeneity of countries. My results show that, in cases where home country economies are less developed than destination country economies, the international-to-domestic tertiary student ratio in a student’s home country has a positive though diminishing effect on the home country’s economic growth. The ratio is nonlinearly associated with increasing economic growth at a decreasing rate up to a tipping point ratio, when the effect turns negative. The results are more pronounced for graduate than undergraduate students. These findings suggest that home country governments and educational institutions should do more to encourage students to go abroad for higher education not only to spur economic growth, but also to alleviate students’ and their families’ financial burdens.
The research and writing of this thesis are dedicated to everyone who helped along the way.

Many thanks,
Mantong Guo
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I. Introduction

Since the late 1940s, according to the Institute of International Education (IIE), the United States has hosted more globally mobile college and university students than any other country. In the 2015/16 academic year, the IIE reports, the number of international students at U.S. colleges and universities reached more than 1,000,000, hitting the highest growth rate in 36 years (IIE 2016 Open Doors Report).

Figure 1. The trend of total international students in the U.S. from 1954/55 to 2015/16

In 2015/16, the number of international students in the U.S. increased by 7.1 percent to 1,043,839 students, which accounted for 5.2 percent of total number of students in the U.S. higher education system.

Data Source: IIE Open Doors

From the perspective of individual students, the driving force for choosing the U.S. could be the excellent post-secondary education system, cutting-edge academic resources, attractive career opportunities, American style campus life, and numerous other valuable aspects of higher education in the U.S. On the other hand, the choice of study abroad does not only benefit the individual student’s life experience, but also
creates economic value in both the host country and the country of origin. From the holistic perspective of the global community, the growth of the international student population is one of the most important aspects of globalization, boosting cultural communication and accelerating capital flows.

International students bring huge economic benefit to host country. According to the National Association of Foreign Student Advisers’ (NAFSA) latest analysis, during the 2014/2015 academic year, the nearly one million international students studying at U.S. colleges and universities contributed $30.5 billion and supported more than 373,000 jobs in the U.S. economy. But how much economic benefit accrues to the countries of origin? In this study, I attempt to find the answer, focusing specifically on how international students’ group size and academic achievements affect the economic growth of their country of origin. My hypothesis is that sending international students to the U.S. will boost the economic growth of the countries of origin. The unit of analysis for the study is countries of origin. More than 200 countries are included in my data set.

I use gross domestic product (GDP) growth as my indicator of economic growth. Other key indicators in the study include the number of international students by country of origin, the number of students by three academic categories (undergraduate, graduate and non-degree), and the differences of economic status between countries of origin and the U.S. My model also includes a number of control variables that affect a country’s economic growth and education, for example, international openness, rule of law, and inflation rate. To conduct the analysis, I use a pooled OLS model, and a fixed effects OLS model.
If the size of an international student group is positively associated with their country of origin’s economic growth, then encouraging more students to pursue overseas study through certain policy level supports would be a way to boost a country’s economy. If higher-level academic achievement is associated with positive economic growth, then encouraging international students to get higher degrees would be a good choice for the home country’s growth.

The paper proceeds as follows. In the second chapter, I summarize background and review related literature; in the third chapter I present a theoretical framework that focuses on the relation between international study and the home country’s economic growth; in the fourth chapter I describe my data set; in the fifth chapter, I compare two empirical models; in the sixth chapter, I explain my results; and in the final chapter, I state the conclusions and policy recommendations.
II. Background and Literature Review

This chapter provides background on the research dealing with education and economic growth and the economic impact of human capital, education, higher education, and international higher education. I discuss the literature that focuses on the relation of education and economic growth and present some research methods that have been used in the previous literature.

1. Human capital and growth

In previous decades, many empirical and theoretical reports have found that human capital is an important determinant of economic growth and a key factor in explaining differences in income per capita across countries (Schultz 1992, Barro 2002, Jones and Schneider 2006, Mulligan and Sala-i-Martin 1995). For example, Artadi and Sala-i-Martin (2003), Gyimah-Brempong, Paddison, and Mitiku (2006), and Temple (1999) found that human capital, including education, training, and health have a positive and statistically significant impact on growth rates. Similarly, Lucas (1993) in his empirical analysis of East Asia concluded that the main engine of growth is the accumulation of human capital and the main source of differences in living standards among nations is differences in human capital (Lucas Jr 1993, 270). Broadly speaking, the growth miracles of East Asia since 1960 have constituted robust evidence of the economic return on human capital accumulation.
2. Education and growth

Micro and macro research on education’s effect on personal wage and countries’ economic growth both emphasize that education, as one important component of human capital, generates substantial private and social returns, and plays an essential role in economic growth (Schultz 1992, Krueger and Lindahl 2000, Mulligan and Sala-i-Martin 1995, Barro 2000).

In the 1980s and 1990s, the economic impact of human capital, and education in particular, was well explained by two models: the endogenous growth model and the expanded neoclassical growth model (Gyimah-Brempong, Paddison, and Mitiku 2006). The former model sees education as a process that changes production technology (Romer 1989, Mariana 2015), facilitating the absorption of superior technologies from leading countries (Barro 2002) and encouraging resource transfer to more technologically dynamic economies. The latter model considers education as an added input to production, and estimates that the growth of higher education is positively associate with the economic growth rates (Mankiw, Romer, and Weil 1990). Findings from both models indicate that education has a positive impact on a country’s economic growth.

Barro’s (2002) cross-country research on education’s impact on economic growth used average years of school attainment and quality of education as main educational variables. Barro found that years of school attainment and quality of education (measured by science scores) have significantly positive effects on economic growth. But there is a potential concern that, at the cross-country level, education attainment may generate nation-wide externalities that cause problems of reverse causality and omitted-variable bias (Krueger and Lindahl 2000).
Many previous studies have used GDP growth per capita as their measure of economic growth and dependent variable (Barro 2002, Gyimah-Brempong, Paddison, and Mitiku 2006, Ciftcioglu and Begovic 2008), and related it to a set of explanatory independent variables, whose effects may vary by political, social, and economic context. For example, countries with higher initial levels of GDP are more likely to have favorable values for other explanatory variables, such as rule of law and educational attainment (Barro 2002). Barro (2002) also found that the growth rate depends negatively on the ratio of government consumption to GDP, inflation rate, and total fertility rate; while the index for overall maintenance of the rule of law, openness (measured by the ratio of exports plus imports to GDP), and terms of trade (the ratio of export prices to import prices) have positive effects on the rate of economic growth (Barro 2002, 15-17).

Barro (2002) notes that poorer countries tend to grow faster for given values of the relevant explanatory variables. In addition, Krueger and Lindahl (2000) point out that initial levels of human capital stock also prove to be important to economic growth. For those who traditionally complete low levels of schooling, there will be a substantial payoff from getting education. Research also shows that physical capital plays an essential role in economic growth (Lucas Jr 1993, Sala-i-Martin 1997), and that the rate of investment helps explain growth rates at the cross-country level (Romer 1989, Barro 2002).

Levels of education, including primary, secondary and higher education, also affect growth. Higher education, which puts more emphasis on research and development, is especially important (Hall and Jones 1999, Romer 1989, Nelson and Phelps 1966). In addition, higher education has a larger effect on the growth of per capita
3. Effects of international education on growth

In recent decades, the trend of internationalization in higher education has grown significantly. International students are now a core part of the student body at the world’s leading universities. The United States remains the most popular country for international students, followed by the UK, Germany, France and Australia. In addition, in recent years, the most mobile students have been from Asia, especially China, India, and South Korea (Oxford 2016).

![Figure 2. Top places of origin of international students in the U.S. (2015/16)](image)

In 2015/16, 31.5 percent of international students in the U.S. were from China, 15.9 percent from India, 5.9 percent from Saudi Arabia, 5.8 percent from South Korea. 

*Data source: IIE Open Doors*

Studies have determined that studying abroad has positive effect on both private returns and social returns in the home and host countries. For example, Giorgio Di Pietro (2015) found that international study has a relatively large and statistically significant
effect on the probability of being in employed (Di Pietro 2015), while Shulamit Kahn and Megan MacGarvie found that international study may benefit home countries by increasing return flows of highly skilled human capital (Kahn and MacGarvie 2011). Studies also show that international students have a positive economic impact on host countries. According to Institute of International Education (IIE)’s *Open Doors 2015 report*, 72 percent of all international students in the U.S. receive the majority of their funds from sources outside of the United States, including personal and family sources as well as assistance from their home country governments or universities (Open Doors 2015). For the U.S. alone, in 2015, international students, most of whom pay full tuition to U.S. higher education institutions, contributed more than $30.5 billion to the economy.

However, few studies focus on the economic impact of international students on their countries of origin. One exception is Spilimbergo’s “Democracy and Foreign Education” (2007). Spilimbergo studied the question of whether foreign-educated individuals play an important role in fostering democracy in their home countries. His estimates took account of the original country’s initial level of democracy, the number of its students abroad as a share of its total population, the average level of democracy in host countries, and the interaction between the second and third terms (Spilimbergo 2007). All explanatory variables in Spilimbergo’s models were lagged five years so as to capture the effect of foreign education. All regressions had time and country fixed effects. The interaction term in the regressions measured whether the marginal effect of foreign students depends on the level of democracy in host countries (Spilimbergo 2007, 9).
Spilimbergo used three different estimation techniques: pooled OLS, fixed effects OLS, and system GMM. The pooled OLS model gave him a first idea of how the data were correlated without controlling for country fixed effects; the fixed effects OLS model controlled for country effects, but found a downward bias of the coefficients on the lagged dependent variable; the GMM estimators, with the effect of instrument variables, generated estimates that turned out to be more consistent and unbiased. (Spilimbergo 2007, 10) As a result, Spilimbergo found a very strong correlation between democracy in host countries and democracy in counties of origin, but not a very strong correlation between the total number of students abroad and the level of democracy at home.

In addition, Spilimbergo cited endogeneity concern on the student destination choices - that is, that students from a dictatorial country might start going to more democratic countries in anticipation of more democracy at home. In order to address this issue of reverse causality, he used instrument variables that are independent of political variables and not influenced by common factors. (Spilimbergo 2007, 13)

My research follows Spilimbergo’s approach, but applies it with different data and independent variables to the context of home-country economic growth. The main contribution of this research is discovering the home-country economic impact of international education, and providing policy suggestions to countries of origin.

I next turn to my theoretical model.
III. Theoretical Framework

In order to study the correlation between economic growth and foreign education, I develop the theoretical model described below. As in previous studies on education and economic growth, including Barro (2002) and Gyimah-Brempong et al (2006), I use economic growth as my dependent variable. The explanatory variables are: number of international students, number of students with different educational achievements, government expenditure on foreign study, and the GDP difference between the host country and home country.

The theoretical framework of my research can be expressed as:

\[
\text{GDP Growth of Home country} = f (S, D, X, \mu) \tag{1}
\]

Where S measures international students; D measures student’s degree achievements; X measures other control variables; \(\mu\) is error term of the model.

In order to estimate the relation between micro indicators of international study and macro indicator of national economic growth, my model will control many factors that may also have an impact on the economic growth and the number of students who study abroad. Following Barro’s (2002) research on factors that have a statistically significant impact on economic growth, I include a set of economic related control variables, and a set of education related control variables, all of which will be explained in the following chapter. In addition, the control variables and the use of fixed effects will also help reduce the potential problems of endogeneity in the model, for example the reverse causality between sending students overseas and economic growth.
IV. Data and Descriptive Statistics

I use panel data from 1999 to 2015 in my research. The Institute of International Education (IIE) openly provides information on international students studying in the U.S. from 1999 to 2015. Most of my main variables come from its annual Open Doors report. I also draw on United Nations Educational, Scientific and Cultural Organization’s (UNESCO) abundant statistics on global education and demographics, and the World Bank’s World Development Indicators (WDI) database.

On the other hand, this is also the most proper range of panel data for my research. After the 1990s, more students are studying abroad as transportation has become more convenient, people care more about higher education, and globalization has become a major trend of economic development. Moreover, after September 11th terrorist attacks in 2001, the U.S. has stricter immigration law toward international students. This causes the ratio of returning students to their home countries to rise, and have a more direct impact on home countries’ economic development.

Table 1 presents descriptive statistics for the variables in my models.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Variable name</th>
<th>N</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dependent variable</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GDP growth rate (%)</td>
<td>GDPG</td>
<td>1,981</td>
<td>4.149</td>
<td>4.640</td>
<td>-15.088</td>
<td>54.158</td>
</tr>
<tr>
<td><strong>Main variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of students in the U.S. by country of origin (in thousands)</td>
<td>STUDENTS</td>
<td>2,044</td>
<td>4.164</td>
<td>16.166</td>
<td>0</td>
<td>304.04</td>
</tr>
<tr>
<td>Number of domestic tertiary students (in thousands)</td>
<td>POPTERSTU</td>
<td>2,044</td>
<td>906.224</td>
<td>2,830.995</td>
<td>.051</td>
<td>41,924.2</td>
</tr>
<tr>
<td>International-domestic tertiary student ratio (%)</td>
<td>INTLRATIO</td>
<td>2,044</td>
<td>1.839</td>
<td>5.093</td>
<td>0</td>
<td>78.797</td>
</tr>
<tr>
<td>Quadratic term of international-domestic tertiary student ratio</td>
<td>INTLRATIO_ SQ</td>
<td>2,044</td>
<td>29.307</td>
<td>211.375</td>
<td>0</td>
<td>6,209.040</td>
</tr>
<tr>
<td>Number of undergraduate students (in thousands)</td>
<td>UNDERGRADS</td>
<td>1,907</td>
<td>1.756</td>
<td>6.234</td>
<td>0</td>
<td>124.552</td>
</tr>
<tr>
<td>Number of graduate students (in thousands)</td>
<td>GRADS</td>
<td>1,907</td>
<td>1.862</td>
<td>8.425</td>
<td>0</td>
<td>120.331</td>
</tr>
<tr>
<td>Number of other students (including non-degree and OPT) (in thousands)</td>
<td>OTHER</td>
<td>1,907</td>
<td>0.649</td>
<td>2.967</td>
<td>0</td>
<td>59.157</td>
</tr>
<tr>
<td><strong>Control variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natural log of GDP per capita difference between home country and the U.S.</td>
<td>ln_GDPCAP_DIFF</td>
<td>1,832</td>
<td>10.209</td>
<td>0.677</td>
<td>3.711</td>
<td>10.883</td>
</tr>
<tr>
<td>Government expenditure on education, total (% of GDP)</td>
<td>GOVEXP</td>
<td>1,370</td>
<td>4.610</td>
<td>1.797</td>
<td>1.012</td>
<td>15.615</td>
</tr>
<tr>
<td>School Life Expectancy, primary to tertiary, both sexes (years)</td>
<td>SLE</td>
<td>1,663</td>
<td>12.935</td>
<td>3.252</td>
<td>2.899</td>
<td>20.691</td>
</tr>
<tr>
<td>International openness index</td>
<td>OPEN</td>
<td>1,926</td>
<td>90.126</td>
<td>50.757</td>
<td>0.979</td>
<td>455.277</td>
</tr>
<tr>
<td>Fertility rate (births per woman)</td>
<td>FERTRATE</td>
<td>1,990</td>
<td>2.760</td>
<td>1.545</td>
<td>0.827</td>
<td>7.718</td>
</tr>
<tr>
<td>The rule of law\textsuperscript{a}</td>
<td>RULELAW</td>
<td>1,765</td>
<td>0.065</td>
<td>0.981</td>
<td>-2.114</td>
<td>2.120</td>
</tr>
<tr>
<td>Inflation in consumer prices (annual %)</td>
<td>INFLATION</td>
<td>1,861</td>
<td>6.327</td>
<td>14.125</td>
<td>-9.798</td>
<td>293.679</td>
</tr>
<tr>
<td>Investment (FDI, net inflows) (billions)</td>
<td>INVEST</td>
<td>1,967</td>
<td>9.317</td>
<td>32.412</td>
<td>-35.815</td>
<td>734.010</td>
</tr>
<tr>
<td>Terms of trade\textsuperscript{b}</td>
<td>TRADE</td>
<td>1,913</td>
<td>108.716</td>
<td>31.336</td>
<td>50.193</td>
<td>290.904</td>
</tr>
<tr>
<td>Unemployment rate (%)</td>
<td>UNEMPL</td>
<td>1,900</td>
<td>8.759</td>
<td>6.411</td>
<td>0.100</td>
<td>38.600</td>
</tr>
</tbody>
</table>

\textsuperscript{a} The rule of law: a variable indicating secure property rights and a strong legal system
\textsuperscript{b} Terms of trade: Net barter terms of trade index, the ratio of an index of a country's export prices to an index of its import prices
1. **Dependent variables**

   My dependent variable is the growth rate of Gross Domestic Product (GDP) at the country level. The data come from World Bank open data. GDP growth rate is a macro-economic indicator. Therefore, I use a combination of micro level and macro level indicators to measure international students’ effect on macro-economic growth.

2. **Main explanatory variables**

   Data sets for my main explanatory variables mainly come from the Institute of International Education (IIE), which is a private not-for-profit research organization focusing on the international exchange of people and ideas.

   As measurement for international students, I use the ratio of international students to total domestic tertiary students in home countries, rather than the absolute number of international students, because considering huge variance of population among countries, the ratio make more sense than absolute number. *International-domestic tertiary student ratio (%)* is a variable that calculated by *Number of students in the U.S. by country of origin* divided by that country’s total domestic tertiary students. *Number of students in the U.S. by country of origin* is a variable that represents how many foreign students were in the U.S. for higher education during each year of the reference period. This data set has 2,044 observations, with students from more than 200 countries, from the year 1999 to 2014. The mean value of student number is 4.164 thousand students, with a 16.166 thousand standard deviation and a maximum value of 304.04 thousand, which is the number of students from China in 2014. *Number of domestic tertiary students* represents the total number of domestic tertiary students in each country. There are 2,044 observations in this data set with a mean of 906.224 thousand domestic tertiary students,
and a standard deviation of 2,830.995 thousand. After calculating the ratio of these two variables based on year and country, the *International-domestic tertiary student ratio* has 2,044 observations, with a mean of 1.839 percent and a 5.093 standard deviation.

Academic status is divided into three categories, *number of undergraduate students, number of graduate students, and number of other academic level students*. This data set has 1,907 observations, with more than 200 countries, from the year 2000 to 2014. According to the IIE, the “other” category in this data set includes students who have non-degrees and students who have Optional Practical Training (OPT); that is, temporary employment that is directly related to a foreign student’s major area of study.

3. **Control variables**

A country’s economic growth could be affected by many factors. Following Barro (2002), I include ten control variables, including educational related variables and economic related variables.

*GDP per capita difference between home country and the U.S.* is a variable calculated by subtracting GDP per capita in the sending country from the GDP per capita in the U.S. In order to better present the relation between this variable and dependent variable, I take a natural log of it. This variable has 1,832 observations, with a mean at 10.209, and a standard deviation of 0.677.

*Ratio of government expenditure on education to GDP* represents the strength of home country government contributions to education. It has 1,370 observations, with a mean at 4.610 percent and a standard deviation of 1.797.

My model also includes *School Life Expectancy*, which presents the total number of years of schooling, from primary to tertiary, that a child can expect to receive. Years of
school life usually has a positive and significant effect on the subsequent rate of economic growth (Barro 2002). This variable has 1,663 observations, with a mean of 12.935 years and a standard deviation of 3.252.

Following Barro (2002), my models use seven additional economy-related variables to help explain economic growth. Data for these variables come from World Bank open data.

Rule of law, a variable indicating secure property rights and a strong legal system, affects investment and other aspects of economic activity. International openness, measured by the ratio of exports plus imports to GDP, also affects economic growth. The inflation rate and fertility rate are usually negatively related to economic growth, while increases in investment ratio and terms of trade usually enhance economic growth. In addition, my model also includes unemployment rate of the country as control variables.
V. Empirical Model

In order to account for the characteristics of different countries and years, I use two different estimation models: Pooled OLS and fixed effects OLS. The pooled OLS model gives a first idea of how the explanatory variables are correlated with my dependent variables, without controlling for country fixed effects. But, it can yield biased results. The fixed effects model controls for country and year trend effects, and addresses unobserved heterogeneity and endogeneity. Therefore, it should yield less biased estimates. I specify these models as:

- **Pooled OLS model:**

  \[
  GDP_{Gj} = \beta_0 + \beta_1 \text{INTLRATIO}_{j(i-t)} + \beta_2 \text{INTLRATIO}_\text{SQ}_{j(i-t)} + \beta_3 \text{UNDERGRADS}_{j(i-t)} + \beta_4 \text{GRADS}_{j(i-t)} + \beta_5 \text{GDP}_{G(j-1)} + \beta_6 \ln_{\text{GDPCAP_DIFF}}_{j(i-t)} + \beta_7 \text{GOVEXP}_{ji} + \beta_8 \text{SLE}_{ji} + \beta_9 \text{OPEN}_{ji} + \beta_{10} \text{FERTRATE}_{ji} + \beta_{11} \text{RULELAW}_{ji} + \beta_{12} \text{INFLATION}_{ji} + \beta_{13} \text{INVEST}_{ji} + \beta_{14} \text{TRADE}_{ji} + \beta_{15} \text{UNEMPL}_{ji} + \text{i. year} + \mu
  \]  

  (2)

- **Fixed effects model:**

  \[
  GDP_{Gji} = \beta_0 + \beta_1 \text{INTLRATIO}_{j(i-t)} + \beta_2 \text{INTLRATIO}_\text{SQ}_{j(i-t)} + \beta_3 \text{UNDERGRADS}_{j(i-t)} + \beta_4 \text{GRADS}_{j(i-t)} + \beta_5 \text{GDP}_{G(j-1)} + \beta_6 \ln_{\text{GDPCAP_DIFF}}_{j(i-t)} + \beta_7 \text{GOVEXP}_{ji} + \beta_8 \text{SLE}_{ji} + \beta_9 \text{OPEN}_{ji} + \beta_{10} \text{FERTRATE}_{ji} + \beta_{11} \text{RULELAW}_{ji} + \beta_{12} \text{INFLATION}_{ji} + \beta_{13} \text{INVEST}_{ji} + \beta_{14} \text{TRADE}_{ji} + \beta_{15} \text{UNEMPL}_{ji} + \text{Country Fixed Effects} + \text{Time Fixed Effects} + \mu
  \]  

  (3)

Where:

- \(j\) indicates country;
- \(i\) indicates year of panel data;
- \(t\) indicates the year lag;

\(GDPG\) is the home country’s GDP growth rate;
**INTLRATIO** is the foreign-domestic student ratio expressed as a percentage, which is the number of students studying abroad as a share of total domestic tertiary students in the home country;

**INTLRATIO\_SQ** is the quadratic form of **INTLRATIO**;

**UNDERGRADS** is the number of students abroad pursuing undergraduate degrees in thousands;

**GRADS** is the number of students abroad pursuing graduate degrees in thousands;

**GDPG_{j(t-1)}** is the GDP growth of the home country with a one-year lag;

**GDP\_CAP\_DIFF** is the difference of GDP per capita between the home country and the U.S.;

\[ ln\_GDP\_CAP\_DIFF \] is the natural log of **GDP\_CAP\_DIFF**;

**GOVEXP** is government expenditure on education as percent of GDP;

**SLE** is school life expectancy of the home country in years;

**OPEN** is an index of the home country’s international openness, measured by the ratio of exports plus imports to GDP;

**FERTRATE** is an index of the home country’s fertility rate, measured by births per woman;

**RULELAW** is an index of the home country’s rule of law, measured by the ratio of export prices to import prices;

**INFLATION** is an index of the home country’s inflation rate;

**INVEST** is an index of the home country’s investment ratio, measured by foreign direct investment as a share of GDP;

**TRADE** is an index of terms of trade, measured by the relative prices of exports in terms of imports;

**UNEMPL** is the home country’s unemployment rate;

and \( \mu \) is the random error.
I use cross-country panel data to control for variables that cannot be observed or measured through years, or variables that can change overtime within each country. This could help the model account for individual countries’ heterogeneity.

All main explanatory variables are lagged, so as to capture the lagged effect of foreign education on economic growth. In the next chapter, I will test several year-lags for sensitivity. (In the appendix, I include results of lags of from one year to seven years.)

The quadratic term of INTLRATIO measures whether there is a non-linear relationship between the foreign-domestic student ratio and the home country’s GDP growth rate. Or in other words, I use the quadratic form of INTLRATIO to find out if the marginal effect of the foreign-domestic student ratio varies by different levels of itself.

The one-year lag term of GDPG addresses the initial economic level of each country in each year. However, this variable could also increase the collinearity among economic control variables in the model. Therefore, in the next chapter, I test the joint significance of certain economic control variables, so as to make the model more efficient.

The ln_GDPCAP_DIF variable addresses the economic difference between the sending country and the receiving country. I assume that a poorer country will gain more economic benefit than a wealthier country by sending students to a wealthier country – in this case the United States. For example, compared to Germany, Indonesia has a bigger economic difference from the U.S. Therefore, sending tertiary students to the U.S. will have greater positive effects on Indonesia’s economic growth than it would for Germany.

In the fixed effects model, the country fixed effects control unchanging country characteristics, such as ethnic composition, religion, language, geographical variables,
and many other unobservable characteristics; while the time fixed effects control world-
wide trends over the reference period, including higher income, trade, and education
(Spilimberg 2007).

In the next section, I present my results.
VI. Results

Table 2 presents estimates of the effect of studying in the U.S. on a home country’s economic growth rate. Models 4, 5, 6, and 7 are fixed effects models; while models 8, 9 and 10 are pooled OLS models. Model 4 and 8 estimate the economic impact of foreign students one year after their international study; models 5 and 9 estimate the impact of foreign students four years following their international study; and models 6, 7 and 10 estimate the impact of foreign students six years following their international study. Model 7 includes all control variables mentioned in the previous chapter. All the fixed effects models and pooled OLS models with different year-lags show strong results. The F statistics of the overall models are all highly significant at 0.0001 level. Most of my models’ R-squares are higher than 0.5, indicating that each of these models account for more than 50 percent of the variance of home country’s GDP growth.
<table>
<thead>
<tr>
<th></th>
<th>Fixed Effects Models</th>
<th>Pooled OLS Models</th>
<th></th>
<th></th>
<th></th>
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<td>(5)</td>
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<td>6-year lag</td>
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<td></td>
<td>(0.163)</td>
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<td>-0.260***</td>
<td>-0.042***</td>
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<td>(0.097)</td>
<td>(0.108)</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<td>R-sq</td>
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<td>0.510</td>
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<td>0.553</td>
<td>0.516</td>
<td>0.561</td>
<td>0.573</td>
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<td>Observations</td>
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<td>622</td>
<td>475</td>
<td>463</td>
<td>881</td>
<td>622</td>
<td>475</td>
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<td>Overall F test</td>
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<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
<td></td>
</tr>
</tbody>
</table>

* Statistically Significant at the 0.1 Level.
** Statistically Significant at the 0.05 Level.
*** Statistically Significant at the 0.01 Level.
1. Main model results

To compare the results of all models, I use model 6 (the 6-year-lag fixed effects model with tailored independent variables) as my main model. First, compared to the pooled OLS models, the fixed effects models address the unobserved heterogeneity of each country, which should yield less biased estimates. Second, as I increase the lag of years, the coefficients of my main variables of interest become more statistically significant, which indicates that it may take years for international students to actually make an impact on their home countries’ economies. Last, the joint t test for the five economic control variables, including \textit{RULELAW}, \textit{INFLATION}, \textit{INVEST}, \textit{TRADE}, and \textit{UNEMPL}, is highly insignificant. Considering that their individual t statistics are also insignificant, it is more efficient to drop them from the model. This doesn’t mean that rule of law, inflation rate, investment, trade, and unemployment rate are uncorrelated with a country’s economic growth. One possible reason for their insignificant outcome may be the variable \textit{L1.GDPG}, my initial level of economic growth variable, which may cause collinearity with the five dropped economic control variables, since the last year’s economic growth rate already reflects a country’s economic status.

Table 3 presents estimates of model 6. Overall, this model is highly statistically significant at the 0.0001 level, although it only has 475 observations, which is dramatically reduced from the original sample size due to the 6-year-lag. The within R-square is 0.541, indicating that model 6 accounts for 54.1 percent of the variance within each country. This high R-square mainly comes from the one-year lag GDP growth variable \textit{L1.GDPG}, since previous year’s GDP growth can explain some GDP growth in this year. The between R-square is 0.015, indicating that this model only accounts for 1.5
percent of the variance between countries. The overall R-square is 0.031, which is a weighted average of the prior two R-squares. This study focuses mainly on the variance within each country. And the results suggest that this model accounts for more than half of such variance.

Table 3. Regression results of my 6-year-lag fixed effects model

<table>
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<tr>
<th>GDPG</th>
<th>Coefficient</th>
<th>Clustered Std. Err.</th>
</tr>
</thead>
<tbody>
<tr>
<td>L6. INTLRATIO</td>
<td>1.526***</td>
<td>0.288</td>
</tr>
<tr>
<td>L6.INTLRATIO_SQ</td>
<td>-0.052***</td>
<td>0.011</td>
</tr>
<tr>
<td>L6.UNDERGRADS</td>
<td>-0.222***</td>
<td>0.108</td>
</tr>
<tr>
<td>L6.GRADS</td>
<td>0.218</td>
<td>0.346</td>
</tr>
<tr>
<td>L1.GDGP</td>
<td>0.188**</td>
<td>0.076</td>
</tr>
<tr>
<td>L6.In_GDP_CAPDIFF</td>
<td>1.866*</td>
<td>1.063</td>
</tr>
<tr>
<td>GOVEXP</td>
<td>-1.127***</td>
<td>0.417</td>
</tr>
<tr>
<td>SLE</td>
<td>-0.288</td>
<td>0.540</td>
</tr>
<tr>
<td>OPEN</td>
<td>0.044*</td>
<td>0.025</td>
</tr>
<tr>
<td>FERTRATE</td>
<td>-5.559***</td>
<td>1.413</td>
</tr>
<tr>
<td>Year</td>
<td></td>
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</tr>
<tr>
<td>2007</td>
<td>0.559*</td>
<td>0.518</td>
</tr>
<tr>
<td>2008</td>
<td>-2.454***</td>
<td>0.652</td>
</tr>
<tr>
<td>2009</td>
<td>-6.252***</td>
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<td>2012</td>
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<td>2013</td>
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<td>2014</td>
<td>-1.856**</td>
<td>13.494</td>
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<td>_cons</td>
<td>2.597</td>
<td>0.288</td>
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</table>

* Statistically Significant at the 0.1 Level.
** Statistically Significant at the 0.05 Level.
*** Statistically Significant at the 0.01 Level.

The coefficients of L6. INTLRATIO and L6.INTLRATIO_SQ are highly significant at 0.001 level, and they are jointly significant at 0.001 level, which indicates that the international-domestic tertiary student ratio has a statistically significant impact on a home country’s economic growth. The positive sign of L6.INTLRATIO and the negative sign of its quadratic term indicate that the relation between L6.INTLRATIO and
$GDPG$ is not linear. The impact of the international-domestic tertiary student ratio on a home country’s economic growth increases at a decreasing rate. This means that before a tipping point of international-domestic tertiary student ratio, an increase in $INTLRATIO$ could positively affect a student’s home country’s economic growth in six years with a diminishing rate.

The coefficient of $L6. INTLRATIO$ is 1.526. The coefficient of $L6. INTLRATIO\_SQ$ is around -0.052.

$$\Delta GDPG = 1.526(\Delta L6. INTLRATIO) + (-0.052)*(\Delta L6. INTLRATIO\_SQ)$$

Holding other variables in the model constant, if the international-domestic tertiary student ratio increases one percentage point from its mean (1.839), the GDP growth rate six years later is predicted to be increased by 1.28 percentage points.

The reference line of $UNDERGRADS$ and $GRADS$ is $OTHER$ includes students who study in non-degree programs and students who obtain F-1 Optional Practical Training (OPT) after their graduation. The coefficient of $L6. UNDERGRADS$ is significant at the 0.05 level, but the coefficient of $L6. GRADS$ is not statistically significant. The negative sign of $L6. UNDERGRADS$ indicates that international students who are pursuing undergraduate degrees in the U.S. have less impact than other students, including graduate students and students with OPT, on their home country’s economic growth in six years. For example, in my data set, Indonesia sent 7,692 international students to the U.S. in 2007. The $INTLRATIO$ of that year was 0.202 percent, the number of $UNDERGRADS$ was 4,894, and the number of $GRADS$ was 1,841. Considering value of other variables, including $ln\_GDPCAP\_DIFF$ in 2007, $GDPG$ in 2012, $GOVEXP$, $SLE$, $OPEN$ and $FERTRATE$ in 2013, the GDP growth rate for Indonesia in 2013 is
predicted to be 3.99 percent. Holding other variables in the model constant, if Indonesia
increases the number of undergraduate students in the U.S. by one thousand in 2007, the
GDP growth rate for Indonesia in 2013 is predicted to be 3.77 percent, which is 0.22
percent lower.

The coefficient of $L1. GDPG$ is statistically significant at the 0.05 level, which
means the previous year’s GDP growth rate has a statistically significant impact on this
year’s GDP growth. In other words, holding other variables constant, each additional
percentage point increase in the previous year’s GDP growth rate is predicted to be
associate with a 0.188 percentage point increase in this year’s GDP growth.

The coefficient of $L6. ln_GDPCAP_DIFF$ is statistically significant at the 0.1
level, which indicates that the economic difference between the home country and host
country has a statistically significant impact on the home country’s economic growth rate
in six years. To be more specific, for each additional percentage point increase in the
difference in GDP per capita, the GDP growth rate in the home country is predicted to
increase by 1.866 percentage points in six years, holding other variables constant.

The coefficient of $GOVEXP$ is highly significant at the 0.01 level, which suggests
that government expenditure on education has a negative and statistically significant
impact on a home country’s GDP growth in six years. For each additional percentage-
point increase in the ratio of government expenditure on education to GDP, the GDP
growth rate in six years is predicted to decline by 1.127 percentage points. This negative
result is different from my initial expectation on the $GOVEXP$, and may be due to the
bias caused by variables which I omitted from the model.
The coefficient of SLE is not statistically significant. However, this school life expectancy variable cannot be excluded from the model, since dropping this variable generates a biased result in the coefficient of INTLRATIO. The negative sign of this variable may indicate that a country with a poor education system could gain more economic growth from international study than a country with a well-established education system.

The coefficient of OPEN is statistically significant at the 0.1 level. A home countries’ openness is positively correlated with its economic growth rate. For each additional unit increase of a country’s openness index, the GDP growth rate of that country is predicted to increase by 0.044 percentage points, holding other variables constant.

The coefficient of FERTRATE is highly significant at 0.001 level, suggesting that countries with lower fertility rates will gain more economic growth from international study. Conversely, for each additional percentage-point increase in its fertility rate, the home country’s GDP growth rate is predicted to decline by 5.559 percentage points, holding other variables constant.

Almost all the year variables are statistically significant, except 2010. However, they have huge variations in their coefficients. This outcome suggests that year impact may be difficult to address in this model.

The constant in my model is not statistically significant.

I chose a fixed-effects rather than a random-effects model base on the Hausman test. The Hausman test can help analysts choose between fixed effects models and random effects models. The null hypothesis is that the preferred model is random effects;
the alternate hypothesis is that the preferred model is fixed effects. The result of my
Hausman test is highly significant at the 0.0001 level, which indicates that the fixed
effects model is better for my purposes.

2. Sensitivity checking

I have tested two other lags for my fixed effects models. In the one-year-lag fixed
effects model (4), my main variables are not statistically significant and have very small
impacts. The international-domestic tertiary student ratio is negatively correlated with a
home country’s economic growth. This result indicates that a one-year lag may not be
enough for international students to make some impact on their home country’s economic
growth. Students who have just graduated or who are still studying in universities are less
likely to show effective economic productivity than students who graduated years before
and have some working experience. They are spending a large amount money on tuition
or living expenses in the U.S., which may have a temporary negative impact on their
home country’s economic growth.

In the four-year-lag fixed effects model (5), the coefficients of my major variables
are highly statistically significant. But the impact is still small. The relation between the
home country’s international-domestic tertiary student ratio and its GDP growth rate is
nonlinear. And the trend is the same with 6-year lag models (6 and 7). This may indicate
that after four years, international students start to have some impact on their home
country’s economic growth, but the magnitude of the impact is still relatively small.

As the lag in years becomes longer, the economic impact of international students
on their home country’s economic growth is greater and more significant. While adding
years to the lag dramatically reduces number of observations, the consistency in the
results and the increasingly significant outcomes build my confidence in the economic impact of international study. (In the appendix, I also include the results of fixed effects models with two, three, five, and seven year lags. The pattern is the same.)

3. Pooled OLS model results

Table 2 (above) indicates that the estimates of my three pooled OLS model are mostly consistent with those of my fixed effects models, but have some variations under different circumstances. These variations are mostly due to the fact that the pooled OLS model failed to address the unobserved heterogeneity across countries, and therefore produced biased estimates.

The home country’s international-domestic tertiary student ratio variables are not statistically significant in any of the pooled OLS models, although the four-year lag model (9) and 6-year lag model (10) have the same signs as my main model (6).

The coefficient of UNDERGRADUATES and GRADUATES also have same sign as model 6. This indicates that international graduate students have a greater economic impact on home countries than undergraduate students. In all three pooled OLS models, the coefficients of GRADUATES are highly statistically significant, while in the two shorter lag models, the coefficients of UNDERGRADUATES are significant.

In all pooled OLS models, previous year’s economic status is highly significant, and is positively related to home country’s economic growth. This finding is consistent with my fixed effects models.

In my pooled models, the natural log of the difference in country GDP per capita is positively related to home country GDP growth, which is consistent with my fixed effects models, but the finding is only statistically significant in two shorter lag models.
In all pooled OLS models, the coefficients of government expenditure on education are statistically significant. The variables are also negatively related with home country’s economic growth, which is the same as in my fixed effects models.

In both the shorter and longer lag pooled models, school life expectancy is statistically significant. The variables are negatively related with economic growth as well.

Also, the economic control variables, OPEN and FERTRATE have same sign in pooled OLS models as in fixed effects models. OPEN is statistically significant in two shorter lag models, while FERTRATE is statistically significant in the four-year lag model.

In all pooled OLS models, the year variables have huge variations in sign, magnitude, and significance level.

4. Data limitations

The lag of years in my models dramatically reduced the number of observations. In addition, there is a large amount of missing data among the variables for many countries throughout the targeted years. Most of my data are drawn from open access information provided by the World Bank, United Nations Educational, Scientific and Cultural Organization, and Institute of International Education Open Doors Data. Data for my main variables, the international student data, are limited to 16 years (1999 to 2014), while a considerable proportion of the data for my economic- and educational-related variables are missing for the low-income developing countries. With a more comprehensive data set and more years of data, my estimated results would have been stronger.
Meanwhile, due to the limitation of data on how many students return their home countries each year after graduating from U.S. universities, I was unable to address the economic impact of returning students, as well as the impact of the difference between returning students and students staying in the U.S. after their graduation. With further data on the number of returning students each year, estimates of the economic impact of sending students overseas will be more specific and focused.

In addition, I lacked data on the number of students in different fields of study. The IIE Open Doors Data provides limited data on fields of study, but only for the 25 countries with the largest number of international students, and only for some fields of study, including Business/Management, Education, Engineering, Fine Applied Arts, Health Professions, Humanities, Intensive English, Math Computer Science, Physical Life Sciences, and Social Sciences. If more comprehensive data were available, I could have dived further to estimate the economic impact of different fields of study.

Finally, my study uses a combination of macro level data on economic and educational variables, and micro level data on international studies. If I could obtain more individual level data, like personal earnings after graduating from U.S. universities, and personal earnings after graduating from domestic universities, I would be able to estimate the economic impact of international study on individuals. Considering the economic impact at both the country level and individual level would allow for a more comprehensive assessment of the impact of international study.

I now conclude with a discussion of the implications of my findings.
VII. Conclusion and Policy Recommendations

I set out to study the economic impact of international students on their countries of origin. My hypothesis was that sending international students to the U.S. will boost the economic growth of their home countries. My results show that there is a non-linear relation between home country’s international-domestic tertiary student ratio and home country’s GDP growth rate. The impact of the ratio on a home country’s economic growth increases at a decreasing rate before a tipping point, supporting my hypothesis.

Overall, my models generate some interesting findings. First, the international-domestic tertiary student ratio has a nonlinear effect on a student’s home country’s economic growth. The ratio is associated with increasing economic growth at a decreasing rate up to a tipping point ratio, when the effect turns negative. This means that, before the tipping point, the more international students that are sent to the U.S., the more positive the impact on the home country’s GDP growth, although the positive impact diminishes at the margin as the international-domestic tertiary student ratio increases toward the tipping point.

The positive effect before the tipping point may reflect the fact that more and more international students choose to return to their home country directly after their graduation, or after gaining several years working experience in the U.S. Once students pursue higher education in the U.S., they tend to transfer some of their skills back to their home country, either in the form of actual skill transfer or through entrepreneurial activity (Han et al. 2015). Han et al. (2015) point out that economic gain could include the increased productivity of returned students, those who work in transnational corporations that have branches in both the home country and the destination country, those who work
in companies that have business activity between the two countries, and those who work in the destination country but make economic contributions in other ways, for example sending money back to their families in the home country. However, the reverse effect after the tipping point may be due to human capital loss caused by sending out excessive number of international students. After reaching the tipping point of a home country’s international-domestic tertiary student ratio, the negative effect of human capital outflow offsets the positive economic impact from international students.

The models show that the economic status difference between the sending country and receiving country also matters to the economic benefit of international study. Compared to advanced economies, developing economies can gain more from sending international students to the U.S. Therefore, less developed countries should increase the international-domestic tertiary student ratio by encouraging more students to go abroad for higher education.

Second, the magnitude of impact differs for undergraduate and graduate students. My models show that international graduate students have a greater economic impact on their home country economy than undergraduate students. This may be partly because graduate students are more likely to work in knowledge-intensive industries, or higher level position in government, research, and policy making institutions, which could have a greater impact on their country’s economic growth. This finding implies that home countries should encourage students to get a higher degree in a foreign country, so as to gain more skills and expertise in certain fields, which in turn has a more positive impact on the home country’s economic growth.
Moreover, the models reveal that, as year lags become longer, the significance and magnitude of the effects of international students become greater. One possible explanation of this finding is that the international study has lagged effects. It takes time for students to dive into each field, gain work experience, and make an impact. As international students work more and more years, their expertise and skill advantages gained from foreign study make an increasingly positive impact on economic development.

One policy implication of my result is that home country governments and educational institutions should do more to encourage students to go abroad for higher education. According to the IIE Open Doors Data (IIE 2016), the primary sources of funding for international students in the U.S. are: 67 percent from personal and family; 17 percent from the U.S. college or university; 7 percent from a foreign government or university; 7 percent from current employment; and 2 percent from other sources. Thus, home country domestic public support for international study accounts for less than 7 percent of funding. If more public funding could be provided to students for international study, it could not only spur economic growth, but also alleviate students’ and their families’ financial burdens and reduce concerns about studying abroad. In addition, sending countries could adopt policies to encourage more international students to come back to their home countries and directly contribute to economic development. Given the real and perceived economic benefits of international students with higher education, particularly in STEM fields, there should be strong incentives for home countries to convince those brightest students who have gone abroad to return home (Han et al. 2015). Indeed, some countries have already implemented policies that promote the return of
talent to their home countries; for example, Brazil’s “Young Talent Program”, China’s “1000 Talents Program”, and South Korea’s “Brain Return 500”. Especially under more restrictive immigration policies in the U.S., such return policies could be increasingly successful.

Lastly, as I mentioned in the previous chapter, data limitation is a serious issue in this field of research. International organizations, local educational institutions and governments should work together to build a more comprehensive data system on international study. Facilitating research in this field could also help countries to build stronger relationships by learning from each other and working with each other.
### Table 4. Regression results of fixed effects models with different years

<table>
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<tr>
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<th>Fixed Effects Models</th>
<th>1-year lag</th>
<th>2-year lag</th>
<th>3-year lag</th>
<th>4-year lag</th>
<th>5-year lag</th>
<th>6-year lag</th>
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<td>0.885***</td>
<td>1.062***</td>
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<td>0.284</td>
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<td>-0.012</td>
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<td><strong>UNDERGRADS</strong></td>
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<td>-0.314**</td>
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<td>-0.097</td>
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<td>0.279***</td>
<td>0.268***</td>
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<td>-0.076</td>
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<td>0.034</td>
<td>0.044*</td>
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* Statistically Significant at the 0.1 Level.
** Statistically Significant at the 0.05 Level.
*** Statistically Significant at the 0.01 Level.
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