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THE GLOBAL ISSUE OF IMMIGRATION: A FOCUS ON ILLEGAL IMMIGRANTS FOR U.S. AGRICULTURE, REFUGEE IMMIGRANTS FOR GERMANY’S TRADE AND THE CLIMATE-INDUCED DIASPORA FROM LEAST DEVELOPED COUNTRIES

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DISSERTATION

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the College of Agriculture, Food and Environment at the University of Kentucky

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ABSTRACT OF DISSERTATION

THE GLOBAL ISSUE OF IMMIGRATION: A FOCUS ON ILLEGAL IMMIGRANTS FOR U.S. AGRICULTURE, REFUGEE IMMIGRANTS FOR GERMANY'S TRADE AND THE CLIMATE-INDUCED DIASPORA FROM LEAST DEVELOPED COUNTRIES

Nowadays, the large scale of migratory movements caused by violence, poverty or climate change have made topics related to this worldwide diaspora a vanguard of research on international development. For one thing, the so-called "caravan migrants" that traveled from Central America in search for a better life in the U.S. have been blocked at the U.S.-Mexico border while U.S. agricultural sectors that are labor-intensive, such as the sectors of fruits and vegetables where most illegal immigrant farmworkers are hired, have been suffering from the shortage of farm labors for years. Such a situation calls for a development of U.S. immigration laws and policies. On the other hand, years of armed conflict in the Middle East and North Africa result in a large number of refugees moving to the heart of Europe and directly lead to the European migrant crisis. Whether those refuges are good or bad for a host country's economy is an urgent question that should be answered without delay. Lastly, people in least developed countries (LDCs) are forced to leave their traditional habitats for improving the quality of life in host countries due to climatic factors that jeopardize their existence in their home countries. Those who are unable to afford the migration cost are trapped in poverty. How to weaken the "climate-migration poverty trap" is thus an issue that needs to be addressed as soon as possible.

This dissertation consists of three essays respectively regarding the three issues mentioned above. To begin with, the division of opinions on the U.S. Real ID Act that has restricted many illegal immigrants from working allows essay one (Chapter 2) to employ a difference-in-differences (DID) method to estimate the impact of the Act implementation on U.S. fruit and vegetable sectors that are labor-intensive. A hypothesis is made to pre-suppose that the impact is negative and then a hypothesis test is conducted for verifying if the hypothesis should be rejected or not. Empirical results are in general consistent with the hypothesis and suggest a way of legalizing those illegal immigrant farmworkers.

Essay two (Chapter 3) estimates the relationship between Germany's refugee stocks and its exports to and imports from the home countries where the refugees originate. This analysis assumes that Germany's refugee stocks are positively correlated with its exports to and imports from those home countries given lenient immigration policies towards refugee immigrants in Germany. It then conducts an estimation to test the hypothesis by using a gravity model with a Poisson Pseudo-Maximum Likelihood (PPML) estimator. Empirical results are not consistent with the hypothesis but suggest that Germany's refugee immigrants may be not yet capable of exerting remarkable pro-trade effects.

Essay three (Chapter 4) quantifies the impacts of three adaptation means (more access to irrigation, less CO_2 emission and larger amount of foreign direct investment (FDI)) on the migration rate for 23 LDCs of origin with respect to 129 countries of destination. This analysis assumes that the three adaptation means are effective measures for LDCs in response to high temperatures that reduce agricultural yields and that they function as promoters that facilitate climate-induced migration. Data used in this essay are cross-sectional, so solving the problem of heteroscedasticity and endogeneity by using generalized method of moments (GMM) is necessary to ensure that the estimates are not biased. Empirical results are consistent with the hypothesis, suggesting that the three adaptation means are promising ways of weakening the “climate-migration poverty trap”.

Overall, the dissertation conducts estimations based on hypothesis tests. It provides planners and policy makers with evidence regarding the economic contributions that immigrants bring for a host country and sheds light on the measures of dealing with the global issue of immigration.

KEYWORDS: Illegal Immigrants, Real ID Act, Difference-in-differences, Refugees, Gravity Model, Climate-induced Migration

Yunzhe Zhu

July 26th, 2021

THE GLOBAL ISSUE OF IMMIGRATION: A FOCUS ON ILLEGAL IMMIGRANTS FOR U.S. AGRICULTURE, REFUGEE IMMIGRANTS FOR GERMANY'S TRADE AND THE CLIMATE-INDUCED DIASPORA FROM LEAST DEVELOPED COUNTRIES

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DEDICATION

This dissertation is dedicated to the co-directors of mine, Dr. Sayed Saghaian and Dr. Michael Reed, who have been constant sources of support academically and financially during the whole process of dissertation writing. This dissertation is also dedicated to my parents, Miaohua Zhu and Yihong Hu, whose unconditional love has helped me go through the tough time during the Covid-19 pandemic. Lastly, this dissertation is dedicated to those migrants, who have been forced to leave their traditional habitats and whose lives are rife with uncertainty.

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CHAPTER 1. INTRODUCTION

Nowadays, the large scale of migratory movements caused by violence, poverty or climate change have made topics related to this worldwide diaspora a vanguard of research on international development. For one thing, the so-called "caravan migrants" that traveled from Central America in search for a better life in the U.S. have been blocked at the U.S.-Mexico border while U.S. agricultural sectors that are labor-intensive, such as the sectors of fruits and vegetables where most illegal immigrant farmworkers are hired, have been suffering from the shortage of farm labors for years. Such a situation calls for a development of U.S. immigration laws and policies. On the other hand, years of armed conflict in the Middle East and North Africa result in a large number of refugees moving to the heart of Europe and directly lead to the European migrant crisis. Whether those refuges are good or bad for a host country's economy is an urgent question that should be answered without delay. Lastly, people in least developed countries (LDCs) are forced to leave their traditional habitats for improving the quality of life in host countries due to climatic factors that jeopardize their existence in their home countries. Those who are unable to afford the migration cost are trapped in poverty. How to weaken the "climate-migration poverty trap" is thus an issue that needs to be addressed as soon as possible.

1.1 Research Objectives and Dissertation Framework

This dissertation consists of three essays respectively regarding the three issues mentioned above. To begin with, the division of opinions on the U.S. Real ID Act that has restricted many illegal immigrants from working allows essay one (Chapter 2) to employ a difference-in-differences (DID) method to estimate the impact of the Act implementation on U.S. fruit and vegetable sectors that are labor-intensive. A hypothesis is made to pre-suppose that the impact is negative and then a hypothesis test is conducted for verifying if the hypothesis should be rejected or not. For the first time, this essay addresses the issue of causal effect of those anti-immigration policies on the U.S. economy by using econometric methods.

Essay two (Chapter 3) estimates the relationship between Germany's refugee stocks and its exports to and imports from the home countries where the refugees originate. This analysis assumes that Germany's refugee stocks are positively correlated with its exports to and imports from those home countries given lenient immigration policies towards refugee immigrants in Germany. It then conducts an estimation to test the hypothesis by using a gravity model with a Poisson Pseudo-Maximum Likelihood (PPML) estimator. This essay is the first to combine the gravity model with PPML estimator to investigate the refugee-trade link, providing empirical evidence for further studies.

Essay three (Chapter 4) quantifies the impacts of three adaptation means (more access to irrigation, less CO_2 emission and larger amount of foreign direct investment (FDI)) on the migration rate for 23 LDCs of origin with respect to 129 countries of destination. This analysis assumes that the three adaptation means are effective measures for LDCs in response to high temperatures that reduce agricultural yields and that they function as promoters that facilitate climate-induced migration. Data used in this essay are cross-sectional, so solving the problem of heteroscedasticity and endogeneity by using generalized method of moments (GMM) is necessary to ensure that the estimates are not biased. This essay is the first to quantify the effect of applying multiple adaptation strategies on climate-induced migration.

Overall, this dissertation conducts estimations based on hypothesis tests. It provides planners and policy makers with evidence regarding the economic contributions that immigrants bring for a host country and sheds light on the measures of dealing with the global issue of immigration. Chapter 5 summarizes key conclusions and policy implications.

CHAPTER 2. IMPACTS OF THE REAL ID ACT ON U.S. STATE-LEVEL AGRICULTURAL CASH RECEIPTS

Abstract

Anti-immigrant provisions of the U.S. Real ID Act have restricted many illegal immigrants[1] from working and are hypothesized to have negative impacts on labor-intensive sectors of U.S. agriculture. The division of opinions on the Act participation among U.S. states allows the present study to employ a generalized difference-in-differences (DID) method to estimate impacts of the Act implementation on U.S. state-level cash receipts for eight categories of agricultural commodities. Consistent with the hypothesis, empirical results show that compliance with the Act has negative impacts on cash receipts of agricultural commodities produced in labor-intensive sectors, where most illegal immigrant farmworkers are hired. While the Act implementation fails to yield a significant effect in cash receipts for "Fruits and nuts", it leads to a decrease in cash receipts for "Vegetables and melons" by 17.2%. The weak immigrant-receipt link for "Fruits and nuts" suggests that growers' vulnerability to changes in immigration policies varies by commodities, and the strong immigrant-receipt link for "Vegetables and melons" calls on the need for a deceleration of current immigration law enforcement and a tacit tolerance of unauthorized employment.

KEYWORDS: Real ID Act, Agricultural Cash Receipts, Difference-in-differences, Illegal Immigrants, Labor-intensive Sectors

2.1 Introduction

The Real ID Act, enacted on May 11th, 2005, is an Act of Congress that modifies U.S. federal law pertaining to new authentication standards for state-issued driver's licenses and non-driver identification cards, as well as various immigration policies pertaining to terrorism (Wikipedia, 2020). While the passage of the Real ID Act is aimed to strengthen U.S. national security, several portions of the Act have imposed stricter standards of proof for individuals applying for the Real ID credentials – thereby restricting illegal immigrants, who are unable to prove their legal status or who lack social security numbers, from working, causing many immigrants and foreign nationals to lose their jobs (Wikipedia, 2020). Figure 2.1 provides unauthorized immigrant population trends for top U.S. states. As Figure 2.1 shows, the number of unauthorized immigrants, for most states, rose sharply in the 1990s and reached their peaks in 2007 when the recession began. They declined through the end of the recession in 2009 and then stabilized with a slightly further decline until ticking down in 2017. Given the large number of unauthorized immigrants in the U.S., the impact caused by the Real ID Act is expected to be huge.

The website of the National Conference of State Legislatures (NCSL) presents a timeline for the history behind the Real ID Act: it starts with the terrorist attacks of September 11, 2001, after which the whole nation was shocked by the sheer horror. U.S. states then accelerated their efforts to counter issues with counterfeit driver's licenses and identification cards in order to prevent terrorists from gaining immigration status in the U.S. In July 2002, the first *"National Strategy for Homeland Security"* produced by the Office of Homeland Security was released. It outlined major state initiatives, including driver's licenses: states with assistance from the federal government should craft solutions to curtail the future abuse of driver's licenses by terrorist organizations. In July 2004, the 9/11 Commission issued a 585-page report on how to reform the U.S. Intelligence community and to implement other security measures to prevent future terrorist attacks against the U.S. On page 390, under the heading Immigration Law and Enforcement, minimum standards for identification documents were developed. In December 2004, President Bush signed into law the *"National Intelligence Reform Act of 2004"*. The law required the U.S. Secretary of Transportation to establish a negotiated rule making process to establish minimum standards for state-issued driver's licenses and identification cards. On May 11, 2005, President Bush signed into law the *"Emergency Supplemental Appropriation for Defense, the Global War on Terror, and Tsunami Relief, 2005"*, which included the *"Real ID Act of 2005"*.

Although people whose ID cards do not meet the new federal standards are not allowed to fly on a domestic commercial flight or enter a federal building after October 1, 2020, the Act participation by states is voluntary. Some states have adopted the Act, while some others refused to implement it. As of October 2018, 37 states and territories have been certified as compliant, and 19, that provide adequate justification for noncompliance, have granted extensions of time to meet the Real ID requirements. It was expected that all but four of the 56 U.S. states/territories would be issuing Real ID compliant licenses/IDs by early 2019 (U.S. Department of Homeland Security (DHS)). Regan and Deering (2009) find that relatively less populous, less wealthy, and more conservative states were more likely to oppose the Real ID Act. To get more insight into the geographic differences, Figure 2.2 shows the status of states regarding the Real ID Act by the end of 2017. In

Figure 2.2, the 27 states in green are considered in the "compliant group" and the 23 states in yellow are considered in the "non-compliant group".

In addition, there is a tremendous variation in the timing of the Act implementation across U.S. states. As Table 2.1 shows, the Act implementation had been implemented in 13 states as early as 2012, whereas the two states – Oklahoma and Oregon are still being granted extension up to now. Therefore, the Real ID Act was not mandatorily imposed at the national level and not all states treated it identically. Hoynes and Schanzenbach (2009), in their study of food stamp program, emphasize the shortcomings of the absence of such a variation in the timing for a research design. The variation of the Real ID Act starting date precludes boiling down the present study to a simple before-after analysis for causal effects.

When it comes to the agricultural sector, Passel and Cohn (2018) estimate that 325,000 unauthorized immigrants worked in the U.S. agricultural sector in 2016. Passel and Cohn (2015) report that it is farming in which unauthorized immigrant employees are the highest share of the workforce in most states. The farming sector has grown increasingly dependent on a steady supply of workers who have entered the U.S. illegally and this has created a situation where presently half of all crop farmworkers are unauthorized (Ruark and Moinuddin 2011).

Table 2.2 presents 2014 estimated unauthorized immigrant population by state. These tabulations show that the numbers of both unauthorized immigrants and unauthorized immigrant farmworkers differ significantly among states. For the number of unauthorized immigrants, California, Texas, Florida and New York are the top 4. These four states plus New Jersey and Illinois account for 59% of unauthorized immigrants in the U.S. (Passel, Cohn, and Pew Research Center 2016). California and New York have more job opportunities and friendlier immigration policies than other states. California even made history by officially becoming the first sanctuary state in 2018. Bohn, Lofstrom, and Raphael (2014) summarize that the 2007 Legal Arizona Workers Act (LAWA), a restrictive state law concerning unauthorized immigrants, may cause those planning to migrate illegally to Arizona to migrate elsewhere, because LAWA has made it more difficult for them to find work there. They also document a notable and statistically significant reduction in the proportion of the Hispanic noncitizen population in Arizona that matches the timing of LAWA's implementation. Watson (2013) finds that one type of 287(g) agreement[3] nearly doubles the propensity for the foreign-born to relocate within the United States. So more lenient immigration policies may partially explain the large number of unauthorized immigrants in California and New York.

Only 4% of unauthorized immigrant workers held farming jobs, and 48% are employed in service and construction occupations (Passel and Cohn 2016). California and Texas lead the nation in the number of unauthorized farmworkers. In 2014, the shares of farming's civilian workforce in the two states that consists of unauthorized immigrants are 35% and 26%, respectively (Passel and Cohn 2016). Unauthorized immigrant farmworkers account for a small percentage of the farm labor force for New York and Illinois (percentages less than that in the occupations of construction, service, and production) and are not reported. Generally, unauthorized immigrant farmworkers are widely distributed in both "compliant" and "non-compliant" states, which is valid for data analysis.

The Real ID Act affects those immigrant farmworkers in two ways. First, the Act causes decreased employment among illegal immigrant farmworkers. Under the increased authentication standards, their driver's licenses or non-driver identification cards may not be renewed or may be retroactively canceled. Without driver's licenses or non-driver identification cards, they are unable to complete documents (e.g., form I-9[4]) proving work authorization in the U.S. Employers in the agricultural sector are required to verify that everybody working for them is authorized to work in the U.S. on pain of severe penalties and even criminal prosecution for hiring workers who do not present appropriate documents (Wroblewski 2019). Orrenius and Zavodny (2009) find strong evidence of a decline in employment among male Latin American immigrants under the stricter immigration-related law enforcement including the implementation of the Real ID Act in the post-9/11 period.

Second, weaker workforce participation may take place. Studies show that individuals who lack the ability to obtain a driver's license have more difficulties in maintaining steady employment (Pawasarat and Stetzer 1998; Sandradanziger, Danziger, and Heflin 2000). Since lack of public transportation is especially prominent in rural areas where many immigrants settle, driving in these regions is not a privilege, but rather, a necessity to perform daily activities associated with living such as working or conducting regular business transactions (García 2006). Those illegal immigrant farmworkers do not always have access to public transportation or other transit opportunities, and they thus may become less flexible in response to advanced planning for work shifts and overall have weaker ability to work more frequently. Farm employers may find it less attractive to hire individuals, who often show up late or miss work shifts.

Which sectors in the field of U.S. agriculture does the Real ID Act affect the most? Johnson (2014) reports that farm labor accounts for 42% of the variable production expenses for U.S. fruit and vegetable farms and that increased enforcement of immigration laws is resulting in labor shortages, especially for harvesting tree fruits and specialty row crops. Labor-intensive fruit and vegetable farming attracts a relatively large illegal workforce. Carroll, Georges, and Saltz (2011) document the findings of the National Agricultural Workers Survey (1989 – 2009) that most of the 54,000 farmworkers interviewed work in the sectors of "Fruits and Nuts" and "Vegetables". Martin and Calvin (2010) report that farms producing fruits and nuts, vegetables and melons, and horticultural specialties, such as greenhouse and nursery crops, accounted for $ 13.6 billion, or over half of the $26.4 billion in U.S. farm labor expenditures in 2007. On the other hand, prior studies present that farm work does not appeal to U.S. citizens due to relatively low wages, hard physical labor, and seasonal work (Martin and Calvin 2010; Ruark and Moinuddin 2011), so an orchardist, nursery operator, packer, or processor, who hires seasonal farmworkers, may have no alternatives but to employ illegal immigrants. By contrast, land-intensive crops (e.g., wheat, corn, cotton, soybean, and sorghum) are largely automated and do not depend heavily on illegal immigrant workers. Hence, the Real ID Act is expected to have a significant impact on the labor-intensive sectors, such as the sectors of fruit and vegetable.

The Real ID Act implementation may result in two economic effects towards labor-intensive agricultural sectors. First, it may put upward pressure on farm wages. Agriculture industry groups in many states have consistently complained of a shortage of agricultural workers, yet tighter immigration policies tend to reduce the supply of agricultural workers even further (Blanco 2016; *Michigan Law Revision Commission 47th annual report* 2015-2016; Richards 2018). Ali and Lucier (2011) from the USDA report that chronic farm labor shortages are one of the challenges that U.S. vegetable and melon production industry faces. Holding the labor demand curve unchanged, the reduced labor availability may cause a substantial leftward shift of the agricultural labor supply curve – thereby increasing farm wages and, in turn, raising the cost of farm labor for employers in the "compliant" states. Richards (2018) conducts counter-factual policy simulations and finds that removing 50% all undocumented farmworkers from California would lead to an increase in wages of over 22%. Employers in the "noncompliant" states, on the other hand, can gain from lower labor costs and the ability to use their land, capital, and technology more productively.

Second, the Act implementation may disrupt the flow of "pickers". Fruits and vegetables become ripe at a fixed time and must be picked quickly before they rot. If farmers cannot find workers when they need them, their crops may be ruined (Fan, Pena, and Perloff's 2016). During harvest seasons, both migrant and seasonal farmworkers[5] may move from farm to farm to remain employed. Following the growing season, those illegal immigrant farmworkers often travel a set route (e.g., Florida and its way north) (Fitz 2012), so disrupting this flow may have a negative impact on the fruit and vegetable sectors. Given the two economic effects, those non-compliant states may gain a comparative advantage in producing labor-intensive agricultural products. On the other hand, fruit and vegetable growers in the compliant states, in response to rising wages and worsening labor availability, may use less labor by stop planting or harvesting a field, switch to crops whose harvesting and processing systems can easily be mechanized, or simply sell their farmland. Therefore, states with such a comparative disadvantage are expected to face reduced yields and, in turn, reduced cash receipts of labor-intensive agricultural products.

As discussed above, the following hypothesis is made:

H. The implementation of the U.S. Real ID Act has had a statistically negative impact on cash receipts for the labor-intensive agricultural sectors of fruit and vegetable in states compliant with the Act. The non-labor-intensive sectors have been influenced as well, but in a statistically insignificant way.

2.2 Literature Review

The reliance of labor-intensive sectors on unauthorized immigrants has made the question, "How to address their unauthorized status?", one of the most challenging policy issues these days. Much has been written about the connection between immigration policies and their economic impacts. Previous studies in this field of interest tend to point out the pernicious effects of accelerated immigration enforcement in developed countries on their economies and suggest a tacit tolerance of unauthorized employment: Zahniser et al. (2012) evaluate two hypothetical scenarios by using a computable general equilibrium (CGE) model and conclude that a 40 percent reduction in the number of unauthorized workers throughout the U.S. economy had a marked, long run impact on U.S. agriculture, causing a 2- to 5-percent relative decline in agricultural output; a 2- to 9-percent relative decline in farm exports, and a 3- to 7-percent relative increase in the wage rate for U.S.-born and foreign-born, permanent resident farmworkers; Zahniser et al. (2011) conduct an immigration policy simulation and find that for the most labor-intensive agricultural sectors, the policy expansion scenario (looser application of immigration controls) results in a long-run 1-2% increase in output and 0.2-3.2% increase in exports, while the policy enforcement scenario (tighter application of immigration controls) results in a 2-4%

decrease in output and 0.8-6.3% decrease in exports; Genc et al. (2012) perform a meta-analysis and find that an increase in the number of immigrants by 10 percent may be expected to increase the volume of trade on average by about 1.5 percent; Faustino and Leitão (2008) use a static and dynamic panel data analysis and find that the stock of immigrants has a positive effect on Portuguese exports, imports and bilateral intra-industry trade.

Michigan's Migrant and Seasonal Farmworkers Workgroup (MSFW) (2013) issues a report that recommended improving the system in which migrant and seasonal farmworkers go about applying for licenses and that made it clear that access to a driver's license is extremely important for regular seasonal and migrant farmworkers' ability to participate in the workforce. Fitz (2012) reports that the Georgia Agribusiness Council estimated that the state could lose up to $1 billion in produce from a lack of immigrant labor after the passage of Georgia's anti-immigrant law, H.B.87 and that a survey of farmers conducted by the Georgia Department of Agriculture found 56 percent of those surveyed were having trouble finding workers.

When it comes to impacts of the Real ID Act, most existing literature focused on examining the case law upon which some of the provisions are based and offering interpretations for unclear provisions. Cianciarulo (2006) argues that several portions of the Act may result in the denial of bona fide asylum applications and provides concrete guidance for policymakers to protect victims of persecution. Fletcher (2006) predicts that the Real ID Act may perpetuate gender bias and widen the gap between access to protection of asylum seekers in general and that of asylum seekers escaping gender-related persecution. The paper also discusses legal strategies for minimizing the negative consequences of the Act through both strategic representation of asylum seekers and broader advocacy efforts. García (2006) concludes that 1) under the anti-immigrant provisions of the Real ID Act, it will be more difficult for immigrants to obtain asylum in the U.S.; 2) immigrants, legal and illegal, will have difficulty obtaining an acceptable driver's license and an identification card which are necessary to live and conduct everyday transactions in the U.S.; 3) immigrant lives will be put at risk with the construction of physical barriers along the U.S. borders.

So far, no study has addressed the issue of causal effect of those anti-immigration policies on the U.S. economy, not to mention on agricultural cash receipts, by using econometric methods (e.g., difference-in-differences, regression discontinuity, propensity score and synthetic control). The present article contributes to the literature by applying a generalized difference-in-differences (DID) method to quantifying the expected negative impact and provides empirical evidence for further studies.

2.3 Econometric Model

Following the methodology from Hoynes and Schanzenbach's (2009) study of the food stamp program, a generalized DID model is employed, with controls for state and year fixed effects. We do not add state-specific linear time trends for assuming yearly values of agricultural cash receipts to be stationary. In particular, the following model is estimated:

$$\ln Y_{ist} = \alpha + \beta CState_{st} + \gamma_1 FEmploy_{st} + \gamma_2 Input_{ist} + \eta_s + \delta_t + \varepsilon_{ist} \quad (2.1)$$

where $\ln Y_{ist}$ is log of cash receipt for commodity *i* produced in state *s* in year *t*. Y includes cash receipts for fruits and nuts, vegetables and melons, cattle and calves, hogs, poultry and eggs, wheat, corn, and oil crops. $CState_{st}$ is a dummy variable equal to one if state s in year t is certified by DHS as Real ID compliant. $FEmploy_{st}$ is the number of hired laborers engaged in the direct production of agricultural commodities for state s in year t. $Input_{ist}$ is a vector that contains expenses for inputs used as control variables for producing commodity i (i.e., expenses on feed, livestock and poultry, seed, pesticide purchases, fertilizer, lime, and soil conditioner, petroleum fuel and oil, electricity, contract labor and hired labor, non-cash employee compensation, and other expenses) for state s in year t. η_s are state fixed effects, δ_t are year fixed effects, and ε_{ist} are the error terms. Standard errors are clustered on state. All estimates are weighted by each year's state-level farms GDP correspondingly.

The DID approach depends heavily on the counterfactual assumption that the treatment and control groups experience a common trend, also known as a parallel trend, in the absence of a policy change, with the treatment and control groups tending to have different trajectories after the policy change. To show the parallel trend, Figure 2.3 plots cash receipt trends of vegetables and melons for ten U.S. states that adopted the Real ID Act in the earliest year 2012 and that for eighteen states that were in the non-compliant group by the end of the year 2017. As Figure 2.3 shows, before 2012 the trend lines for the compliant group and the non-compliant group are nearly, although not perfectly, paralleled, but after 2012 the former group tends to have a downward trend and the latter group tends to have an upward trend. This implies a success of the research design in the sense of a parallel trend in counterfactual outcomes for commodities produced in labor-intensive sectors of U.S. agriculture.

2.4 Data

The website of United States Department of Agriculture (USDA) Economic Research Service provides state-level cash receipts in real 2019 dollars by agricultural commodity, 1998 – 2017. Data about the status of states regarding the Real ID Act (i.e., DHS certification as the Act compliant by year) are obtained from Wikipedia. The website of the Bureau of Economic Analysis (BEA) provides 1998 – 2017 state GDP in chained 2012 dollars for the industry of "Farms" that includes both crop and animal production and provides data on "Farm wage and salary employment" that is the number of hired laborers engaged in the direct production of agricultural commodities, either livestock or crops. Data on agricultural input expenses in real 2019 dollars come from USDA U.S. and State-Level Farm Income and Wealth Statistics. For each of the agricultural commodities, we exclude states that have missing value(s) of cash receipt in any of the 20 years. The total values of cash receipt for states with the missing value(s) are all very small – thereby making themselves inconsequential for the analysis. The final data set contains cash receipts for eight categories of commodities, the dummy for state status, the farms GDP, the farm employment estimates, and eleven categories of agricultural input expenses. There are separate regressions for each of the commodities on the 20-year panel data. Table 2.3 presents summary statistics for the variables used in this study.

2.5 Empirical Results

Estimation results are presented in Table 2.4. Overall, the values of R^2 are all above 90%, indicating a good fit. As row 1 of Table 2.4 shows, the coefficient on the state-status dummy variable has the expected negative sign for "fruits and nuts", but it surprisingly is not strong enough to yield significant effects. This unexpected result may be due to "growers' vulnerability to changes in labor costs varies by commodities" (Calvin and Martin 2010; Calvin and Martin 2012). In other words, the picking or processing may or may not be mechanized depending on the characteristics of the commodity being produced. It is likely that fruit growers have adopted mechanized harvesters or other labor-saving technologies more easily due to certain fruits' unique characteristics. For example, harvesting for Florida's processing oranges and California's fresh-market oranges are partially mechanized. Given fruit growers' mechanized strategies to adapt to the rising wages caused by reduced farm labors, U.S. fruit industry may not have been significantly affected by the Real ID Act implementation. The coefficients on contract labor and that on hired labor for "fruits and nuts" are positive and statistically significant both at the 1% significance level. Holding other factors constant, a one-billion increase in contract labor expenses and that in hired labor expenses lead to an increase in cash receipts for "fruits and nuts" by 27.5% and 17.6%, respectively – a remarkable sign that fruits and nuts are produced in a labor-intensive sector.

Unlike the coefficient on the state-status dummy variable for "fruits and nuts", that for "vegetables and melons" is negative and statistically significant at the 10% significance level. Holding other factors constant, the Real ID Act implementation leads to a decrease in cash receipts for "vegetables and melons" by 17.2%, which is consistent with the hypothesis that we make. The coefficients on contract labor and that on hired labor for "vegetables and melons" are not statistically significant. This empirical result seems surprising at the first glance for more labor costs should be correlated with more outcome for labor-intensive agricultural sectors. However, it makes sense if we know that illegal immigrant workers have annual incomes that are $5600 less than that of authorized workers working in the same farming sector (Ruark and Moinuddin 2011) – they are underpaid compared to their legal counterparts. In this case, vegetable growers may prefer spending on illegal workers to spending on legal ones. If U.S. vegetable sector has a significant part, where illegal employment takes place, legal labor costs (e.g., contract labor expenses and hired labor expenses) could become a less important factor that contributes to the increase in agricultural output in this sector. The coefficients in row 1 for other agricultural products are all statistically insignificant, which is in accord with the hypothesis that there is not a statistically significant relationship between the Act implementation and non-labor-intensive agricultural sectors that do not depend heavily on illegal immigrant workers.

2.6 Conclusions and Discussions

The basic purpose of this study is to quantify the economic impact of the implementation of the Real ID Act on U.S. agricultural cash receipts. We assume that compliance with the Act affects significantly and negatively on cash receipts of agricultural commodities produced in the labor-intensive sectors of fruit and vegetable, where most illegal immigrant farmworkers are hired, and that it does not have a statistically significant impact on agricultural cash receipts for non-labor-intensive sectors. The results are generally consistent with the hypothesis. The vegetable sector, as expected, is found to experience a decrease in its cash receipt by 17.2%, and cash receipts for the non-labor-intensive crops are not statistically impacted.

The fruit sector is an exception. Changes in cash receipt in this sector are neutral to the Act implementation, indicating that farmers have strategies to alleviate the impact caused by reduced labor supply. Mechanization is one of the ways through which they can overcome this reduced supply. But the same strategy may not be used in the vegetable sector, because it is more difficult for the vegetable sector to be mechanized – automated picking and harvesting are more widely used in the fruit sector than in the vegetable sector. This keeps the fruit sector less reliant on illegal immigrant farmworkers – thereby making this sector less sensitive to the Act implementation.

The shortage of labor force in agriculture has been a critical problem that haunts certain sectors of U.S. agriculture for decades. Unsteady federal immigration policy and enforcement put U.S. farmers in a dilemma – whether to hire an immigrant worker when realizing that his or her documentation may not be valid. Even if illegal employment takes place, without working authorization, those immigrant workers' human rights cannot be fully protected, and their working conditions cannot be properly improved. The saving grace for U.S. agriculture has been the H-2A guest worker program. It provides a temporary visa to foreign workers. They return home when their job is over. However, this program is limited to temporary workers, and it is too costly for some U.S. farmers. Given the strong connection between farm labor supply and the agricultural economy, creating a process through which those unauthorized immigrants can work legally, at least giving them basic rights for living, such as issuing a driver's license or an identification card, would stabilize the agricultural labor market and enhance U.S. food security.

The present study has its own limitation. The analysis is limited only to the agricultural sector. However, most illegal immigrant workers are hired in the industries of construction and service. If further studies could compare results to that in the sectors of construction, hotels, and restaurants, like Fan, Pena, and Perloff's (2016) recession-farmworker study, we would gain a better and more comprehensive understanding of the consequences caused by the implementation of the Real ID Act and the conclusions drawn here would be reinforced.

2.7 Tables and Figures for Chapter 2

Table 2.1 States by year of DHS certification as Real ID compliant

2012	2013	2014	2016	2017	2018	2019	2020	Granted extension
Colorado	Alabama	Nevada	Arizona	North Carolina	Idaho	Alaska	New Jersey	Oklahoma
Connecticut	Florida		Arkansas	Texas	Louisiana	California		Oregon
Delaware	Hawaii		New Mexico		Massachusetts	Illinois		
Georgia	Kansas				Michigan	Kentucky		
Indiana	Mississippi				Minnesota	Maine		
Iowa	Nebraska				New Hampshire	Missouri		
Maryland	Utah				New York	Montana		
Ohio	Vermont				North Dakota	Pennsylvania		
South Dakota					South Carolina	Rhode Island		
Tennessee					Virginia			
West Virginia					Washington			
Wisconsin								
Wyoming								

Source: Wikipedia contributors. (2020, May 17). Real ID Act. In *Wikipedia, The Free Encyclopedia*. Retrieved 15:06, June 3, 2020.

Table 2.2 Estimated unauthorized immigrant population, by state, 2014

State	Unauthorized immigrant population		Population of unauthorized immigrant farmworkers[2]	
	Population	Rank	Population	Rank
Alabama	65,000	32	4765	30
Alaska	10,000	42	25	39
Arizona	325,000	9	20618	10
Arkansas	70,000	30	9093	23
California	2,350,000	1	130347	1
Colorado	200,000	15	13534	16
Connecticut	120,000	19	1585	35
Delaware	25,000	40	606	37
Florida	850,000	3	43130	4
Georgia	375,000	7	19034	11
Hawaii	45,000	35	3496	33
Idaho	45,000	35	30243	8
Illinois	450,000	6	*	*
Indiana	110,000	21	6200	27
Iowa	40,000	38	4571	31
Kansas	75,000	29	12249	18
Kentucky	50,000	34	34263	7
Louisiana	70,000	30	8922	25
Maine	< 5,000	45	*	*
Maryland	250,000	11	6070	28
Massachusetts	210,000	13	*	*
Michigan	130,000	17	22487	9
Minnesota	100,000	22	11532	19
Mississippi	25,000	40	1355	36
Missouri	55,000	33	5057	29
Montana	< 5,000	45	*	*
Nebraska	45,000	35	2806	34
Nevada	210,000	13	4182	32
New Hampshire	10,000	42	*	*
New Jersey	500,000	5	6937	26
New Mexico	85,000	26	16648	14
New York	775,000	4	*	*
North Carolina	350,000	8	42027	5
North Dakota	< 5,000	45	*	*
Ohio	95,000	24	10119	20
Oklahoma	95,000	24	17028	13
Oregon	130,000	17	37131	6
Pennsylvania	180,000	16	17156	12
Rhode Island	30,000	39	506	38
South Carolina	85,000	26	10096	21
South Dakota	5,000	44	*	*
Tennessee	120,000	19	9073	24
Texas	1,650,000	2	95702	2
Utah	100,000	22	9262	22
Vermont	< 5,000	45	*	*
Virginia	300,000	10	13632	15
Washington	250,000	11	70144	3
West Virginia	< 5,000	45	*	*
Wisconsin	80,000	28	12912	17
Wyoming	5,000	44	*	*

Note: The numbers have been rounded up to the nearest digits. "*" indicates either "data unavailable" or "data unreported due to less than 5,000 unauthorized immigrants in the civilian labor force in 2014".
Source: Pew Research Center estimates for 2014 based on augmented American Community Survey. 2014 Farm employment, Bureau of Economic Analysis.

Table 2.3 Variables and summary statistics

	Units	N	Mean	S.D.	Min.	Max.
Dependent Variable						
Fruits and nuts	Billions of 2019$	680	0.71	2.79	0.01	24.97
Vegetables and melons	Billions of 2019$	820	0.52	1.35	0.0007	9.78
Cattle and calves	Billions of 2019$	1000	1.28	2.18	0.0006	13.82
Hogs	Billions of 2019$	1000	0.39	0.98	0.0002	9.93
Poultry and eggs	Billions of 2019$	960	0.82	1.16	0.000002	5.95
Wheat	Billions of 2019$	840	0.27	0.43	0.0009	2.88
Corn	Billions of 2019$	820	1.04	2.01	0.004	15.00
Oil crops	Billions of 2019$	760	0.88	1.28	0.0001	7.14
Independent Variable						
CState	1 = Compliant	1000	0.13	0.34	0	1
Farm employment	Ten thousand jobs	1000	1.62	2.79	0.02	27.24
Feed purchases	Billions of 2019$	1000	0.99	1.14	0.002	6.87
Livestock and poultry purchases	Billions of 2019$	1000	0.49	0.88	0.000007	5.77
Seed purchases	Billions of 2019$	1000	0.34	0.43	0.003	2.45
Pesticide purchases	Billions of 2019$	1000	0.27	0.32	0.0003	2.26
Expenses on fertilizer, lime, and soil conditioner	Billions of 2019$	1000	0.43	0.51	0.002	2.94
Expenses on petroleum fuel and oil	Billions of 2019$	1000	0.28	0.28	0.002	1.66
Expenses on electricity	Billions of 2019$	1000	0.11	0.15	0.0006	1.29
Contract labor expenses	Billions of 2019$	1000	0.10	0.36	0.0004	3.88
Hired labor expenses	Billions of 2019$	1000	0.55	0.96	0.01	8.74
Non-cash employee compensation	Billions of 2019$	1000	0.01	0.02	0.0001	0.14
Other expenses	Billions of 2019$	1000	2.93	2.98	0.02	18.58
Weight						
Farms GDP	Billions of 2012$	1000	3.17	4.33	0.02	40.25

Note: The number of observations for each dependent variable varies due to missing data.

Table 2.4 Estimation results

	Fruits and nuts	Vegetables and melons	Cattle and calves	Hogs	Poultry and eggs	Wheat	Corn	Oil crops
CState	-0.112	-0.172*	0.007	-0.068	0.003	-0.053	-0.011	-0.053
	(0.136)	(0.092)	(0.053)	(0.093)	(0.075)	(0.069)	(0.070)	(0.090)
Farm employment	0.011	0.021	-0.013	0.044**	0.021	-0.023	0.010	0.038*
	(0.013)	(0.015)	(0.013)	(0.019)	(0.013)	(0.014)	(0.014)	(0.022)
Feed	0.062*	-0.058	0.033	0.097**	0.035	0.052	0.015	-0.114
	(0.031)	(0.046)	(0.022)	(0.047)	(0.034)	(0.044)	(0.050)	(0.069)
Livestock and poultry	-0.085	0.069	0.030	-0.002	0.029	-0.072*	-0.007	-0.037
	(0.115)	(0.078)	(0.034)	(0.048)	(0.047)	(0.042)	(0.041)	(0.053)
Seed	-0.302**	-0.135	-0.027	0.384*	-0.084	-0.242**	-0.272***	-0.092
	(0.146)	(0.146)	(0.078)	(0.194)	(0.110)	(0.101)	(0.097)	(0.159)
Pesticide	0.184	0.065	-0.102	-0.032	-0.259	-0.189	0.009	0.365
	(0.338)	(0.343)	(0.135)	(0.261)	(0.227)	(0.274)	(0.270)	(0.259)
Fertilizer, lime, and soil conditioner	0.038	0.266	0.074	-0.229	0.062	0.001	-0.020	0.229
	(0.117)	(0.180)	(0.058)	(0.165)	(0.080)	(0.141)	(0.120)	(0.174)
Petroleum fuel and oil	0.094	0.024	-0.009	0.257**	0.093	-0.303	-0.147	-0.227
	(0.203)	(0.187)	(0.101)	(0.119)	(0.099)	(0.205)	(0.245)	(0.186)
Electricity	0.397**	0.146	0.042	-0.597**	-0.360**	0.136	0.185	-0.077
	(0.175)	(0.168)	(0.149)	(0.227)	(0.150)	(0.137)	(0.188)	(0.227)
Contract labor	0.275***	-0.014	0.082*	-0.059	-0.018	-0.157**	-0.345***	-0.301***
	(0.092)	(0.093)	(0.047)	(0.060)	(0.072)	(0.074)	(0.124)	(0.065)
Hired labor	0.176***	0.059	-0.007	-0.006	0.062	-0.112**	-0.071	-0.172**
	(0.058)	(0.063)	(0.042)	(0.069)	(0.050)	(0.051)	(0.068)	(0.068)
Non-cash employee compensation	-1.487	-2.414**	-0.956	-0.620	1.078	0.421	1.893***	1.333
	(1.033)	(0.953)	(0.633)	(1.321)	(0.709)	(1.243)	(0.642)	(0.819)
Other expenses	-0.046	-0.001	0.014	0.069**	0.024	-0.042	0.019	-0.026
	(0.039)	(0.020)	(0.019)	(0.029)	(0.021)	(0.043)	(0.047)	(0.039)
Constant	-4.062***	-5.863***	-6.115***	-7.866***	-5.296***	0.695	-0.345	-2.069**
	(0.090)	(0.081)	(0.025)	(0.076)	(0.056)	(0.555)	(0.918)	(0.954)
Number of observations	680	820	1000	1000	960	840	820	760
R^2	0.991	0.976	0.992	0.988	0.977	0.976	0.989	0.986
States excluded	AK, AR, DE, IN, IA, KS, KY, MT, NE, NV, NH, ND, RI, SD, TN, WY	CT, IA, KY, MA, NH, OK, RI, VT, WV			AK, CO	AK, CT, HI, ME, MA, NH, RI, VT	AK, CT, HI, ME, MA, NV, NH, RI, VT	AK, AZ, CT, HI, ME, MA, NV, NH, RI, VT, WV, WY

Note: Each estimate is from a separate regression of the outcome variable with state fixed effects and year fixed effects, and the standard errors are clustered on state. Standard errors are in parentheses. All estimates are weighted by each year's state-level farms GDP correspondingly. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 2.1 Unauthorized immigrant population trends for top U.S. states, 1990-2017
Source: Pew Research Center estimates based on augmented U.S. Census Bureau data.

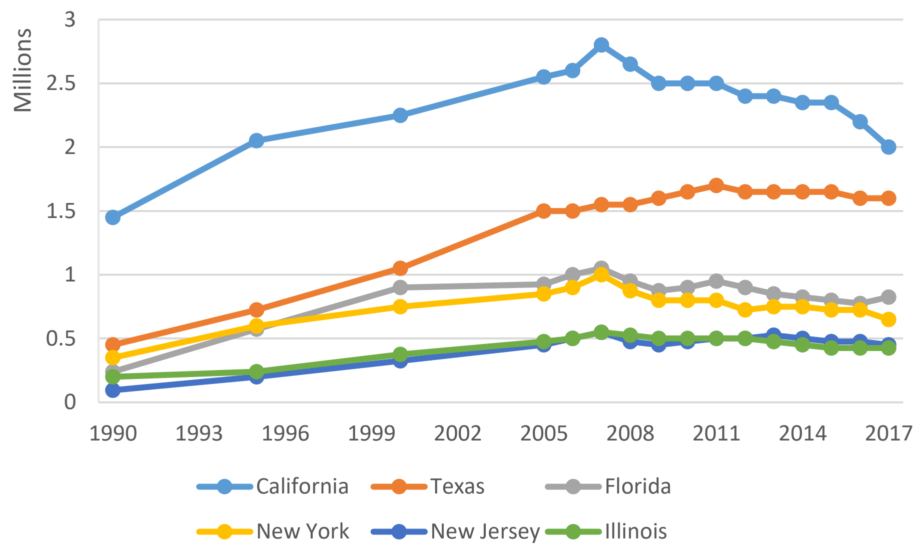


Figure 2.2 The status of states regarding the Real ID Act by the end of 2017
Source: Authors' tabulation of data from Wikipedia (Table 2.1).

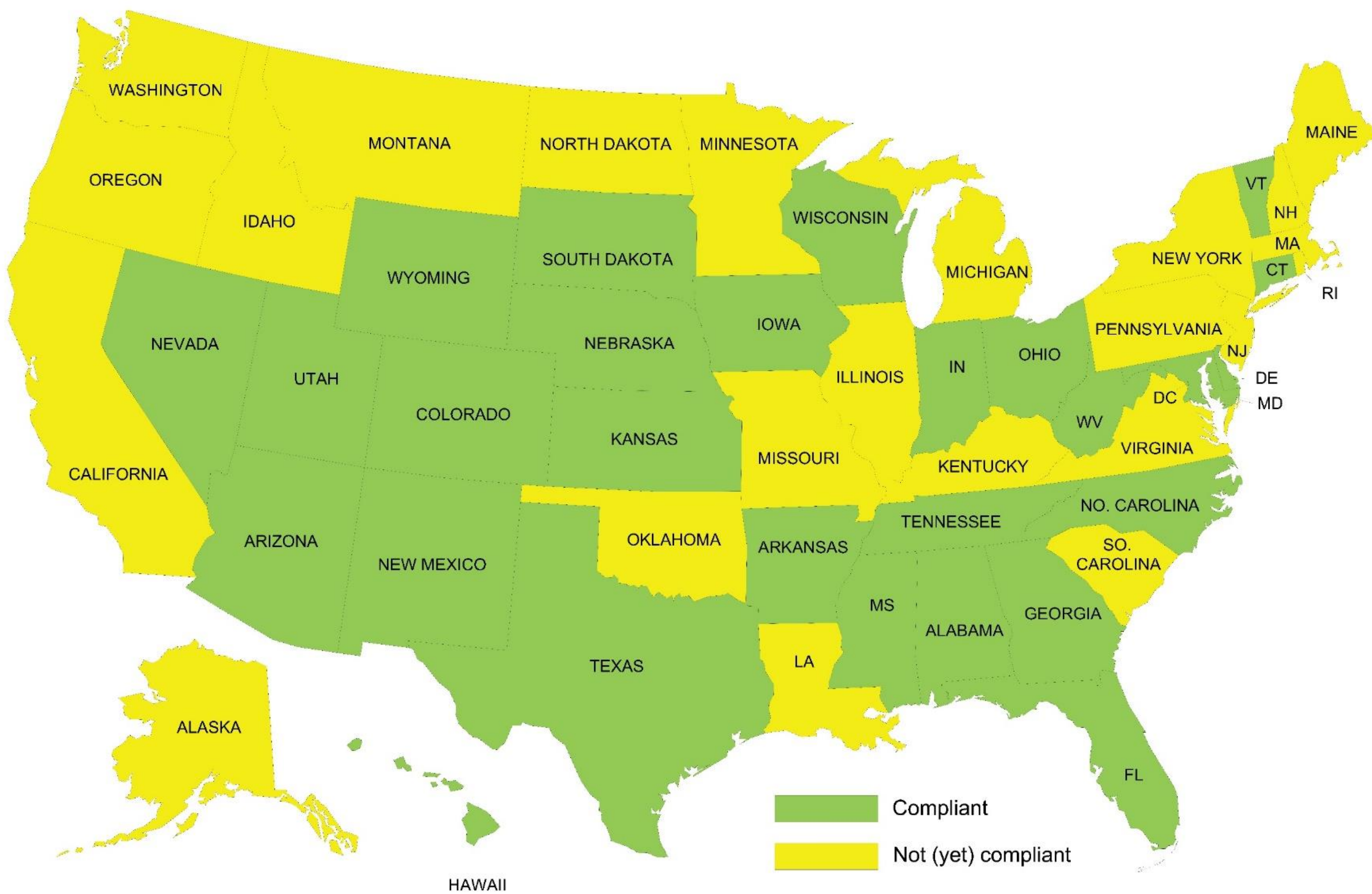
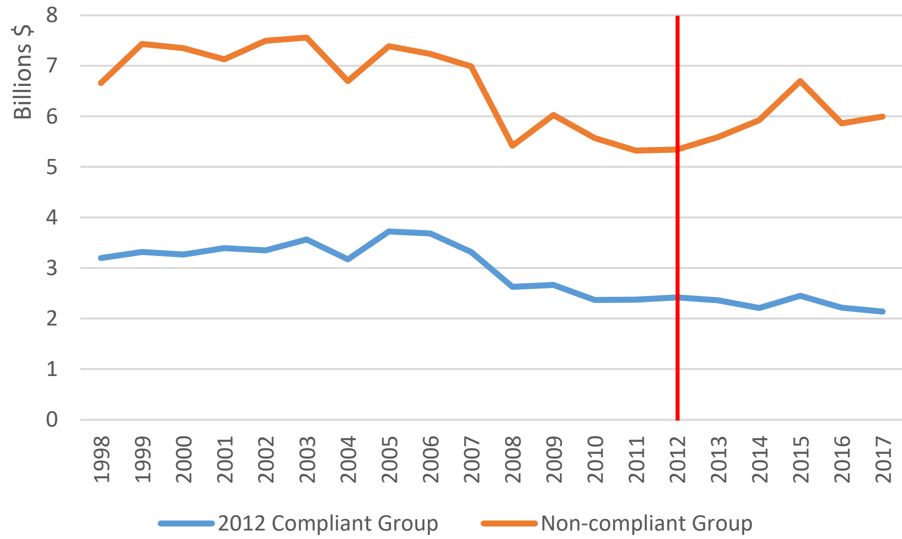


Figure 2.3 Parallel trends: 2012 Compliant Group versus Non-compliant Group

Note: The figure plots cash receipt trends of vegetables and melons for ten U.S. states that adopted the Real ID Act in the earliest year 2012 and that for eighteen states that were in the non-compliant group by the end of the year 2017. The values of the cash receipts for the two groups are averages weighted by each year's state-level farms GDP correspondingly. The 2012 Compliant Group includes Colorado, Delaware, Georgia, Indiana, Maryland, Ohio, South Dakota, Tennessee, Wisconsin, Wyoming. The Non-compliant Group includes Alaska, California, Idaho, Illinois, Louisiana, Maine, Michigan, Minnesota, Missouri, Montana, New Jersey, New York, North Dakota, Oregon, Pennsylvania, South Carolina, Virginia, Washington. The values for the 2012 Compliant Group have been multiplied by 10 for comparison. Connecticut, Iowa, West Virginia, Massachusetts, New Hampshire, Kentucky, Rhode Island, Oklahoma are excluded due to missing data.



CHAPTER 3. IMPACTS OF REFUGEE IMMIGRANTS ON GERMANY'S TRADE

Abstract

Germany's pro-immigration policies towards refugees are hypothesized to enhance the connection between Germany's refugee immigrants and the countries where they originate, thereby enabling those refugee immigrants to facilitate Germany's exports to and imports from those home countries. Employing data on Germany's refugee stocks and trade flows with 71 home countries, we quantify impacts of Germany's refugee immigrants on its bilateral trade. The refugee-trade link is estimated by using a gravity model. A Poisson Pseudo-Maximum Likelihood (PPML) estimator is used to deal with the zero-trade-value problem. Empirical results show that Germany's refugee stocks do not have a positive and significant impact on its exports to and imports from those home countries. The surprisingly weak refugee-trade link for Germany suggests that refugee immigrants there are not capable of exerting pro-trade effects, despite Germany's friendly immigration policies.

KEYWORDS: Gravity Model, Immigrants, Refugees, Bilateral Trade

3.1 Introduction

Known as a major immigrant destination as well as a target country for flows of asylum seekers looking for sanctuary, Germany had 1.1 million refugees in its territory by the end of 2018 and is the only western industrialized nation among the top ten refugee host countries (United Nations High Commissioner for Refugees (UNHCR) Global Trends 2018). Since the European migrant crisis, the large number of refugees arriving in Germany have drawn significant attention worldwide and have aroused intense political, social, and academic debates. Quantifying the effect of receiving refugee immigrants can help answer whether refugees are good or bad for a host country's economy.

While few existing studies have analyzed impacts of refugee immigrants on a host country's trade, much has been written about how immigrants without entry classifications (e.g., non-refugees, refugees, asylum-seekers, internally displaced persons, and stateless persons) affect a host country's exports to and imports from the countries that immigrants originate. The key paper on the refugee-trade link is White (2007), who proposes the "transplanted home bias" channel – immigrants with preferences for goods that are unavailable in a host country potentially increase that host country's imports from the home country.

On the other hand, immigrants may have knowledge of home country markets that, if exploited, could increase trade flows (White and Tadesse 2010). Researchers refer to this channel as "information bridge hypothesis" (Dunlevy 2006). Greenaway, Mahabir, and Milner (2007) further expound this channel as involving a "cultural bridge" and an "enforcement bridge". The former bridge is presented as helping lower communication barriers by immigrants understanding both home and host countries' languages, and business culture and regulations, hence increasing trade flows between home and host countries. The latter bridge means that sanctions for violations of contracts in international trade can be enforced through co-ethnic networks, which promote trade flows. In general, existing literature reaches a consensus that immigration exerts a positive effect on a host country's exports and imports (White 2007; Tung, Chung, and Enderwick 2011; Girma and Yu 2002; White 2008; Genc et al. 2012).

When it comes to immigration policies towards refugees in Germany, especially after the European migrant crisis, Germany government has been known to fulfill its humanitarian obligations well. Germany opened its border to hundreds of thousands of refugees, provided refugees with good, basic living conditions, offered them language and vocational trainings, and has won world-wide reputation (Ostrand 2015; Gurer 2019; Anderson 2016). Such efforts to integrate those refugee immigrants suggest that refugees in Germany live in good institutional and economic status, and that they can well participate in social activities – thereby imposing enhanced influence on the trade flows between Germany and their home countries. From this perspective, the following hypothesis is made:

H. Given lenient immigration policies towards refugee immigrants in Germany, Germany's refugee stocks are positively correlated with its exports to and imports from those home countries.

3.2 Literature review

Voluminous studies have investigated the immigrant-trade link by using different models. The commonly used ones are gravity models (Piperakis, Milner, and Wright 2003;

Faustino and Leitão 2008; Parsons 2005; Genc et al. 2012; White and Tadesse 2010; White 2007; Girma and Yu 2002), which form a log-linear relationship among trade flows, traits of home and host countries, and immigrant stocks. Literature with other models that relates to the immigrant-trade link involves Wagner, Head, and Ries (2002), who develop an alternative functional form with a constant-elasticity specification and a decreasing marginal effect specification to capture the immigration-trade link in their study on Canadian Provinces' immigration and trade; Bowen and Wu (2013), who apply a unique derivation to an economy that they model and find that immigration and trade are complements; Kohn (2001), who uses a Heckscher – Ohlin –Samuelson Model to examine the relationship between immigration and trading partners' capital transfers.

When it comes to the refugee-trade link, we only find two papers related to this topic. One is Ghosh and Enami (2015), who examine the impact of refugees from Afghanistan to Pakistan on the bilateral trade between the two countries by using a Vector Error Correctio model and Granger causality tests and find that changes in Afghani refugees do not granger cause movements in the bilateral trade. The other is White and Tadesse (2010), who compare how refugee and non-refugee immigrants affect U.S. trade with their home countries by using a gravity model and find that the influence of refugee immigrants is much smaller than that of their non-refugee counterpart. This paper, however, fails to consider the zero-trade-value problem.

The presence of zero trade flows is a common feature of trade data both at the aggregate and disaggregate levels. Simply excluding zero-trade-value or using traditional estimators (e.g., standard threshold-Tobit estimators) when zero trade flows are involved may yield severely biased estimates, and researchers find that Poisson Pseudo Maximum

Likelihood (PPML) estimator is a preferred estimator for solving this problem (Martin and Pham 2020; Burger, Van Oort, and Linders 2009; Hurd 1979). To the best of our knowledge, our study is the first to combine the gravity model with the PPML estimator to investigate the refugee-trade link, providing empirical evidence for further studies.

3.3 Model and data

We follow White and Tadesse's (2010) study on U.S. refugee-trade link by using a gravity model with X_{ijt}^{ϕ}, a vector that contains trade-facilitating/inhibiting factors that are often discussed in the literature (e.g., population, exchange rate, contiguity, common language, colonial ties, and membership in the same regional trade agreement (RTA)). In particular, the gravity equation can be written as:

$$T_{ijt} = \alpha \left(\frac{Y_{it}^{\beta_1} Y_{jt}^{\beta_2}}{GD_{ij}^{\gamma_1}} \right) X_{ijt}^{\phi} \varepsilon_{ijt} \quad (3.1)$$

where each of the three types of trade flows (i.e., trade in aggregate, manufacturing and agricultural goods) between two countries i and j during year t (T_{ijt}) is an increasing function of the trading partners' combined economic scale measured in the product of host country GDP ($Y_{it}^{\beta_1}$) and home country GDP ($Y_{jt}^{\beta_2}$) and is a decreasing function of the two countries' geodesic distance ($GD_{ij}^{\gamma_1}$). ε_{ijt} is the error term. Allowing α to be a constant, we then take natural logarithms on both sides of equation (3.1), resulting in the empirical specification:

$$
\begin{aligned}
LnT_{ijt} = \alpha_0 + \beta_1 LnY_{it} + \beta_2 LnY_{jt} + \gamma_1 LnGD_{ij} + \lambda_1 LnRE_{ijt} + \phi_1 LnPOP_{it} \\
+ \phi_2 LnPOP_{jt} + \phi_3 LnUSDXRATE_{jt} + \phi_4 LnEuroXRATE_{jt} \\
+ \phi_5 Contig_{ij} + \phi_6 Comlang_{ij} + \phi_7 Colony_{ij} + \phi_8 RTA_{ijt} + \varepsilon_{ijt} \quad (3.2)
\end{aligned}
$$

where RE_{ijt} is Germany's refugee stock from home country *j* in year *t*. POP_{it} and POP_{jt} are population of Germany in year *t* and population of home country *j* in year *t*, respectively. $USDXRATE_{jt}$ is exchange rate between the U.S. dollar and local currency of home country *j* in year *t*. $EuroXRATE_{jt}$ is exchange rate between Euro and local currency of home country *j* in year *t*. $Contig_{ij}$, $Comlang_{ij}$ and $Colony_{ij}$ are three dummies. They are equal to one if Germany and home country *j* have a common border, common official language(s), and colonial ties, respectively. RTA_{ijt} is another dummy variable, which is equal to 1 if Germany belongs to the same RTA with home country *j* in year *t*.

To deal with zero-trade observations, we then use a PPML estimator in Sun and Reed's (2010) free trade agreement study. We specify the model as:

$$
\begin{aligned}
T_{ijt} = \exp\{\alpha_0 + \beta_1 LnY_{it} + \beta_2 LnY_{jt} + \gamma_1 LnGD_{ij} + \lambda_1 LnRE_{ijt} + \phi_1 LnPOP_{it} \\
+ \phi_2 LnPOP_{jt} + \phi_3 LnUSDXRATE_{jt} + \phi_4 LnEuroXRATE_{jt} \\
+ \phi_5 Contig_{ij} + \phi_6 Comlang_{ij} + \phi_7 Colony_{ij} + \phi_8 RTA_{ijt} \\
+ \varepsilon_{ijt}\} \quad (3.3)
\end{aligned}
$$

Standard errors are clustered on country to control unobservable characteristics that lead to similar effects in different years for the trading partners.

White (2007) states, "assuming that high-income nations have developed markets and contracting procedures and that low-income nations have less complete markets and weaker contracting and enforcement mechanisms, it is likely that immigrants from lower-income nations present opportunities for increased trade." He then stratifies the home countries by income class and finds that the U.S. immigrant-trade link is driven by immigration from relatively low-income countries. Following this method, we stratify the home countries by income in the present study to find out if the link in Germany is driven by the same way.

The sample used for this analysis totals 71 countries as Germany's trading partners with a sample period from 2002 – 2017. Table 3.1 lists the countries estimated with average refugee stocks. Therefore, there are 1136 (71×16) observations. The World Bank's definition of income levels for countries is used to classify countries as low- or high-income[6]. Of the 1136 observations, 352 are from low-income countries and 784 are from high-income countries. Bilateral trade flow (i.e., total trade flow, trade flow in manufacturing, trade flow in agriculture, forestry and fishing) data come from OECD STAN Bilateral Trade Database. Data on refugee stocks come from UNHCR Population Statistics. Data on gross domestic product (GDP), population and exchange rate (local currency units (LCU) per US$) come from World Bank Open Data. U.S./Euro Exchange Rate obtained from FRED Economic Database is used for calculating exchange rate (LCU per Euro). Data on border adjacency, common official language(s), colonial ties, and geodesic distance come from the Centre d'Etudes Prospectives et d'Informations Internationales. The WTO Regional Trade Agreements (RTAs) database is the main source for RTAs. Table 3.3 presents summary statistics for the variables used in this study.

3.4 Empirical Results

Estimation results for low-income countries are presented in Table 3.4. For low-income home countries, we observe that higher GDP values of Germany correlate with increased trade flows in a statistically significant manner only when manufacturing imports are employed as the dependent variable while higher GDP values of home countries are found to statistically correlate with increased trade flows when aggregate and manufacturing exports are employed as dependent variables. The coefficients on geodesic distance are negative and statistically significant at the 1% significance level only when three types of exports are employed as dependent variables. They are not strong enough to yield a statistically significant effect when three types of imports are employed as dependent variables. Surprisingly, the coefficients on stocks of refugee immigrants from low-income countries are found not to significantly facilitate Germany's trade. Their magnitudes are small compared to that of coefficients on GDP and geodesic distance, and the only significant effect is the one when agricultural exports are employed as the dependent variable, but the coefficient is negative, which is not consistent with the hypothesis that we made.

Turning to the estimated coefficients that are statistically significant on the remaining independent variables in Table 3.4, we find that the coefficient on Germany's population is negative and statistically significant at the 5% significance level when agricultural imports are employed as the dependent variable, which means that Germany with less domestic population imports more agricultural goods from low-income home countries holding other factors constant. We also find that the coefficient on the population of home countries is positive and statistically significant at the 10% significance level when manufacturing imports are employed as the dependent variable, which means that Germany imports more manufacturing goods from low-income home countries with relatively larger population holding other factors constant. The coefficient on exchange rate between Euro and local currency of a home country is found to be positive and statistically significant at the 10% significance level when agricultural imports are employed as the dependent variable, suggesting that depreciation of a home country's currency relative to Euro may significantly increase Germany's agricultural imports from that home country despite the fact that most goods exported and imported by Germany can be invoiced by either U.S. dollar or Euro. Lastly, significant trade creation is found to exist for Germany's agricultural imports. Being as members of a common RTA increases Germany's agricultural imports from low-income home countries by 221.56% ($[(e^{1.168} - 1) \times 100]\%$).

Estimation results for high-income countries are presented in Table 3.5[7]. For high-income home countries, the GDP coefficients are all positive and statistically significant at the 1% significance level except for the coefficient on the GDP of a home country when agricultural imports are employed as the dependent variable, indicating that Germany with bigger value of GDP trades more with larger rich economies. The values of the GDP coefficients are below or close to unity, which is accord with the result from Sun and Reed's (2010) free trade agreement study. The coefficients on geodesic distance are in general negative and statistically significant, suggesting that distance does have an inhibiting effect on trade flows. Like the results for low-income home countries in Table 3.4, refugee coefficients in Table 3.5 are found not to be positive and statistically significant. Their small magnitudes suggest an inconsequential impact on Germany's trade flows. The hypothesis again is not supported by the empirical results.

Remaining coefficients that are statistically significant in Table 3.5 show: 1) Germany with less domestic population exports and imports more agricultural goods to/from high-income home countries; 2) Germany's aggregate and manufacturing imports from high-income home countries with bigger number of population is larger; 3) Having a common border significantly facilitates Germany's aggregate and manufacturing exports to as well as its agricultural imports from high-income home countries; 4) Having common official language(s) has a positive effect on Germany's aggregate and manufacturing exports to high-income home countries, but it has a negative effect on Germany's agricultural imports from high-income home countries.

3.5 Conclusions and Discussions

The basic purpose of this study is to quantify impacts of Germany's refugee immigrants on its trade flows. Given that prior studies show that immigrants generally facilitate host countries' trade, and that Germany carries out lenient policies of integrating its refugee immigrants, we hypothesize that Germany's refugee-trade correlation is statistically positive. We also assume that Germany's refugee immigrants from low-income home countries play a more important role in determining the volume of its trade flows than those from high-income home countries do. Empirical results of this study, nevertheless, are not consistent with both hypotheses – positive and significant relationship between Germany's refugee stocks and its exports to and imports from those home countries is not found either for low-income home countries or for high-income home countries.

This surprising result makes us to reconsider the impact that Germany's refugee immigrants have on its trade. White and Tadesse (2010) attribute the weak impact that U.S. refugee immigrants on U.S. trade to their tenuous ties to home countries and the constraints on refugees' ability to maintain/foster connections to home countries' business and/or social networks. Similarly, it is likely that the economic and institutional status of Germany's refugee immigrants as well as their access to Germany's human and/or resource networks is not capable of exerting significant pro-trade effects, despite Germany's friendly immigration policies. If further studies could research on reasons to which the weak link is attributable, they would provide a better and more comprehensive understanding of Germany's refugee-trade link and the conclusions drawn here would be reinforced.

3.6 Tables for Chapter 3

Table 3.1 Country listing, with refugee stocks (year = 2002-2017)

Country	Avg. Refugee stock	Country	Avg. Refugee stock
Albania	1469	Mexico	41
Angola	2340	Morocco	1434
Argentina	34	Mozambique	80
Australia	22	Netherlands	26
Bangladesh	592	New Zealand	8
Belgium	11	Nigeria	2018
Brazil	190	Pakistan	6410
Bulgaria	516	Peru	218
Burkina Faso	233	Philippines	190
Canada	73	Poland	4851
Cabo Verde	5	Portugal	15
Chile	422	Romania	1813
China	3560	Russia	28191
Colombia	207	Saudi Arabia	208
Croatia	4236	Senegal	117
Czech Republic	1545	Serbia	85989
Dominican Republic	50	Singapore	15
Egypt	892	Slovakia	167
El Salvador	18	Slovenia	147
Estonia	182	South Africa	80
France	35	South Korea	279
Ghana	2137	Spain	170
Hungary	945	Sri Lanka	9183
India	2093	Sweden	10
Indonesia	125	Syria	73534
Iran	25400	Tanzania	29
Iraq	57795	Thailand	518
Israel	260	Turkey	96128
Italy	65	Ukraine	22663
Japan	116	United Kingdom	21
Jordan	532	United States	262
Latvia	753	Uruguay	10
Lebanon	9467	Venezuela	39
Libya	649	Vietnam	15504
Lithuania	415	Zambia	12
Malaysia	44		

Source: The author’s calculation based on UNHCR Population Statistics.
Note: The numbers have been rounded up to the nearest digits.

Table 3.2 Countries represented

Low-income countries	Lower middle-income countries	Upper middle-income countries	High-income countries
Bangladesh	Angola	Albania	Australia
Burkina Faso	Cabo Verde	Argentina	Belgium
Mozambique	Egypt	Brazil	Canada
Tanzania	El Salvador	Bulgaria	Croatia
	Ghana	Chile	Czech Republic
	India	China	Estonia
	Indonesia	Colombia	France
	Iraq	Dominican Republic	Hungary
	Morocco	Iran	Israel
	Nigeria	Jordan	Italy
	Pakistan	Latvia	Japan
	Philippines	Lebanon	Netherlands
	Senegal	Libya	New Zealand
	Sri Lanka	Lithuania	Poland
	Syria	Malaysia	Portugal
	Ukraine	Mexico	Saudi Arabia
	Vietnam	Peru	Singapore
	Zambia	Romania	Slovakia
		Russia	Slovenia
		Serbia	South Korea
		South Africa	Spain
		Thailand	Sweden
		Turkey	United Kingdom
		Uruguay	United States
		Venezuela	

Source: 2010 World Bank per capita GNI-based classification.

Table 3.3 Variables and summary statistics (year = 2002-2017, observation = 1136)

	Description	Mean	S.D.	Min.	Max.
Dependent variable					
EXP_{ij}	Germany's total exports to country *j* (million dollars)	13906.47	25675.85	6.29	141249.70
IMP_{ij}	Germany's total imports from country *j* (million dollars)	11287.34	20882.46	0.08	117764.30
$MaEXP_{ij}$	Germany's exports to country *j* in manufacturing (million dollars)	13135.20	24175.95	5.56	133968.60
$MaIMP_{ij}$	Germany's imports from country *j* in manufacturing (million dollars)	9617.36	18518.20	0.01	115207.60
$AgEXP_{ij}$	Germany's exports to country *j* in agriculture, forestry and fishing (million dollars)	123.09	326.82	0	3123.81
$AgIMP_{ij}$	Germany's imports from country *j* in agriculture, forestry and fishing (million dollars)	344.71	897.54	0	8224.14
Independent variable					
Y_i	GDP of Germany (million dollars)	3301129.00	494991.20	2079136.00	3898727.00
Y_j	GDP of country *j* (million dollars)	757150.30	2088755.00	620.97	19500000.00
GD_{ij}	Geodesic distance between Germany and country *j* (kilometers)	5304.69	4168.28	279.86	18386.66
RE_{ij}	Refugee stock with origin country *j* (thousand)	6.59	27.30	0.001	496.67
POP_i	Population of Germany (thousand)	81841.36	785.64	80274.98	82657.00
POP_j	Population of country *j* (thousand)	81228.09	212664.50	442.95	1386395.00
$USDXRATE_j$	Exchange rate between U.S. dollar and local currency of country *j*	773.89	3221.00	0.48	33226.30
$EuroXRATE_j$	Exchange rate between Euro and local currency of country *j*	962.52	3974.45	0.58	37549.04
$Contig_{ij}$	1 if Germany and country *j* share a border; 0 otherwise	0.07	0.26	0	1
$Comlang_{ij}$	1 if Germany and country *j* have a common official language; 0 otherwise	0.01	0.12	0	1
$Colony_{ij}$	1 if Germany and country *j* have colonial ties; 0 otherwise	0.01	0.12	0	1
RTA_{ij}	1 if Germany belongs to the same Regional Trade Agreement with country *j*; 0 otherwise	0.44	0.50	0	1

Table 3.4 Estimation results for low-income countries

	Dependent variable					
	EXP_{ij}	IMP_{ij}	$MaEXP_{ij}$	$MaIMP_{ij}$	$AgEXP_{ij}$	$AgIMP_{ij}$
Independent variable						
LnY_{it}	0.042	1.082	-0.034	1.665^{*}	0.910	1.143
	(0.572)	(0.797)	(0.591)	(0.963)	(0.808)	(0.789)
LnY_{jt}	0.774^{***}	0.386	0.773^{***}	0.162	0.415	0.406
	(0.201)	(0.239)	(0.211)	(0.301)	(0.321)	(0.281)
$LnGD_{ij}$	-1.052^{***}	0.261	-1.064^{***}	0.522	-1.413^{***}	0.168
	(0.209)	(0.630)	(0.217)	(1.187)	(0.181)	(0.820)
$LnRE_{ijt}$	-0.014	0.066	-0.016	0.052	-0.103^{*}	0.045
	(0.047)	(0.064)	(0.049)	(0.090)	(0.059)	(0.091)
$LnPOP_{it}$	-0.754	-4.132	-0.495	-0.231	-2.643	-6.553^{**}
	(3.573)	(4.057)	(3.407)	(2.848)	(5.786)	(3.196)
$LnPOP_{jt}$	0.129	0.346	0.131	0.611^{*}	-0.009	0.132
	(0.196)	(0.233)	(0.204)	(0.320)	(0.291)	(0.330)
$LnEuroXRATE_{jt}$	0.016	0.092	0.015	0.093	0.038	0.240^{*}
	(0.076)	(0.080)	(0.079)	(0.108)	(0.083)	(0.123)
RTA_{ijt}	0.099	0.518	0.081	0.323	0.436	1.168^{*}
	(0.259)	(0.445)	(0.266)	(0.828)	(0.389)	(0.679)
Constant	13.316	26.504	11.571	-29.285	25.741	52.188
	(37.721)	(49.460)	(35.184)	(40.187)	(67.243)	(37.800)
R^2	0.882	0.727	0.876	0.694	0.540	0.673
Number of observations	352	352	352	352	352	352

Note: Each parameter is from a separate regression, and the standard errors are clustered on country. Standard errors are in parentheses.
$LnUSDXRATE_{jt}$, $Contig_{ij}$, $Comlang_{ij}$, $Colony_{ij}$ are excluded to ensure that the estimates exist.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 3.5 Estimation results for high-income countries

	Dependent variable					
	EXP_{ij}	IMP_{ij}	$MaEXP_{ij}$	$MaIMP_{ij}$	$AgEXP_{ij}$	$AgIMP_{ij}$
Independent variable						
LnY_{it}	0.545***	0.728***	0.534***	0.676***	0.561**	0.927***
	(0.104)	(0.143)	(0.104)	(0.182)	(0.283)	(0.316)
LnY_{jt}	0.696***	0.461***	0.692***	0.465***	0.716***	0.234
	(0.071)	(0.100)	(0.069)	(0.133)	(0.213)	(0.213)
$LnGD_{ij}$	-0.643***	-0.813***	-0.633***	-0.720***	-1.060***	-0.120
	(0.065)	(0.099)	(0.065)	(0.164)	(0.191)	(0.188)
$LnRE_{ijt}$	0.002	-0.036*	0.002	-0.046*	-0.043	-0.082
	(0.015)	(0.021)	(0.015)	(0.027)	(0.049)	(0.050)
$LnPOP_{it}$	0.308	-1.229	0.117	-0.640	-5.821***	-3.904***
	(0.815)	(1.075)	(0.784)	(0.771)	(1.404)	(1.278)
$LnPOP_{jt}$	0.106	0.387**	0.114	0.436**	-0.216	0.204
	(0.088)	(0.156)	(0.082)	(0.199)	(0.307)	(0.306)
$LnEuroXRATE_{jt}$	-0.031	0.005	-0.031	0.025	-0.077	-0.170
	(0.034)	(0.050)	(0.035)	(0.056)	(0.106)	(0.106)
$Contig_{ij}$	0.263**	0.457	0.245**	0.488	0.652	1.501**
	(0.121)	(0.286)	(0.110)	(0.315)	(0.504)	(0.734)
$Comlang_{ij}$	0.323***	0.286	0.320***	0.400	-0.228	-1.476**
	(0.103)	(0.267)	(0.087)	(0.265)	(0.466)	(0.574)
$Colony_{ij}$	-0.042	-0.339	-0.034	-0.244	0.114	-0.586
	(0.101)	(0.225)	(0.091)	(0.249)	(0.346)	(0.479)
RTA_{ijt}	0.194	-0.177	0.191	0.125	-0.552	0.371
	(0.120)	(0.198)	(0.117)	(0.279)	(0.537)	(0.534)
Constant	-7.433	8.555	-5.250	0.975	63.392***	31.630**
	(8.995)	(12.202)	(8.707)	(8.707)	(15.981)	(12.609)
R^2	0.960	0.849	0.963	0.816	0.679	0.433
Number of observations	784	784	784	784	784	784

Note: Each parameter is from a separate regression, and the standard errors are clustered on country. Standard errors are in parentheses. $LnUSDXRATE_{jt}$ is excluded to ensure that the estimates exist.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

CHAPTER 4. ADAPTATION MEANS AS PROMOTERS FOR CLIMATE-INDUCED MIGRATION: EVIDENCE FROM LEAST DEVELOPED COUNTRIES

Abstract

Climate-induced migration refers to population mobility of the international community where people are forced to leave their traditional habitats for improving the quality of life in host countries due to climatic factors that jeopardize their existence in their home countries. This type of migration occurs mostly in least developed countries (LDCs), because these countries have comparatively high rural population shares and agricultural earnings represent the major income source for their citizens. These migrants are among the poorest, and consequently they are more vulnerable to adverse climatic factors that have negative impacts on agricultural yields. The main adverse climatic factor for agriculture is higher temperature. Higher temperature reduces agricultural yields and in turn reduces agricultural earnings, making costs of long-distance migration to comparatively rich countries unaffordable to those climatic migrants. This is known as the climate-migration poverty trap. Much has been written about the means that can modulate the trap. In this study, we quantify impacts of three adaptation means (more access to irrigation, less CO_2 emission and larger amount of foreign direct investment (FDI)) on the migration rate for 23 LDCs of origin with respect to 129 countries of destination. Empirical results show that all the three means are promotors that significantly facilitate the climate-induced migration and that access to irrigation has a much bigger influence.

KEYWORDS: Climate-induced Migration, Least Developed Countries, Irrigation, CO_2 Emission, Foreign Direct Investment

4.1 Introduction

According to 2020 Global Report on Internal Displacement, issued by Internal Displacement Monitoring Centre (IDMC), a part of Norwegian Refugee Council (NRC), some 5.1 million people in 95 countries and territories have relocated within their home countries because of natural disasters that happened in 2019 or prior years. The exact number of people relocating abroad due to adverse climatic factors remains controversial, but there is no doubt that the total number of climatic migrants is soaring and is predicted to reach tens and hundreds of millions within the next 20 and 50 years, respectively (Park 2011). The consequential number of climatic migrants has made topics in climate-induced migration a vanguard of research on international development.

Climate-induced migration occurs more often in least developed countries (LDCs) than in their more developed counterparts. For one thing, LDCs have a larger share of rural population whose income level depends heavily upon weather conditions, and those countries have limited capacity for applying mitigation measures (e.g., planting drought-resistant crops and investing in irrigation) that can offset, at least in part, the negative impacts caused by adverse climate. They also lack necessary preparations through adaptation means, such as well-established systems for agricultural insurance and improvements for water storage, use and flood defense. Countries fall within the sphere mentioned above thus are more vulnerable and are affected more significantly when environmental changes or natural disasters take place. The United Nations (UN) defines LDCs as countries highly vulnerable to environmental shocks. The Least Developed Counties Report 2015 issued by United Nations Conference on Trade and Development (UNCTAD) finds that more than two thirds of total population of LDCs live in rural areas.

The report points out that climate change is one of the main factors that affect yield growth in agriculture in LDCs and that it is likely to have a negative effect on agricultural productivity in most LDCs.

For another, people from LDCs commonly migrate abroad in search of more affluent lives. This is understandable given that wages abroad usually are far higher than those at home. Tangible evidence is that the amount of their remittances, the income that they send home, has been increasing (Taylor 2006; De Haas 2007; Maimbo and Ratha 2005). The remittances increase household income directly, encouraging consumption and investment in LDCs. They also become an important source of foreign-exchange reserves for those migrants' countries of origin. All this helps reduce poverty, improve people's welfare, and increase LDCs' resilience to climatic shocks, so migrating abroad cannot only benefit LDCs' people individually, but a country as a whole.

Nevertheless, the fact is that not all can afford migration costs, and those who are unable to migrate due to financial constraints are thus trapped in poverty. Researchers use the term "climate-migration poverty trap" to describe this pernicious circle (Jacobson et al. 2019; Benonnier, Millock, and Taraz 2019). The "climate-migration poverty trap" starts with negative outcomes for agricultural yields, like low levels of rainfall, scarcity of underground water, or locust plagues. All these abnormalities result from one adverse climatic factor – high temperature. Then the "climate-migration poverty trap" begins – high temperature reduces agricultural yields, and in turn reduces the income of people from LDCs, making migration costs unaffordable for them. The impossibility of moving from LDCs where high temperature hits then becomes a trap that results in worsening poverty.

The “climate-migration poverty trap” is found in existing literature. On the one hand, previous studies show direct impacts of high temperatures that reduce agriculture yield and in turn reduce farm net revenues (Mendelsohn & Massetti 2017; Jones and Olken 2010; Dell, Jones, and Olken 2009; Dell, Jones, and Olken 2012; Kurukulasuriya and Mendelsohn 2007). On the other hand, the relationship between high temperatures and human migration for LDCs has also been quantified by existing literature. Benonnier, Millock, and Taraz (2019) find that higher temperatures correlate with decreased migration rates from the poorest countries (measured by GDP per capita) while no such effect is found for countries with GDP per capita in the upper quartiles of the distribution. Cattaneo and Peri (2016) analyze the impact of warming trends on internal and external migration by applying data from 115 countries between 1960 and 2000 and conclude that higher temperatures reduce the probability of both domestic and international migration in poor countries. Cattaneo and Massetti (2015) investigate migration as a response to climate change in Ghana and Nigeria and find that households located in districts with high temperature are less likely to become migrant families than their counterparts located in districts with mild temperatures.

The “climate-migration poverty trap” causes humanitarian emergencies, presenting the question, “How to overcome the mobility constraint and get “trapped” population out of persistent poverty?” This is one of the most challenging policy issues nowadays. Investment in irrigation expansion could be an adaptation strategy that helps weaken the poverty trap. Researchers find that irrigation expansion reduces vulnerability to water stress in warmer climate for target regions, increasing crop productivity to provide food for many people applying irrigation as an effective adaptation against higher temperature to agriculture (Rosa et al. 2020; Kurukulasuriya and Mendelsohn 2007; Ashofteh, Bozorg-Haddad, and Loáiciga 2017). This offsetting effect of irrigation on the poverty trap can make agriculture in LDCs less sensitive to unfavorable climate caused by higher temperature and those climate migrants more likely to be able to afford the migration cost.

Two other adaptions that this study considers feasible involve less CO_2 emission and larger amount of foreign direct investment (FDI). For the former, reducing the amount of CO_2 emission is found to decelerate the global warming trend (Radhi 2009; Matthews and Caldeira 2008). In 2015, top emitters of CO_2 signed the Paris Agreement, committed to reduce the emission for fighting the climate crisis. CO_2, known as a major greenhouse gas, is found to be responsible for global and regional increase in temperature (Hansen and Sato 2016). Although the amount of CO_2 emission from LDCs is very small compared to that from industrialized nations, low-carbon growth paths, instead of high-carbon growth paths, is suggested for LDCs' development (Bowen, Fankhauser, and Best 2011). Therefore, reducing the amount of CO_2 emission may not be a means to moderate LDCs' temperature directly, but it is a suggested way of enhancing LDCs' productivity and well-being, making LDCs' people more likely to be able to afford the migration cost.

For the latter, UNCTAD reports that FDI contributes to promoting sustainable development and reducing social and income disparities in most LDCs. The benefits of FDI for LDCs are including but not limited to: 1) employment generation and growth; 2) integration into the global economy; 3) raising skills of local manpower; 4) transfer of modern technologies (Dupasquier and Osakwe 2006). The prominent benefits of FDI means that FDI has been of great help for LDCs in their efforts to reduce poverty and overcome income inequality. FDI, therefore, also plays as a role for improving the affordability of people in LDCs as irrigation expansion does.

In this paper, we quantify impacts of the three adaptation means (more access to irrigation, less CO_2 emission and larger amount of FDI) on migration rate for 23 LDCs of origin with respect to 129 countries of destination. Of the 23 LDCs, 21 are sub-Saharan countries. Most of sub-Saharan countries have a tropical climate and a yearly average temperature around 64 degrees Fahrenheit (about 18 degrees Celsius) (Pulsipher and Pulsipher 2008). They thus serve as good observations on how to overcome the "climate-migration poverty trap". We believe that adaptation means in response to adverse climate caused by high temperature can help people escape, at least in part, from the "climate-migration poverty trap". Therefore, the following hypothesis is made:

H. More access to irrigation, less CO_2 emission and larger amount of foreign direct investment are three adaptation strategies for LDCs in response to high temperatures that reduce agricultural yields. They function as promotors that facilitate climate-induced migration.

4.2 Literature review

While the viewpoint that adverse climate (e.g., high temperature, low level of precipitation, natural disasters, etc.) negatively correlates with international migration for less developed countries prevails in academia, opposite findings also exist in literature. Beine and Parsons (2015) consider high temperature as an environmental factor that influences international migration, but find little direct, temperature-induced impact across their entire sample consisting of both LDCs and other countries. They also find that natural disasters cause increasing flows of migrants to urban environs. Bohra-Mishra et al. (2017) conclude that increases in temperature and typhoon activity lead to increases, rather than decreases, in outmigration for the Philippines and that precipitation does not have the same, significant effect. Cai et al. (2016) show that a rise in temperature positively, instead of negatively, correlates with outmigration only for agriculture-dependent countries (1℃ increase in temperature leads to 5% increase in outmigration). Other studies with opposite findings (Bohra-Mishra, Oppenheimer, and Hsiang 2014; Gray and Wise 2016; Mueller, Gray, and Hopping 2020; Marchiori, Maystadt, and Schumacher 2012) make the viewpoint towards the impact of temperature on migration more mixed. However, those who find that climate change has little impact do not deny that environmental factors influence international migration but argue that they might influence migration through indirect channels (e.g., temperature-related natural disasters). Studies which find a positive relationship between temperature and human mobility see such an effect usually in internal migration in which the cost of relocation is comparatively low and more affordable for those climatic migrants.

When it comes to the methods that can absorb the income shock caused by adverse climate in agriculture-based economies, other than irrigation expansion, researchers have also offered suggestions pertaining on how to weaken the climate-migration poverty trap to planners and policy makers through social or institutional perspectives (Black et al. 2008; Luetz 2018). Nawrotzki and DeWaard (2018) find that access to migrant networks enables climate related mobility in the poorest district. Barrett et al. (2007) highlight the importance of micro-finance innovation in climate-induced migration. To date, few studies have quantified the effect of applying a wide range of adaptation strategies on climate-induced migration. The present paper tries to fill this void by accounting for three means (i.e., more access to irrigation, less CO_2 emissions and larger amounts of FDI) that are assumed to attenuate the link between adverse climate and migration flows, providing empirical evidence for future research.

4.3 Econometric Model

Since the assumption that the relationship between climate-related stresses and migration is linear is not supported by existing literature (Black et al. 2008; Feng, Krueger, and Oppenheimer 2010; Bohra-Mishra, Oppenheimer, and Hsiang 2014; Beine and Parsons 2015; Cai et al. 2016), we follow Benonnier, Millock, and Taraz's (2019) climate-migration-irrigation study by using a log-linear model and estimate:

$$\ln\left(Migr_{ij}\right) = \alpha + \beta_1 Irrig_i + \beta_2 Emiss_i + \beta_3 FDI_i + \beta_4 Temp_i + \beta_5 Prec_i + \beta_6 Rural_i + \beta_7 PerGDP_i + \beta_8 PerGDP_j + \beta_9 Contig_{ij} + \beta_{10} Comlang_{ij} + \beta_{11} Colony_{ij} + \beta_{12} GD_{ij} + \varepsilon_{ij} \quad (4.1)$$

where *i* is a country of origin, and *j* is a country of destination. ln ($Migr_{ij}$) is the log of migration rate ($\frac{The\ number\ of migrants\ in\ the\ i-j\ migration\ corridor}{The\ native\ population\ in\ country\ i}$) in 2017. $Irrig_i$ is the share of 2017's land area equipped for irrigation for country *i*. $Emiss_i$ is 2017's total CO_2 emission in agriculture for country *i*. FDI_i is 2017's total foreign direct investment for country *i*. $Temp_i$ and $Prec_i$ are 2017's temperature change[8] and long-term average of annual precipitation, respectively, for country *i*. $Rural_i$ is 2017's rural population share for country *i*. $PerGDP_i$ and $PerGDP_j$ are per capita GDP for country *i* and *j* in 2017, respectively. $Contig_{ij}$, $Comlang_{ij}$ and $Colony_{ij}$ are three dummies. They are equal to one if country i and j have a common border, common official language(s) and colonial ties, respectively. GD_{ij} is the geodesic distance between country i and j. ε_{ij} is the error term. For comparison, we conduct two separate regressions based on the model by using the methods of ordinary least squares (OLS) and then generalized method of moments (GMM).

Two reasons account for the use of GMM. To begin with, our use of cross-sectional data raises the issue of heteroscedasticity (the null hypothesis of homoscedasticity is found to be rejected at the 1% significance level by a White test). What is more, we consider an endogeneity issue that 2017's temperature change is potentially correlated with the error term ε_{ij}, which includes unobserved, temperature-related factors in 2017. To address the issue of endogeneity, we choose 2016's temperature change for a country of origin as the sole instrument for this model. We suppose: 1) 2016's temperature change does not have a direct effect on 2017's migration rate; 2) 2016's temperature change is not correlated with the error term ε_{ij}; 3) 2016's temperature change is strongly correlated with 2017's temperature change. Hausman test shows that 2017's temperature change is correlated with the error term ε_{ij} at the 1% significance level, which verifies our concern of endogeneity. We also verify that 2016's temperature change is a strong instrument by conducting the Software Stata's first stage check.

4.4 Data

The website of UN Department of Economic and Social Affairs provides data on 2017 estimates of international migrant stock at mid-year by origin. The dataset also presents classification of countries by development level or income. FAOSTAT, a UN

Food and Agriculture Organization (FAO) database, provides data on total population, land area equipped for irrigation, total land area, total CO_2 emission in agriculture, and total FDI inflows in the year of 2017. FAOSTAT also provides data on 2016's and 2017's temperature change. Another database of FAO, AQUASTAT, provides data on long-term average (over space and time) of annual precipitation and 2017 rural population by country. Data on per capita GDP by country are obtained from The World Bank database. Data on border adjacency, common official language(s), colonial ties and geodesic distance come from the Centre d'Etudes Prospectives et d'Informations Internationales. The final sample consists of 23 countries of origin and 129 counties of destination. After excluding missing data, we have 1007 observations left for analysis. Table 4.1 presents summary statistics for the variables used in this study.

4.5 Empirical Results

Table 4.2 shows the results of estimating equation 4.1. OLS and GMM regressions explain 49.2% and 48.2% of the variation in the observed migration flows, respectively. Given that the migration rates are quite heterogenous and that we use cross-sectional data, the values of R^2 are reasonable. Overall, all estimates in both estimations have expected signs, which are consistent with the hypothesis.

We first find a significant and positive effect of irrigation on emigration at the 1% significance level and the magnitude is the largest in both the OLS and GMM columns: a one-percent increase in proportion of land area equipped for irrigation for a country of origin leads to a 1620.4% increase (OLS) and a 1938.1% increase (GMM) in migration rate for that country. The mean value of the migration rate across the sample in this study is around 0.11%, so we use the Burkina Faso-Niger corridor, whose migration rate is 0.118%, as an example to put the estimate into perspectives: when the GMM method is applied, in 2017, if Burkina Faso's share of irrigated land could increase by 1%, its migration rate to Niger would increase by nearly twentyfold, from 0.118% to 2.287%, holding other factors constant. Given that Burkina Faso's population in 2017 is 19,193,234, this result means that about 416,301 more people in Burkina Faso would be able to migrate to Niger because of the improvement of irrigation.

As to the other two adaption means, a one-thousand-gigagram increase in CO_2 emission in agriculture significantly reduces the migration rate at the 1% significance level, leading to a 2.5% decrease in the OLS estimation and a 3.2% decrease in the GMM estimation. In other words, less CO_2 emission is correlated with increased migration rate. Bowen, Fankhauser, and Best (2011) discuss the reasons why LDCs should adopt low-carbon growth paths in details. They point out that reductions in CO_2 emission allow LDCs to well integrate themselves to the increasingly "green" world in terms of trade, technological progress and environmental protection and that individuals and a country as a whole eventually benefit from this trending and promising ways of development. A one-billion-dollar increase in FDI significantly increases migration rate at the 5% (OLS) and the 1% (GMM) significance levels, leading to a 27.9% increase and a 37.2% increase, respectively. This positive relationship between FDI and migration rate tacitly demonstrates that FDI helps improve the affordability of LDCs' people. Using the Burkina Faso-Niger corridor as an example again, we can conclude that when the GMM method is applied, in 2017, if Burkina Faso's FDI amount could increase by one billion dollars, its migration rate to Niger would increase from 0.118% to 0.162%. This result means that about 8445 more people in Burkina Faso would be able to migrate to Niger because of the increased amount of FDI.

The coefficients on the remaining variables in the OLS and GMM columns are as expected. Temperature change positively affects the migration rate at the 5% (OLS) and the 1% (GMM) significance levels. This result remarkably shows that temperature anomalies are a vital factor linking to the climate-induced migration. The coefficient on precipitation is significant only in the OLS estimation. It is positive and significant at the 5% level of significance, but the magnitude is small, only 0.03%.

A one-percent increase in the rural population share for a country of origin significantly reduces that country's migration rate by 123.7% when the OLS method is applied. This coefficient is significantly different from zero at the 10% significance level. In other words, people in rural areas of LDCs are found to be less likely to afford the migration cost. No such significant effect is found when the GMM method is applied. The coefficients on per capita GDP for the country of origin and that for the country of destination are positive and statistically significant at the 1% significance level in both estimations. A one-thousand-dollar increase in the per capita GDP for a country of origin leads to a 75.1% increase (OLS) and a 78.7% increase (GMM) in the migration rate, indicating the important role that affordability plays when people in LDCs decide whether to move to a foreign country. A one-thousand-dollar increase in the per capita GDP for a country of destination leads to a 2.7% increase in the migration rate in both estimations, suggesting that richer countries are more attracted to those climate-induced migrants.

The coefficients on the three dummies are all statistically significant at the 1% significance level. Having a common border, common official language(s) and colonial ties for a country of destination appeal to climate-induced migrants more by 340.6%, 229.4% and 321.8%, respectively, in the OLS estimation, and 348.7%, 230.9% and 321.1%, respectively, in the GMM estimation. Lastly, a one-thousand-kilometer increase in the geodesic distance between home and host countries causes a decrease in the migration rate by 31.4% and 29.9%, in the OLS and GMM estimations, respectively, both at the 1% significance level.

4.6 Conclusions and Discussions

The basic purpose of this study is to quantify the impacts of three adaptation means in response to adverse climate, higher temperature mainly, on external migration for LDCs. We assume that expansion of irrigated cropland, reductions of CO_2 emission and attracting more FDI can help increase agricultural income for rural people living in LDCs, making long-distance migration to a foreign country more affordable for them. The three adaptation means therefore function as promotors that facilitate climate-induced migration. The results are generally consistent with the hypothesis. While demonstrating that more access to irrigation is an agricultural channel that drives climate-induced migration as some studies have confirmed, we also find that less CO_2 emission and larger amount of FDI have the same, although smaller, effect.

Our results shed light on ways of helping the rural population in LDCs to get rid of poverty. The 2019 report issued by the UN International Organization for Migration (IOM) states that international migration contributes to LDCs' economic and social development if managed well, because the remittances, the transfer of skills, the access to possible education abroad make the diaspora population active agents for developing their home countries. For that matter, we should take actions aiming at supporting LDCs' people to access safe and regular migration channels. The positive relationship between the expansion of irrigated cropland and migration rate in this study suggests that enhancing a wide range of infrastructure that can positively affect LDCs' agriculture yield may greatly increase the rural people's affordability for migratory movement to a foreign country. Investing in this area should be a promising way for developed countries that want to help. Limiting LDCs' emission of greenhouse gases to the criteria of low-carbon development is another way. Adopting low-carbon growth paths allow LDCs to well integrate themselves to the increasingly "green" world in terms of trade, technological progress, and environmental protection, and LDCs eventually benefit from this trending ways of development. As to FDI in LDCs, the influence of FDI on the migration rate in this study seems much smaller than that of irrigation, probably because FDI in most LDCs has been disproportionately inflowing into urban centers, leaving large rural areas suffering from the lack of FDI (UNCTAD Report 2011). The limited amount of FDI in poorer regions causes that the effect of FDI on well-being improvement for LDCs' people is not as prominent as expected. If policy makers could find a way of attracting more FDI while letting FDI favor the rural areas, the large number of the rural population would benefit more from the financial input, and the migration rate among them would significantly increase.

4.7 Tables for Chapter 4

Table 4.1 Summary statistics of variables (year = 2017, observations = 1007)

Variable	Units	Mean	S.D.	Min.	Max
Migration rate estimated at mid-year for country of origin with respect to country of destination	%	0.11	0.51	0.00000094	6.81
Proportion of land area equipped for irrigation for country of origin	%	1.07	2.22	0.002	9.55
Total CO_2 emission in agriculture for country of origin	Thousand gigagrams	23.46	25.90	0.26	102.93
Total foreign direct investment for country of origin	Billion dollars	0.64	0.98	0.003	4.02
Temperature change for country of origin	Celsius	1.38	0.40	0.27	2.12
Long-term average of annual endogenous precipitation in depth for country of origin	mm/year	1109.33	574.59	151.00	2526.00
Rural population share for country of origin	%	66.58	14.03	37.31	88.14
Per capita GDP for country of origin	Thousand dollars	0.81	0.30	0.36	1.55
Per capita GDP for country of destination	Thousand dollars	25.84	24.08	0.29	107.63
Contiguity between country of origin and country of destination	1 = common border	0.08	0.28	0	1
Common official language between country of origin and country of destination	1 = common language	0.26	0.44	0	1
Colonial ties between country of origin and country of destination	1 = colonial ties	0.02	0.14	0	1
Geodesic distance between country of origin and country of destination	Thousand kilometers	5.26	3.32	0.16	17.65

Table 4.2 Estimation results

Dependent variable: log of Migration rate	OLS	GMM
Proportion of land area equipped for irrigation	16.204^{***}	19.381^{***}
	(4.001)	(4.078)
Total CO_2 emission in agriculture	-0.025^{***}	-0.032^{***}
	(0.005)	(0.005)
Total foreign direct investment	0.279^{**}	0.372^{***}
	(0.109)	(0.114)
Temperature change for country of origin	0.546^{**}	1.495^{***}
	(0.213)	(0.330)
Long-term average of annual precipitation	0.0003^{**}	0.00008
	(0.0002)	(0.0002)
Rural population share	-1.237^{*}	-0.167
	(0.639)	(0.697)
Per capita GDP for country of origin	0.751^{***}	0.787^{***}
	(0.246)	(0.256)
Per capita GDP for country of destination	0.027^{***}	0.027^{***}
	(0.004)	(0.004)
Contiguity	3.406^{***}	3.487^{***}
	(0.269)	(0.276)
Common official language	2.294^{***}	2.309^{***}
	(0.181)	(0.183)
Colonial ties	3.218^{***}	3.211^{***}
	(0.304)	(0.313)
Geodesic distance	-0.314^{***}	-0.299^{***}
	(0.028)	(0.029)
Constant	-11.382^{***}	-13.185^{***}
	(0.667)	(0.826)
Number of observations	1007	1007
R^2	0.492	0.482

Note: Standard errors are in parentheses.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

CHAPTER 5. CONCLUSION

This dissertation provides some important findings. Firstly, as an anti-immigrant law, the U.S. Real ID Act does have a negative impact on the U.S. agricultural sectors that are labor-intensive. Although empirical results in essay one (Chapter 2) suggest that U.S. farmers may alleviate the negative impact through adaptation means, finding a way of legalizing those illegal immigrant farmworkers is still much needed to stabilize the agricultural labor market and enhance U.S. food security. Secondly, although positive and significant relationship between Germany's refugee stocks and its exports to and imports from the home countries where the refugees originate is not found, empirical results in essay two (Chapter 3) do not show that refugees are a burden of Germany's economy in terms of the trade flows. Germany's refugee immigrants may be not yet capable of exerting remarkable pro-trade effects, but Germany's efforts to well integrate refugee immigrants into its society should be acknowledged and appreciated.

Lastly, essay three (Chapter 4) sheds light on ways of helping the rural population in LDCs to access migration channels. Expanding irrigated cropland, reducing emission of greenhouse gases, and attracting more FDI are three suggested measures of increasing the well-being of people in LDCs. They eventually make people in LDCs more likely to be able to afford the migration cost. To sum up, this dissertation suggests lenient laws and policies towards immigrants and provides feasible methods and strategies for the international community that seeks to help underdeveloped countries.

APPENDIX 1

Notes

1. Illegal, unauthorized and undocumented will be used interchangeably. These terms are used to mean a person who resides in the United States, but who is not a U.S. citizen, has not been admitted for permanent residence, and is not in an authorized temporary status permitting longer-term residence and work (Passel, Van Hook, and Bean 2004).

2.

$$\text{Population of unauthorized immigrant farmworkers} = \frac{\text{Estimated total authorized farmworkers}}{(1 - \text{shares of unauthorized immigrant farmworkers})} \times \text{shares of unauthorized immigrant farmworkers}$$

3. 287(g) agreement aims to expand the federal government's enforcement capacities while enabling state, county, and local law enforcement agencies to respond directly to popular concerns regarding illegal immigration (Rodriguez et al. 2010).

4. Form I-9 is used for verifying the identity and employment authorization of individuals hired for employment in the United States. Acceptable documents that accompany form I-9 include a state driver's license and a state identification card (U.S. Citizenship and Immigration Services (USCIS)).

5. In general, migrant farmworkers are individuals who travel a greater distance to farm sites and cannot return daily to their permanent residences. Seasonal farmworkers, on the

other hand, temporarily work in agriculture without having to leave their residence (Lewis, Martinez, and Coronado 2017).

6. In the calendar year 2010, the World Bank classified nations as low-income if 2010 gross national income (GNI) per capita was ≤ $1005; lower middle-income if GNI per capita was between $1006 and $3975; upper middle-income if GNI per capita was between $3976 and $12275; high-income if GNI per capita > $12275. We merge the low-income and lower middle-income home countries into one group: low-income countries; the upper middle-income and high-income ones into another group: high-income countries. Table 3.2 lists the countries in the data set by income class.

7. The number of remaining independent variables in Table 3.5 is different from that in Table 3.4 due to Poisson regression creating “perfect predictors”. Stata automatically drops “perfect predictors”, and the number of the “perfect predictors” varies based on data used (Silva and Tenreyro 2010; Silva and Tenreyro 2011).

wis, Martinez, and Coronado 2017).

8. The FAOSTAT Temperature Change domain disseminates statistics of mean surface temperature change by country, with annual updates. The dissemination covers the period 1961 – 2019. Statistics are available for annual mean temperature anomalies, i.e., temperature change with respect to a baseline climatology, corresponding to the period 1951 – 1980.

APPENDIX 2

List of Countries for essay three (Chapter 4)

Origins (23): Benin, Burkina Faso, Central African Republic, Chad, Comoros, Ethiopia, Gambia, Guinea, Guinea-Bissau, Haiti, Liberia, Madagascar, Malawi, Mali, Mozambique, Nepal, Niger, Senegal, Sierra Leone, Togo, Uganda, United Republic of Tanzania, Zimbabwe

Destinations (129): Angola, Antigua and Barbuda, Argentina, Aruba, Australia, Austria, Bahamas, Bahrain, Bangladesh, Barbados, Belarus, Belgium, Belize, Benin, Bhutan, Bolivia, Botswana, Brazil, Brunei Darussalam, Bulgaria, Burkina Faso, Burundi, Cabo Verde, Cambodia, Cameroon, Canada, Cayman Islands, Chad, Chile, Colombia, Republic of the Congo, Costa Rica, Côte d'Ivoire, Cuba, Curaçao, Cyprus, Czechia, Democratic Republic of the Congo, Denmark, Djibouti, Dominica, Dominican Republic, Ecuador, Egypt, Estonia, Ethiopia, Faeroe Islands, Finland, France, Gabon, Gambia, Georgia, Germany, Ghana, Greece, Guatemala, Guinea, Guinea-Bissau, Honduras, Hungary, Iceland, India, Ireland, Israel, Italy, Jordan, Kenya, Kuwait, Latvia, Lesotho, Liberia, Libya, Luxembourg, Madagascar, Malawi, Malaysia, Mali, Malta, Mauritania, Mauritius, Mexico, Morocco, Mozambique, Namibia, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Northern Mariana Islands, Norway, Panama, Papua New Guinea, Peru, Philippines, Poland, Portugal, Puerto Rico, Republic of Korea, Qatar, Romania, Russian Federation, Rwanda, Sao Tome and Principe, Saudi Arabia, Senegal, Serbia, Seychelles, Sierra Leone, Slovakia, Slovenia, South Africa, Spain, Sri Lanka, Sudan, Sweden, Switzerland, Tajikistan, Thailand, Togo, Tunisia, Turkey, Turks and Caicos Islands, Uganda, United Arab Emirates, United Kingdom, United Republic of Tanzania, United States of America, Viet Nam, Yemen, Zambia, Zimbabwe

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Education

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Thesis: *Study on Photosynthate Production and Physiological Properties of Different Genotypes of Maize Varieties*

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Professional Positions Held

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Scholastic and Professional Honors

- A finalist in UK GradResearch Live, University of Kentucky Graduate Student Professional Enhancement (GSPE). October, 2020.
  Video Presentation: *"Are Refugees Good or Bad for a Host Country's Economy? Evidence from Germany. "*

- A finalist in Three Minute Thesis Competition, College of Agriculture, Food and Environment, University of Kentucky. April 12, 2019.
  Presentation: *"Impacts of the Real ID Act on U.S. agricultural sectors that are labor-intensive."*

- A finalist in UK GradTeach Live!, University of Kentucky. April 9, 2019.
  Presentation: *"Make students feel important. Make students feel good."*

Professional Publications

- Yunzhe Zhu, Guosheng Ma, Renhe Zhang, and Jiquan Xue. "Comparative Study on Photosynthate Accumulation and Distribution of Different Types of Maize with Different Yield Levels." *Acta Agriculturae Boreali-occidentalis Sinica*, 2013, 22(5): 20-24 (in Chinese with English abstract).

Presentations

- 52nd South Agricultural Economics Association (SAEA) Annual Meeting, Louisville, KY. February 1-4, 2020.
  "Impacts of Refugee Immigrants on Germany's Trade."

- 51st South Agricultural Economics Association (SAEA) Annual Meeting, Birmingham, AL. February 2-5, 2019.
  "Examining the Impact of the Real ID Act on U.S. State-Level Agricultural Exports."