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The Impact of Exchange Rate Fluctuations on Labor Migration: Evidence from U.S. Nonimmigrant Visa Statistics

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**THE IMPACT OF EXCHANGE RATE FLUCTUATIONS ON LABOR
MIGRATION: EVIDENCE FROM U.S. NONIMMIGRANT VISA
STATISTICS**

by

Yaqi Gao

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of the requirements for
Honors in the Department of Economics

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ABSTRACT

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Since mid-20th century, international migration has become a widespread phenomenon in nearly all industrialized countries and a major shaping force of the international labor market. Most economic theories consider labor migration to be an investment of human capital where workers seek to maximize household income and minimize financial risks. Because exchange rate changes affect prospective income and financial risks associated with migration, studying the responsiveness of skilled migrants to exchange rate fluctuations contribute to the studies of labor economics and international economics. This paper further investigates whether an appreciation in U.S. dollars incentivizes both skilled and unskilled workers to migrate to the United States.

In addition to analyzing the effect of the percentage changes in exchange rate, this study examines the effect of exchange rate volatility and investigates whether uncertainty and unpredictability discourage labor migration. This paper singles out skilled migration, as represented by Nonimmigrant H-1B Visa admissions before extending to all temporary worker visas and eventually the all visa classes. This paper discovers a positive effect of the depreciation of the migrants' home currency on the migration population. Uncertainty in exchange rates also deters the highly skilled from entering the U.S., while the same effect is not seen in overall labor migration. Comparing the estimated effects on labor migration to student visa and total nonimmigrant visa issuance, this paper adds evidence to the human capital theory of

labor migration and sheds light on the on-going discussion of immigration reform in the U.S.

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CHAPTER ONE

INTRODUCTION

Since mid-20th century, international migration has become a widespread phenomenon in nearly all industrialized countries and a major shaping force that defines the dynamics of the international labor market. Immigrant-receiving countries, mainly developed countries including the United States, Australia and Canada, evolved into a “melting pot” – a diverse, multiethnic society.

Previous studies have shown that economic incentives arising from disparity across the international labor markets are the main drivers for migrations, skilled or unskilled (Bowles 1970; Karemera et al. 2000). Researchers widely consider geographical mobility of migrants an investment in human capital, where workers are mainly concerned about the costs and monetary returns of their migration (Bowles 1970). However, there are a variety of theories of international migration, which vary in contents and assumptions. The oldest and best-known theory explains human migration as an endeavor to maximize income, where migrants are most concerned with the disequilibria in labor markets across the globe, and with migration cost (Massey et al. 1993). Neoclassical economists assume that international migration is motivated by differentials in earnings between the host and source countries, and the migration is justified when such differential exceeds the migration costs (Sjaastad 1962). In the 1980s, a “new economics of migration” emerged and sheds light on migration as a collective decision of the migrants’ families, who seek to minimize risks to household income and overcome capital constraints associated with various potential market failures in their countries of origin (Stark and Bloom 1985). Exchange rate would play an important role under both the neoclassical theory and the new economics of migration. A widening exchange rate gap leads to higher

expected income in the destination. While the immigration costs may increase proportionally, the cost-benefit analysis is likely to still result in a more positive net return and hence be more favorable in migrants' decision-making process. On the other hand, according to the new economics of migration, the uncertainty of the exchange rate would also play an important determinant of international movement. Exchange rate volatility may deter migration as it adds to the risks of family income.

Although relative wage has been recognized as a main economic incentive for international migration, few empirical studies examined this relationship, possibly due to the unavailability of accurate and comparable wage data in many developing countries. The effect of exchange rate changes on international migration has barely been investigated. Yang's (2006) paper on Philippine migrants' response to major, unexpected exchange rate changes following the Asian financial crisis is the only paper on this topic that I am aware of. In his paper, Yang examined the relationship between migrants' return decisions and exchange rate shock, and found that overall, positive exchange rate shocks in host countries are negatively associated with migrants' return rate. While Yang's study zoomed in one source country, my thesis looks at a single host country – the United States, which is also the biggest immigration country in the world. Studying the initiation of skilled migration among all temporary worker visa entries into the U.S. using the gravity model, this paper complements the literature on the effects of exchange rate on labor migration and shows that depreciation of a foreign currency motivates workers from that country to migrate to the U.S. This effect is seen in both skilled and unskilled migration, although the highly skilled tend to respond to exchange rate changes more quickly and are sensitive to the uncertainty of exchange rates.

The paper is organized as follows. Chapter Two provides a review of literature. Chapter Three discusses the gravity model of immigration and the empirical specifications motivated by the theoretical background. Chapter Four discusses the data sources and presents the summary statistics. Chapter Five presents the empiric results. Chapter Six concludes.

CHAPTER TWO

LITERATURE REVIEW

A. Labor Migration in Theory

This study is developed on two fundamental sets of literature. First, over the past half-century, there have been many theories developed to explain the upswing of international migration. Neoclassical economic theory, one of the oldest and best-known theory of international migration, attributes individuals' migration decisions to income maximization. The most simple and straightforward neoclassical theory considers labor migration as an integrated part of studying the process of economic development. From a macro perspective, Lewis (1954) considers the disequilibria in the international labor market the main driver of the labor migration process. As reflected in simple labor supply and demand curves, labor supply and equilibrium market wage is negatively correlated, *ceteris paribus*. Differentials in labor abundance between countries thus induce international flows of human capital from labor-abundant to labor-scarce regions. Sjaastad (1962), furthermore, extends neoclassical economics into the micro arena and zooms more in the individual choice perspective. In this framework, labor migration is considered as a human capital investment, during which process potential migrants evaluates the costs and benefits of migrating into a foreign country. Individuals would migrate when the expected return exceeds the estimated costs, i.e., when there is a positive net expected return. In conclusion, both schemes attributing labor migration to wage differentials between geographically separated labor markets, neoclassical economics largely shaped the public's understanding of immigration. These theories, however, did not take into account how the labor markets may be affected by other kinds of markets (Massey et al. 1993).

Since Stark and Bloom (1985), a “new economics of migration” emerged and sheds light to the migration process as decisions made by the migrants along with people they interact with – families or other units of production – who are not only motivated by higher expected return but also seek to minimize risks and lift financial constraints. While the new economics of migration delivers a set of propositions and implications that are different from the neoclassical theories, both deem the migrants (or their families) to be the innate driven force of the international labor movement. Distinct from these micro-level decision models is the dual labor market theory, first proposed by Piore (1979), which argues that migration is motivated by the labor demands of the receiving countries and initiated by recruitment of employers in modern industrialized societies. The aforementioned theories represent some attempts economists have made over the years to explain the initiation of international migration. Many others, explaining migration initiation as well as perpetuation, are reviewed and discussed in Massey et al. (1993).

On a separate note, literature has also illustrated the significant impacts emigration has on the labor markets in the source countries. Looking at emigrants from Moldova, one of the largest emigration countries relative to total population, Bouton, Paul and Tiongson (2009) find that emigration may be equated to negative labor supply shocks to the source country, which hence leads to higher equilibrium wages in the labor market.

The above discussion reveals the rich reservoir of general literature on international migration. Although to date, there is not a single model that is accepted as the sole authority, many of the theories agree in essence in that as with any economic consideration, the immigration process is motivated by economic

incentives, contributing to which are both push factors in the sending countries and pull factors in the receiving countries.

B. Exchange Rate and Labor Markets

The second strand of literature that provides foundation to the current study recognizes the effects of exchange rate changes on the labor markets. These effects are mostly exerted through the international trade channel. Shown in the standard macro models, as a country's currency depreciates, its exports become more competitive in the international markets, driving up domestic production, which naturally leads to higher demand in the labor market and likely a rise in domestic wages (Campa and Goldberg 2001; Goldberg and Tracy 2001). In the meantime, exchange rate depreciation raises the price of imported good; for intermediate goods and imported capitals, increased costs may put downward pressure on domestic labor demand and wages (Robertson 2004), whereas the induced overall inflation erodes real wages in the economy. In examining the effects of exchange rates on labor markets, a labor supply channel is also proposed. Traditionally, labor supply is considered relatively fixed in the short-run, but as migration occurs, labor supply responds significantly to exchange rate fluctuations. Mishra and Spilimbergo (2011) identify migration cost, outside information, and easiness to transfer remittances or return to home country as three factors that determine how much exchange rate changes can affect labor supply; they find countries that are most affected by globalization are more likely to see a pass-through from exchange rate to domestic wages through international migration.

C. Connecting the dots: exchange rate and migration

Linking the fore-discussed two broad-based strands of literature together, it is not hard to perceive that exchange rate changes likely would have an impact on migrants. For instance, Taylor (2008)'s "Weak Pound has Poles Eyeing Homeland," and Landingin (2007)'s "Exchange Rate Keeps Filipinos from Working Abroad," describe lower emigration rate and higher return rate in Poland and the Philippines, respectively, as the currencies in the immigrants' home country appreciate relative to those of the receiving countries. These articles, both published in *Financial Times*, exemplify the public's recognition of the possible impact of exchange rate on individuals' migration decision.

While the public may have paid more attention to international migration, nevertheless, academic literature has yet to provide an abundance of empirical evidence on migrants' responses to exchange rate changes and most existing literature zooms in on single source countries for the empirical studies. Hanson and Spilimbergo (1999) look at the illegal immigration in the U.S. from Mexico and use apprehension data at the U.S.-Mexico border as proxies of migration intensity. As the first to empirically examine the effects of exchange rate on migration, Hanson and Spilimbergo find that on average, a 10% depreciation of the Mexican peso increases apprehensions by 6-8%. With information of return migrants from various countries to the Philippines after the Asian financial crisis, Yang (2006) conducts a more comprehensive analysis of migrants' responses to exchange rate changes and relates it to the corresponding theoretical basis; appreciation of the receiving country's currency is believed to raise the marginal benefit of engaging in the foreign labor market and fewer migrants returned because of the increased relative value of foreign

income. The same cohort of Filipino migrants is also found to change their remittance-sending behavior after the unexpected exchange rate shocks after the financial crisis, as shown in another paper of Yang's (2008).

Connecting the dots for the aforementioned strands of existing literature on exchange rate, migration, and the labor markets in both the sending and receiving countries, this paper adds to this literature in three ways: (1) by zooming in on the United States, the biggest immigration countries in the world; (2) by investigating the effects of not only the absolute changes in exchange rates, but also the uncertainty inherent to the fluctuations; and (3) by specifically examining skilled immigration while analyzing migration of all types of workers; the implications are also improved as the estimations for student and other type of visas are compared to.

First, this study analyzes the migrant flow into the U.S. in the years of 2000-2012, and complements Hanson and Spilimbergo (1999) and Yang (2006), both of who zoom in on individual origin countries. The United States is widely recognized as an immigrant country. The foreign-born population of the U.S., which entails both the legally and illegally migrated, has changed dramatically during the past 50 years. In the 1960s, the vast majority of immigrants in the U.S. (about 75 percent) are of a European descent, and represented a mere 5 percent of the population (U.S. Census Bureau 2012). In 2010, according to the Census Bureau, the foreign-born population of the U.S. reached 40 million. About one in eight residents in the U.S. are foreign-born, and Asia, Latin America and the Caribbean have become the top sources. While about two-thirds of all U.S. states have more than 5 percent foreign born, over 1 in 4 Californian residents and over 1 in 5 New York and New Jersey residents are immigrants. As immigrants play an important role in shaping the domestic labor market in the U.S., and in consideration to the heated discussion on a potential reform

to the current immigration policy, it is critically essential to study the shaping forces of labor migration into the U.S..

Second, I examine the effects of exchange rate changes on migrant flows to the U.S. using the gravity model of immigration. In addition, however, I test the effect of uncertainty with exchange rate fluctuations. As proposed by the new economics of migration, one of the goals of migrants is to manage and minimize the risks to their household income (Massey et al. 1993). Examining the effects of exchange rate volatility on labor immigration into the U.S. allows me to assess the risk-aversion of the highly skilled.

Third, using the H-1B visa approval statistics as a proxy of skilled immigration, I consider a sub-sample of the foreign born in the U.S., who arguably have the best access to timely information and hence most sensitive to exchange rate fluctuations. The American Community Survey (ACS) analyzes the foreign-born population and their characteristics. Specifically pertaining to this study is the educational attainment of foreign born. Overall, immigrants are less likely to be high school graduates or higher than the native population. Mexican immigrants, accounting for nearly 30 percent of the foreign born population, are mostly low skilled, of whom less than 60 percent completed a high school degree. Nearly half (49 percent) of the immigrants from Asian countries, on the other hand, attained a bachelor's degree or higher (U.S. Census Bureau 2012). Accounting for 1/3 of all temporary visa issuances, H-1B is approved to foreign workers employed by US companies in specialty occupations, which is defined by the Immigration and Nationality Act as areas that require "theoretical and practical application of a body of highly specialized knowledge." The movements of these migrants are more likely to be motivated by a pursuit for a better work opportunity, rather than pressured by other

exogenous factors such as political disputes. Comparing the effects of exchange rate fluctuations on skilled migration and the migration of other foreign workers sheds light on the way information is internalized in the migrants' decision-making process. The implications of these estimations are further confirmed by comparisons with other migrants under other visa categories, in particular foreign students, whose entrance into the U.S. is not driven by the immediate goal to reap the economic benefit.

CHAPTER THREE

THE GRAVITY MODEL OF IMMIGRATION

The gravity model, first developed by Tinbergen (1962), is widely used in the studies of international economics to explain trade flow between countries. In the model, trade flow ($Trade_{ij}$) between two countries (i and j) is expressed as a positive function of the economic “gravitational mass (M),” and negatively to the geographical distance ($Distance_{ij}$):

$$Trade_{ij} = \beta_0 + \beta_1 (M_i \bullet M_j) + \beta_2 Distance_{ij} + \varepsilon_{ij} \quad (1)$$

the economic mass here is often measured using the country’s gross domestic product (GDP), reflecting the country’s overall development level. In empirical studies, regression specifications derived from this model normally control for various demographic, ethnic/linguistic, economic and geopolitical features, such as populations of the two countries, shared language, and common membership in a free trade zone.

As discussed above, labor migration can be considered as a transfer of human capitals between labor markets. Long argued that it can be extended to analyze labor flows (Ravenstein 1885), a gravity model of immigration was carefully developed by Karemera, Oguledo and Davis (2000) and Lewer and van den Berg (2008). In this scheme, the immigration process is seen as driven by the attractive forces of the destination country exerted on origin country natives, and hindered by the potential difficulties of migration.

A. Empirical Specification

Following the literature, I regress log immigration flows on the depreciation rate between the currencies of the origin country and the U.S., controlling for the economic mass of the two countries:

$$\begin{aligned} \ln(M_{t,o}) = & \beta_0 + \beta_1 Depre_{t-1,o} \\ & + \beta_2 Y_{t-1,o} + \beta_3 \ln(Dist_{o,US}) + \beta_4 \ln(Stock_{t-1,o}) \\ & + \beta_5 \ln(Pop_{t-1,o}) + \beta_6 \ln(Edu_{t-1,o}) \\ & + \beta_7 Eng_o + FE_{t-1} + FE_o + \varepsilon_{t,o}. \end{aligned} \quad (2)$$

The dependent variable $M_{t,o}$ is the number of skilled labors immigrated to the U.S. (destination country), from origin country o , in a given year t . The central explanatory variable is the total depreciation of the currency of country o with respect to U.S. dollar during year $t-1$, denoted $Depre_{t-1,o}$. It is constructed according to the standard definition, dividing the difference between the exchange rate at the end of year t ($E_{o,US,t}$) and that of the beginning of year t ($E_{o,US,t-1}$) by the beginning level:

$$Depre_{t,o} = (E_{o,US,t} - E_{o,US,t-1}) / E_{o,US,t-1} \quad (3)$$

The other explanatory variables are selected following the literature, identified by theoretical framework and existing empirical literature as factors facilitating or impeding labor migration (Karemera, Oguledo and Davis 2000; Lewer and Van den Berg 2008; Simpson and Sparber 2012). Representing the average income level in real term, $Y_{t-1,o}$ is per capita gross domestic products (GDP), the macro measures of the average income during year $t-1$, in the origin country. The purchasing power parity (PPP)-adjusted GDP measure is used to capture the real value of incomes.

Assimilating the common empirical practice, $Dist_{o,US}$, the shortest air distance between the origin and destination countries is used as a proxy of the transportation costs of migration. The natural log of country o natives already residing in the U.S. in year $t-1$ ($Stock_{t-1,o}$) controls for other barriers of immigration, as many researchers have shown that a high immigrant stock from the source country lowers the cost of adapting to the new society and hence facilitates immigration. Population of origin country ($Pop_{t-1,o}$) is also included, by which immigration has been shown to be highly significantly affected (Karemera, Oguledo and Davis 2000).

The aforementioned control variables are all part of Simpson and Sparber (2012)'s regression specification. However, in contrast to their focus of the migration flows of only the unskilled workers, in studying the behavior of the highly educated, this study includes a variable reflecting the average education attainment of the origin country population ($Edu_{t-1,o}$). Commonly referred to as the “brain drain,” the highly educated have been shown to migrate more often than the less educated (Carrington and Detragiache 1999; Lewer and Van den Berg 2008). Eng_o is a dummy variable for if the origin country's official language is English. Origin and destination countries sharing a common language has been shown to have a significant facilitating effect on labor migration (Lewer and Van den Berg 2008), and being able to use English fluently may be essential for the highly skilled to apply their skills efficiently in the U.S.

All independent variables are lagged by one year (year $t-1$ versus year t for the dependent variable), while in some specifications, the 2-year and 3-year lagged values of depreciation are also included. This addresses the issue of endogeneity while reflecting the reality where the actual labor movement is often delayed after migration decisions are made due to external factors. In addition, this model includes time fixed

effects FE_{t-1} and origin fixed effects FE_o to account for time trends in immigration, and time-invariant country-specific factors, respectively. These fixed effects variables are important to include as a number of non-economic factors affect immigration significantly. For the time fixed effects, for example, the U.S. immigration policy plays a critical role in determining how many immigrants are admitted. While the traditional gravity model calls for the population and income variables of the receiving country, the inclusion of these fixed effects determines that they are unnecessary for this model, since the only receiving country of interest in this paper is the U.S. and its income and population are fixed for each data point after controlling for variations over time.

The β 's in the equation are coefficients to be estimated and $\varepsilon_{t,o}$ represents the error term.

B. Assessing the effect of exchange rate uncertainty

The second empirics in this paper test the effects of exchange rate uncertainty on skilled immigration into the U.S. Researchers have examined the effects of exchange rate fluctuations on the behavior of foreign firms and oversea investment. Using standard deviation (σ) of the exchange rate to measure exchange rate volatility, Campa (1993) shows that exchange rate uncertainty deters foreign companies from entering the U.S. market, and decreases the amount of direct investments. The behaviors of these firms are mostly attributable to risk aversion, although Campa finds that even risk-neutral firms would deter entry decisions under exchange rate uncertainty. As discussed in the Section II, individuals' migration decisions are at least partly motivated by the intention to minimize households' financial risks. This

theory motivates the empirical specification in Equation (4) in order to test the effects of exchange rate uncertainty on immigration. Similar to Campa (1993), exchange rate volatility is measured by the daily standard deviation of the exchange rates ($Rate_{d,t-1,o}^\sigma$) between the currencies of the origin and destination countries.

$$\begin{aligned}
 \ln(M_{t,o}) = & \beta_0 + \beta_1 Depr_{t-1,o} + \beta_2 Rate_{d,t-1,o}^\sigma \\
 & + \beta_3 Y_{t-1,o} + \beta_4 \ln(Dist_{o,US}) + \beta_5 \ln(Stock_{t-1,o}) \\
 & + \beta_6 \ln(Pop_{t-1,o}) + \beta_7 \ln(Edu_{t-1,o}) \\
 & + \beta_8 Eng_o + FE_{t-1} + FE_o + \varepsilon_{t,o}.
 \end{aligned} \tag{4}$$

CHAPTER FOUR

DATA

The empirical analysis uses Nonimmigrant Visa Statistics from the Office of Visa Services, in the Consular Affairs Bureau, Department of State. Visa categories are classified into temporary work visas and student visas according to the definitions given by the U.S. Department of State. Temporary worker visas include H-1B, H-1B1, H-2A, H-2B, H-3, L, O, P-1, P-2, P-3, Q-1 and student visas include F and M, based on the type of school the foreign student is attending. Detailed descriptions of the various visa categories are listed in Appendix A.

Exchange rate ($E_{o,US}$) data comes from the International Monetary Fund. The representative rates, which are quoted as currency units per U.S. dollar are used. The mean and standard deviation ($Rate_{d,t-1,o}^{\sigma}$) of the exchange rates are calculated over each of the years sampled. For the empirical studies, the standard deviation of exchange rates is divided by 1000 for the coefficient to be comprehensible, but the summary statistics presents the raw values pre-scaling. Depreciation ($Depre$) is calculated by plugging the average exchange rate data into Equation (3), from which positive values indicate depreciation and negative values indicate appreciation of immigrant's home currency. Yearly data of exchange rates also allows the calculation of predicted rates, with which predicted depreciation is calculated ($Depre_{pred}$).

GDP per capita, PPP in constant 2005 international dollar (Y_o), total populations of the origin countries (pop_o) and education attainment of the origin country population (Edu_o), gross enrollment ratio for tertiary education, are from the World Development Indicators (WDI). Population-weighted distance between the origin country and the U.S. ($Dist_{o,US}$), and dummy for English as an official language (Eng_o) are from CEPII's GeoDist database. Immigrant stock ($Stock_o$) is from the

American Community Survey. The final data set contains data for 53 countries. Number of years for which data is available ranges from 2 to 12.

Table 1 presents the descriptive statistics visa issuances data for the period of 2000-12. On average, a total of 106,059 people from each country are granted non-immigrant visa in a year, of which nearly 10,000 entered the U.S. as temporary workers. H-1B visas, which are granted to workers in specialty occupations, requiring attainment of a minimum of a bachelor's degree and ability to apply highly specialized knowledge in their field, account for nearly 1/3 of the temporary worker visas. An average of 7,514 foreign students entered the U.S. each year from their home countries, of which F-1 students account for more than 90%. US dollar is much more highly valued than the average currency in the sample. The average exchange rate is 595.5 foreign currency units per US dollar. While the standard deviation of daily exchange rate varies greatly, some countries in the sample are on a fixed exchange rate scheme with zero variation day-to-day. Average depreciation of currencies in the sample zeros out as some currencies depreciate while others appreciate. Based on observed exchange rate, a trend is estimated of exchange rate over years, and the average exchange rate for a year is predicted based on this time trend. The variable predicted depreciation captures the changes in the predicted values of exchange rate. Because of the nature of the construction of the variable, predicted depreciation has less variation than observed depreciation. The average PPP-adjust per capita GDP of countries in the sample is 21,272 per annum, expressed in constant 2005 international dollar. Mean population in the sending country is about 118 million whereas the population residing in the U.S. averages 599,000. On average, 51 percent of the population in the countries sampled have been enrolled in some sort of tertiary education.

CHAPTER FIVE

EMPIRICAL RESULTS

A. Skilled migration

This study first examines the effect of exchange rate fluctuation on H-1B admissions from the sampled sending countries. Focusing on skilled migration as captured by H-1B visa admissions are motivated by two reasons. First, skilled migrants are expected to have better access and understanding of information, and hence would react to the changes in exchange rates better in a timely manner. Second, as discussed in the Section IV, H-1B constitutes 1/3 of the total temporary worker visas, and is arguably the center of the current Immigration Reform discussion. Examining effects of the exchange rate fluctuation sheds light to the incentives that motivate skilled migration, as it confirms economic factors as an important gravitational force.

Table 2 presents estimation results for H-1B admissions. In column (1), depreciation is the only exchange-rate-related independent variable, and the coefficient is positive but insignificant. However, as average exchange rate and standard deviation of exchange rate were included, as presented in Column (2), the coefficients for all three variables are statistically significant. The positive coefficient of depreciation indicates that when the currency of the immigrants' home country depreciates by one standard deviation, skilled migration from that country to the U.S. increases by 2.5 percentage points. This supports the hypothesis, as when U.S. dollars become more valuable compared to immigrants' home currency, the income disparity becomes larger, generating greater gravitational forces for migrating. The standard deviation of exchange rate has a negative effect on H-1B admissions into the U.S. This also agrees with the hypothesis, as uncertainty deters highly educated individuals

from migrating, and is similar to the findings in Campa (1993), in which firms defer their entries into a foreign market when the exchange rates are volatile. Uncertainty of exchange rate, captured by its standard deviation, has a negative effect on H-1B immigration: an one standard deviation increase in the standard deviation of exchange rate results in a 2.4 percent decrease in H-1B visa counts.

As specified in the Model section, all independent variables including depreciation are lagged one year to illustrate a causation relationship. Columns (3) and (4) are the same regressions as Columns (1) and (2), respectively, except for the inclusion of 2-year and 3-year lagged depreciation. The coefficient of the 2-year lagged value is insignificant while the 3-year lagged is consistent with the general hypothesis for the relationship between depreciation and labor migration as the coefficient is positive and significant at the 0.05 level. Including the lagged values, moreover, boosted the significance for depreciation in Column (3) compared to (1), and the effects of depreciation and volatility are both greater in magnitude in Column (4), compared to (2). The changes in magnitude, however, are small and likely to be the result of a smaller sample size. For some countries, depreciation data is only available for 1 or 2 years and the inclusion of lagged data as additional independent variables excludes these countries from the sample. In Columns (5), the predicted values for depreciation are used instead of real depreciation. This shows the effects of long-term trend of exchange rate fluctuations on H-1B admissions. The coefficient of this variable is positive and significant as that for real depreciation, but is much greater in magnitude as the prediction process smoothes out the variations. The comparison of the normalized beta coefficients, as a result, is more meaningful. Compared to Column (2), where the variation of one standard deviation in depreciation results in a 2.5 percent increase in skilled workers entering the U.S, the

effect of the expected depreciation is 4 times greater, a one-standard-deviation increase of which leads to a 10.7 percent increase in skilled migration. Coefficients of the other independent variables, wherever significant, are consistent with literature. Per capita GDP of the sending countries positively contributes to the gravitational force driving immigration, whereas distance is negatively correlated with H-1B admissions. Percentage enrolled in tertiary education has a positive and significant effect on H-1B admissions, consistent with expectations as this visa type is granted specifically to highly educated workers. In all of the specifications in Table 2, nearly 99% of the variations in H-1B admissions are explained by the estimation, indicating a nearly perfect fit.

B. All temporary worker visas

Table 3 presents the estimation results for all temporary worker visa categories. The columns present specifications in the same order as in Table 2. Coefficients of observed depreciation and standard depreciation of exchange rates are ubiquitously insignificant for the sum of all temporary worker visas. However, the predicted depreciation shows a positive and significant effect, and the magnitude is slightly greater than that for H-1B admissions. Analyzing the results collectively, it may be implied that the less skilled workers indeed have less access to information and make less informed decisions than the highly educated, which served as a practical justification of focusing on the H-1B figure to analyze the effects of exchange rate fluctuations on labor migration. Another interesting contrast is that the coefficient of education is insignificant in these specifications, while the dummy for English fluency has positive and significant coefficients in 4 of the 5 specifications.

These show the different qualifications required for skilled immigrants compared to the average workers. Moreover, note that unlike in the previous regressions, the coefficient for distance is positive while significant. This is inconsistent with the gravity model and existing literature and the reason for this needs further investigation.

C. Effects on foreign students, who are net consumers in the receiving country

To illustrate that the effects of exchange fluctuations on labor migration indeed derives from changes in the earning perspectives, this study advances to investigate the effects of depreciation on another group of visa holders who entered the U.S. for the opposite economic reasons. Unlike workers who seek economic benefits from migration, students studying abroad are consumers in the economy of the receiving countries. Exchange rates hence raise or lower the costs foreign students incur when studying abroad. Based on this analysis, depreciation of the home currency of the students is expected to have an adverse effect on student visa admissions, as the costs is higher when U.S. dollars become relatively more expensive. This is confirmed by the estimation results in Column (1) of Table 4, in which a one-standard-deviation depreciation decreases student visa admissions by 3.5 percent. Similar to the two sets of regressions presented above, long-term trend in exchange rate fluctuations as represented by the predicted depreciation, affect the temporary immigration by a greater magnitude. Uncertainty in exchange rates does not have an effect on students' decision-making. Independent variables education and English proficiency are again very interesting in comparison. As with the average worker, having English as an official language in their home countries increase the likelihood of students to study

in the U.S. Yet the correlation between tertiary school enrollment among the populations in their home countries and students entering the U.S. for education purposes is actually negative. The negative coefficient may in fact be a reflection of the effects of quality disparity of education, as countries with less advanced education system are likely to have less people attending higher education, and at the same time, more young people would look overseas for better opportunities. Similar to the results in Table 3, the reason is unclear for the positive correlation between distance and student entries.

D. The whole picture

Table 5 presents estimation of the effects of exchange rate fluctuations on the visa counts of all visa categories. The coefficients for 1-year lagged depreciation are negative and significant and are of magnitude comparable to those for student visas. This indicates that the majority of foreigners entering the U.S. on nonimmigrant visas expect to be net consumers during their stays in the U.S., for whom depreciation in their home currency means their trips to the U.S. are relatively more expensive. This is consistent with the fact that only 10 percent of the total nonimmigrant visas are granted to foreign workers (See Table 1).

The coefficient of predicted depreciation is insignificant in this specification. This is possibly due to more migrants visiting the U.S. for short terms rather than the long term. This is also supported by the insignificance of standard deviation of exchange rate, as uncertainty is unlikely to be a fear factor for people planning to be in the U.S. for only several weeks or even months. Similar to Tables 3 and 4, distance is positively correlated to all legal immigrants count, contradicting the gravity model.

CHAPTER SIX

CONCLUSION

This paper examines the effects of exchange rate fluctuations on labor migration into the U.S. It analyzes the immigration patterns of temporary workers and students from 2000 to 2012.

The paper shows that for skilled labors, depreciation of their home currency motivates more to migrate. This is because the income disparity between the U.S. and their home countries are exaggerated as a result of the changes in exchange rate. Moreover, uncertainty about future exchange rates can deter entrance into the U.S. on H-1B visas, as the highly educated would rather wait until more information is available with regards to their expected future income. The estimation also shows that a long-term depreciation trend has an even greater effect on skilled migration. Predicted depreciation encourages more skilled labors to move to the U.S. For the average labor, however, only the long-term trend of exchange rate fluctuation has a significant effect on their migrating behavior and expected depreciation is also motivating for the general worker seeking economic benefits from the migration. Possibly due to the lack of access or understanding to information, unlike the highly educated, the cumulative figures of labor migration are not responsive to the observed changes in the most recent years, or the volatility of the exchange rates.

In order to confirm the implications drawn from the estimations of the effects of exchange rate fluctuations on labor migration, this paper analyzes the relationship between exchange rate changes and student visas as well as all visas combined. Students and the majority of all foreigners entering the U.S. are net consumers during their stay, and for them depreciation of their home currency increases the real costs.

The estimations indeed reveal a positive effect of depreciation. Finally, regressions show a lack of significance in the effects of predicted changes and volatility of exchange rates for total visa counts. This confirms that migrating labors have more long-term interests in mind than the average visitors.

The limitation of this paper includes the relatively small sample size with a short time span, the potential effects of immigration regulation on actual visa issuance and rough classification of migrants. First, because the analysis in this paper uses data from a number of different sources, while migrants come to the U.S. from more than 200 countries, the analysis is restricted to the countries whose data is available in all datasets. It could be beneficial to expand the data size, in particular to look farther back into history. The second limitation of this paper is that the effects of immigration restrictions is not sufficiently addressed and controlled for. While this paper observes the actual number of immigration as exchange rate changes, it does not take into account the number of people who might have wanted to migrate but are unable to obtain visas because of the existing quota. Lastly, in using the visa type as classification standard for immigrants, this paper is limited by the rough definition of these visa categories. Future research may consider using information from the ACS further and identify the effects of exchange rate fluctuation on workers in different industries.

Further research is desirable in the same area to improve the findings of this paper. First, one can distinguish labors already residing in the U.S. extending their nonimmigrant visas from migrants landing on the country for the first time. This information will be helpful as decisions to migrate and remain require different amount of efforts from the migrants and hence are motivated by different factors. Second, it would be advantageous to look into the process foreign workers internalize

exchange rate fluctuations in their decision making process. It would allow for the examination of whether collective decision-making plays an important role in the migration process, as the changes in the relative values of remittance can be an explanation for the migrating labors' sensitivity to exchange rate movements. Finally, I would like to examine if there is a demographic switch of migrants as a result of exchange rate changes. In particular, I would expect middle-aged workers are more risk averse and carry more responsibility for their families, and movements in exchanges rates would have greater influences on this group.

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Table 1. Descriptive statistics for visa issuance from 2000 to 2012.

Variables	Mean	Std. Dev.	Min	Max
Visa Count				
Total Visas	106,059	219,032	260	1,693,133
Temporary Worker Visa Categories				
H1B	3,179	11,488	1	83,464
H2A	1,220	7,551	0	61,324
H2B	1,304	7,298	0	60,541
H3	49	106	0	1,099
L1	1,690	5,007	0	41,001
L2	1,551	3,808	0	29,897
O1	156	286	0	2,212
O2	76	185	0	1,408
O3	42	67	0	478
P1	436	854	0	6,028
P2	3	13	0	136
P3	148	323	0	2,457
Q1	31	65	0	392
Total Workers	9,892	25,643	1	151,347
Student Visa Categories				
F1	6,786	16,932	1	189,402
F2	543	1,342	0	7,254
F3	11	93	0	959
M1	168	305	0	2,604
M2	6	14	0	136
M3	0	0	0	1
Total Students	7,514	17,968	1	193,948
Exchange Rates Characteristics				
Average exchange rate	595.48	1,969.82	0.29	10,398.91
Standard deviation of daily exchange rate	26.83	162.04	0.00	2,723.80
Depreciation (Yr/Yr)	0.00	0.17	-0.20	2.61
Predicted Depreciation (Yr/Yr)	-0.01	0.04	-0.09	0.28
Socioeconomic Characteristics				
PPP-adjusted GDP per capita (constant 2005 international dollar)	21,272	12,543	950	49,100
Total Population (in 000)	118,000	295,000	290	1,340,000
Stock of immigrants currently residing in the U.S. (in 000)	599	1,832	7	12,000
Tertiary school enrollment (% gross)	51	24	3	102
English is an official language	0.20	0.40	0	1
Weighted distance (in km)	9,478	3,148	2,468	15,536
Number of Observations				371

Table 2. Estimation of foreign workers entering the United States on H-1B visas.

Independent Variables	Dependent Variable: Log H-1B Admissions				
	(1)	(2)	(3)	(4)	(5)
Depreciation	0.007 (0.99)	0.025** (2.14)	0.014* (1.82)	0.037*** (3.02)	
Depreciation t-2			-0.004 (-0.54)	-0.005 (-0.71)	
Depreciation t-3			0.015** (2.05)	0.018** (2.48)	
Predicted depreciation					0.107*** (4.83)
Average exchange rate		-0.099*** (-3.94)		-0.090*** (-2.89)	
Standard deviation of exchange rate		-0.024** (-2.05)		-0.033*** (-2.67)	
Log GDP per capita	0.186* (1.69)	0.206* (1.92)	0.180 (1.58)	0.194* (1.74)	0.129 (1.20)
Log total population	-0.554 (-1.00)	-0.605 (-1.13)	-0.502 (-0.81)	-0.598 (-0.99)	-0.718 (-1.34)
Log distance (in km)	-0.970*** (-3.53)	-1.000*** (-3.75)	-0.898*** (-3.04)	-0.954*** (-3.30)	-1.008*** (-3.80)
Log stock	-0.027 (-0.58)	-0.023 (-0.51)	0.006 (0.10)	0.006 (0.11)	-0.004 (-0.08)
Education	0.330*** (6.58)	0.332*** (6.83)	0.335*** (6.42)	0.346*** (6.76)	0.342*** (7.07)
English as an official language	-0.427 (-1.06)	-0.454 (-1.16)	-0.368 (-0.82)	3.034*** (3.55)	-0.492 (-1.26)
Fixed Effects	Yes	Yes	Yes	Yes	Yes
Number of observations	371	371	346	346	371
R-squared	0.988	0.989	0.989	0.990	0.989

Normalized beta coefficients reported in the table with t-statistics in parentheses. Constant not presented in table but included in regressions.

*** Statistically significant at the 0.01 level.

** Statistically significant at the 0.05 level.

* Statistically significant at the 0.1 level.

Table 3. Estimation of entrance into the United States under any of the temporary worker visas.

Independent Variables	Dependent Variable: Log all temporary worker visas				
	(1)	(2)	(3)	(4)	(5)
Depreciation	-0.000 (-0.02)	0.003 (0.23)	0.007 (0.92)	0.015 (1.21)	
Depreciation t-2			-0.006 (-0.80)	-0.005 (-0.73)	
Depreciation t-3			0.010 (1.29)	0.012* (1.66)	
Predicted depreciation					0.121*** (5.34)
Average exchange rate		-0.114*** (-4.37)		-0.093*** (-2.95)	
Standard deviation of exchange rate		-0.006 (-0.45)		-0.014 (-1.10)	
Log GDP per capita	0.320*** (2.82)	0.326*** (2.94)	0.238** (2.07)	0.240** (2.11)	0.252** (2.30)
Log total population	0.293 (1.04)	0.260 (0.94)	0.333 (1.12)	0.286 (0.97)	0.243 (0.90)
Log distance (in km)	2.607*** (4.57)	2.521*** (4.54)	2.549*** (4.09)	2.446*** (3.98)	2.401*** (4.39)
Log stock	-0.055 (-1.16)	-0.042 (-0.91)	0.003 (0.05)	0.010 (0.18)	-0.026 (-0.58)
Education	0.024 (0.46)	0.029 (0.57)	0.014 (0.26)	0.024 (0.47)	0.042 (0.85)
English as an official language	1.371*** (3.30)	1.321*** (3.26)	1.336*** (2.96)	-1.686* (-1.93)	1.288*** (3.23)
Fixed Effects	Yes	Yes	Yes	Yes	Yes
Number of observations	371	371	346	346	371
R-squared	0.987	0.988	0.989	0.989	0.988

Normalized beta coefficients reported in the table with t-statistics in parentheses. Constant not presented in table but included in regressions.

*** Statistically significant at the 0.01 level.

** Statistically significant at the 0.05 level.

* Statistically significant at the 0.1 level.

Table 4. Estimation of students entering into the United States under F or M visas.

Independent Variables	Dependent Variable: Log student visas				
	(1)	(2)	(3)	(4)	(5)
Depreciation	-0.035*** (-3.21)	-0.026 (-1.52)	-0.040*** (-3.37)	-0.030 (-1.55)	
Depreciation t-2			-0.011 (-1.02)	-0.015 (-1.31)	
Depreciation t-3			-0.019 * (-1.76)	-0.023** (-2.10)	
Predicted depreciation					-0.074** (-2.20)
Average exchange rate		0.062 (1.64)		0.144*** (3.05)	
Standard deviation of exchange rate		-0.010 (-0.55)		-0.007 (-0.37)	
Log GDP per capita	0.963*** (6.00)	0.969*** (6.03)	0.941*** (5.46)	0.957*** (5.61)	0.993*** (6.10)
Log total population	1.774*** (4.44)	1.791*** (4.49)	2.497*** (5.58)	2.555*** (5.78)	1.771*** (4.40)
Log distance (in km)	5.035*** (6.26)	5.096*** (6.34)	6.451*** (6.90)	6.614*** (7.16)	5.079*** (6.25)
Log stock	0.051 (0.77)	0.039 (0.59)	0.077*** (0.90)	0.057 (0.67)	0.044 (0.65)
Education	-0.179** (-2.46)	-0.183** (-2.51)	-0.282*** (-3.57)	-0.299*** (-3.82)	-0.173** (-2.36)
English as an official language	3.533*** (6.02)	3.571*** (6.09)	4.525*** (6.69)	-7.427*** (-5.67)	3.545*** (5.98)
Fixed Effects	Yes	Yes	Yes	Yes	Yes
Number of observations	371	371	346	346	371
R-squared	0.974	0.974	0.975	0.976	0.974

Normalized beta coefficients reported in the table with t-statistics in parentheses. Constant not presented in table but included in regressions.

*** Statistically significant at the 0.01 level.

** Statistically significant at the 0.05 level.

* Statistically significant at the 0.1 level.

Table 5. Estimation of all legal migrants entering into the United States.

Independent Variables	Dependent Variable: Log all visas				
	(1)	(2)	(3)	(4)	(5)
Depreciation	-0.023** (-2.32)	-0.032** (-1.99)	-0.028** (-2.51)	-0.044** (-2.42)	
Depreciation t-2			-0.001 (-0.14)	0.001 (0.07)	
Depreciation t-3			-0.017 (-1.62)	-0.016 (-1.57)	
Predicted depreciation					0.038 (1.21)
Average exchange rate		-0.054 (-1.55)		-0.026 (-0.57)	
Standard deviation of exchange rate		0.011 (0.65)		0.019 (1.07)	
Log GDP per capita	0.721*** (4.82)	0.714*** (4.76)	0.702*** (4.35)	0.688*** (4.25)	0.692*** (4.57)
Log total population	1.748*** (4.70)	1.734*** (4.67)	2.540*** (6.07)	2.539*** (6.06)	1.710*** (4.57)
Log distance (in km)	6.154 (8.22)	6.097*** (8.14)	7.720*** (8.83)	7.689*** (8.77)	6.034*** (7.99)
Log stock	0.015 (0.25)	0.026 (0.42)	0.069 (0.85)	0.078 (0.96)	0.031 (0.50)
Education	0.102 (1.51)	0.106 (1.56)	0.047 (0.64)	0.050 (0.67)	0.120* (1.75)
English as an official language	4.531*** (8.29)	4.496*** (8.23)	5.651*** (8.93)	-8.566*** (-6.90)	4.479*** (8.14)
Fixed Effects	Yes	Yes	Yes	Yes	Yes
Number of observations	371	371	346	346	371
R-squared	0.978	0.978	0.978	0.978	0.977

Normalized beta coefficients reported in the table with t-statistics in parentheses. Constant not presented in table but included in regressions.

*** Statistically significant at the 0.01 level.

** Statistically significant at the 0.05 level.

* Statistically significant at the 0.1 level.

Appendix. Visa Categories

Table A1. Definition of temporary worker visa categories

Visa category	General description – About an individual in this category:
H-1B: Person in Specialty Occupation	To work in a specialty occupation. Requires a higher education degree or its equivalent. Includes fashion models of distinguished merit and ability and government-to-government research and development, or co-production projects administered by the Department of Defense.
H-2A: Temporary Agricultural Worker	For temporary or seasonal agricultural work. Limited to citizens or nationals of designated countries, with limited exceptions, if determined to be in the United States interest.
H-2B: Temporary Non-agricultural Worker	For temporary or seasonal non- agricultural work. Limited to citizens or nationals of designated countries, with limited exceptions, if determined to be in the United States interest.
H-3: Trainee or Special Education visitor	To receive training, other than graduate medical or academic, that is not available in the trainee's home country or practical training programs in the education of children with mental, physical, or emotional disabilities.
L: Intracompany Transferee	To work at a branch, parent, affiliate, or subsidiary of the current employer in a managerial or executive capacity, or in a position requiring specialized knowledge. Individual must have been employed by the same employer abroad continuously for 1 year within the three preceding years.
O: Individual with Extraordinary Ability or Achievement	For persons with extraordinary ability or achievement in the sciences, arts, education, business, athletics, or extraordinary recognized achievements in the motion picture and television fields, demonstrated by sustained national or international acclaim, to work in their field of expertise. Includes persons providing essential services in support of the above individual.
P-1: Individual or Team Athlete, or Member of an Entertainment Group	To perform at a specific athletic competition as an athlete or as a member of an entertainment group. Requires an internationally recognized level of sustained performance. Includes persons providing essential services in support of the above individual.
P-2: Artist or Entertainer (Individual or Group)	For performance under a reciprocal exchange program between an organization in the United States and an organization in another country. Includes persons providing essential services in support of the above individual.
P-3: Artist or Entertainer (Individual or Group)	To perform, teach or coach under a program that is culturally unique or a traditional ethnic, folk, cultural, musical, theatrical, or artistic performance or presentation. Includes persons providing essential services in support of the above individual.
Q-1: Participant in an International Cultural Exchange Program	For practical training and employment and for sharing of the history, culture, and traditions of your home country through participation in an international cultural exchange program.

Table A2. Definitions of student visa categories

Visa category	To enter the United States to attend:
F	University or college
	High School
	Private elementary school
	Seminary
	Conservatory
	Another academic institution, including a language training program
M	Vocational or other recognized nonacademic institution, other than a language training program

Source: travel.state.gov

