How Tall Are the Paper Walls? Barriers to International Mobility and Technology Diffusion

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Received: 08/02/2019
Accepted: 10/27/2019

Abstract

International mobility promotes technology diffusion across countries; on the other hand, barriers to international mobility can hinder the process of technology diffusion. This paper uses bilateral visa restrictions data from 30 host and 161 home countries for 2001-2012 to show that the global technology gap increases as the barriers to international mobility increase. These results are robust across dyadic and cross-sectional data as well as OLS and 2SLS estimation methods. The results suggest that visa facilitation programs by advanced countries could promote international technology diffusion.

1 Introduction

Total factor productivity (TFP) explains a major portion of difference in GDP per worker across countries.[1] Many researchers believe that productivity differs across countries because of the slow process of international technology diffusion.[2] Why do technologies diffuse slowly? This study follows previous research[3] and assumes that technologies diffuse across countries when societies interact with other societies.[4] This exposure helps societies to adopt advanced technologies and new ideas prevail in a foreign space. However, not all societies enjoy an equal exposure to foreign space which depends on the citizenship of the travelers and their destination countries. The U.S. citizens, for example, have visa-free access to 156 countries, whereas Pakistani citizens have visa-free access to 26 countries.[5] Greater passport power gives its holder easier access to more foreign space, a larger stock of knowledge, and superior technologies abroad. On the other hand, barriers to international mobility restrict access to foreign space, reduce the exchange of tourists, businessmen, and students across countries, slowing down the process of international technology diffusion.[6]

This study illustrates the slow process of international technology diffusion and advances the existing literature in the following three ways. First, this paper analyzes the effects of barriers to international mobility on technology diffusion, a topic not investigated heavily in the economics literature. Most of the earlier research analyzes the effects of barriers to mobility on cross-country tourism and international trade.[7] Second, this study features the bilateral TFP gap, calculated as the difference between the TFP of the home and the host counties, as the dependent variable which helps to further explore the effects of bilateral

[1] See Klenow and Rodriguez-Clare (1997), Hall and Jones (1999), and Caselli (2005).

[2] See Howitt (2000) and Klenow and Rodriguez-Clare (2005).

[3] See Lucas Jr (1988); Irwin and Klenow (1994); Foster and Rosenzweig (1995); Almeida and Kogut (1999); Agrawal et al. (2006); Andersen and Dalgaard (2011); Tani and Joyeux (2013); Hovhannisyan and Keller (2015); Piva et al. (2018).

[4] See for example Keller (2004) and Andersen and Dalgaard (2011).

[5] See www.passportindex.org for the latest ranking of passports and Lawson and Lemke (2012) for an excellent exposition to the political economy of visa restrictions. Moreover, table A1 presents a list of countries with the most powerful and the weakest passports; figure 2 shows the average visa refusal rate of the most restricted countries of the world.

[6] We refer to technology diffusion to the process by which individuals and firms adopt new ideas and technologies available in a given market or a different market.

[7] For example, Neumayer (2010) finds that visa requirements decrease business travel and tourism. Neumayer (2011) also finds that visa requirements reduce bilateral trade and foreign direct investment. Similarly, Lawson and Roychoudhury (2016) estimate that visa requirements reduce inbound travel.

factors, such as geographical distance and common spoken language, on the bilateral TFP gap. Third, earlier research uses a dummy variable, indicating whether a visa is required to enter a country or not, as a measure of international barriers to mobility; whereas, this paper uses the visa refusal rate, calculated as the number of visas refused divided by the total number of applications received, as the primary measure of barriers to international mobility. In addition, two additional measures of barriers to mobility, a visa restriction index and a visa requirement index are also used. The data for the visa refusal rate, visa restriction index, and visa requirement index are taken from Hobolth (2012).

The visa refusal rate, compared to the other two measures of barriers to mobility, shows the intensity of barriers to mobility from the home to the host country. For example, if the citizens of two countries need a visa to travel to a host country, the citizens of the first country may get a visa very easily while excessive paperwork may be required for the citizens of the second country, where the majority of the visas are denied. Thus the barriers to mobility will be higher for the second country. The visa refusal rate captures this effect and shows the extent of barriers to mobility. The second measure of barriers to mobility is the visa restriction index.[8] The visa restriction index encompasses three dimensions of barriers to mobility: (1) whether citizens of the home country need a visa to enter the host country, (2) the intensity of visa restrictions, and (3) whether a visa application can be submitted in the country of origin or not. Hobolth (2012) constructs this index on a scale that ranges from 0 to 3; to simplify, this paper merges and uses only two categories: no barriers to mobility and barriers to mobility. The visa requirement index, the third measure of barriers to mobility, is a dummy variable and indicates whether citizens of the home country need a visa to enter the host country.

To investigate the association between barriers to international mobility and technology diffusion, this paper uses bilateral data of 30 host (mostly OECD) and 161 home countries over the period of 2001-2012.[9] Empirically, the visa refusal rate may be endogenous with the TFP gap. A low TFP home (developing) country may face high barriers to mobility from high TFP host (advanced) countries. In this case, we may have a reverse causality issue. The advanced countries may impose high barriers to mobility on the citizens of the developing country to stop illegal immigration.

This paper addresses this endogeneity issue by using two instrumental variables for visa refusal rate (i) UN voting behavior and (ii) genetic distance in 1500. Our first instrumental variable is the United Nations General Assembly voting ideal points difference (henceforth "UN voting"). The UN voting reveals the member states' voting behavior at the UN General Assembly meetings. We use the distance between the 'Ideal Point' scores of two countries as an indicator of bilateral foreign policy divergence; the ideal points scores of each country is presented in Bailey et al. (2017), who develop an ideal point model to estimate dynamic national ideal points along a single dimension from 1946 to 2012. These ideal points are based on the roll-call voting behavior of UN member states during the UN General Assembly meetings. These voting patterns reveal the foreign policy preferences of nations and thus indicates the bilateral relationship between countries. These bilateral relationships may have a direct effect on visa policies (Mckay and Tekleselassie, 2018).

Our second instrumental variable, genetic distance, is the probability that two randomly selected individuals from two populations will be genetically different. The genetic distance between two populations is zero if and only if the two populations are identical.[10] Our underlying assumption is that genetic dissimilarity (genetic distance) between two populations increases mistrust and, hence, increases barriers to international mobility.[11] The data for genetic distance are taken from Spolaore and Wacziarg (2009). A further concern is that current genetic distance may be correlated with the TFP gap due to factors such as migration. For example, European colonizers migrated to the regions suitable to them. This migration pattern may explain not only the TFP gap but also the genetic distance between populations today. Therefore, we use genetic distance in 1500 AD as an instrumental variable in our model. Because genetic distance in 1500 is from the period before the industrial revolution and great migration, we can argue that genetic distance in 1500 does not affect bilateral TFP gap today.

[8] See Hobolth (2012) for detail.

[9] Host and home country lists are mutually exclusive, see tables A2 and A3.

[10] See Spolaore and Wacziarg (2009) for a complete exposition on genetic distance and its effect on barriers to technology transfer.

[11] See, for example, Guiso et al. (2009). Moreover, Ashraf and Galor (2013) explore genetic diversity and cultural fragmentation.

This paper estimates the relationship between barriers to international mobility and bilateral TFP gap using OLS and 2SLS estimation methods. In panel OLS settings, the bilateral TFP gap shows an elasticity of 0.02 for the visa refusal rate, while this elasticity is about 0.16-0.24 in 2SLS settings. If we use the average visa refusal rate (15 percent) as a benchmark, the global TFP gap increases in the range of about 2.4 to 3.6 percent due to barriers to mobility. The average visa refusal rate for the top 20 most restricted countries is about 40 percent, indicating that the TFP gap is increasing in the range of about 6.4 to 9.6 percent for these countries due to the visa refusal.

This paper is related to the economic literature which investigates the effects of barriers to mobility on international trade, foreign direct investment, and tourism. For example, Neumayer (2010) finds that visa requirements (whether a visa is required to enter a country or not) decrease business travel and tourism. Neumayer (2011) also finds that visa requirements reduce bilateral trade and foreign direct investment. Similarly, Lawson and Roychoudhury (2016) estimate that visa requirements reduce inbound travel. However, the effects of international barriers to mobility on international technology diffusion are not explored in this literature, and this paper fills this gap.

This paper is also related to the economic literature which has explored the effects of human interaction on technology diffusion (Lucas Jr, 1988; Irwin and Klenow, 1994; Foster and Rosenzweig, 1995; Almeida and Kogut, 1999; Agrawal et al., 2006; Andersen and Dalgaard, 2011; Tani and Joyeux, 2013; Hovhannisyan and Keller, 2015; Piva et al., 2018; Valette, 2018). However, this paper is different from previous studies as it tests the flip-side of the Andersen and Dalgaard (2011) and Tani and Joyeux (2013) argument; what are the effects of barriers to international human interaction on technology diffusion?

The rest of the paper is organized as follows: Section 2 explores the channels through which barriers to mobility could affect technology diffusion; Section 3 describes the data; Section 4 presents bilateral empirical methodology and results; Section 5 presents cross-sectional analysis, and; Section 6 concludes.

2 How Do Barriers to Mobility Affect International Technology Diffusion?

This section explores different types of barriers to mobility that international travelers face and then explores the link between barriers to mobility and international technology diffusion. International travelers face barriers to mobility in different forms, either in the form of requiring a visa before the physical entry into a host country or in the form of a high visa rejection rate.[12] Most international travelers require a valid visa before entering a foreign space. A visa is defined as a "document issued in the country of origin (or residence) of the individual by the authorities of the state to which he or she wishes to go" (Guild, 2009). National states have always had a monopoly over who can enter or exit their national borders. Most democratic states use this monopoly for economic and political reasons[13] and exercise exit control only for a few cases.[14] Autocratic and repressive regimes, on the other hand, may use this monopoly, exclusively, for political reasons: to prevent entry and exit of their opponents and ordinary citizens.[15] These regimes may use this monopoly to subsidize political threats and extend their political power (La Porta et al., 1999). This paper, however, ignores exit control and discusses the more ubiquitous case: controlling and restricting foreigners to enter in the national borders.

Barriers to mobility can also take the form of a high visa refusal rate; a state can refuse to share its space with a foreigner. In 2015, the U.S. refused 3.1 million non-immigrant visas,[16] a visa refusal rate of about 22 percent. Among these were 0.25 million student visas[17] and 2.2 million business visas. The average visa refusal rate in the sample is about 15 percent. The average visa refusal rate for the top 20 most restricted home countries is about 40 percent. Somalia has the highest average visa refusal rate of about 60 percent. Each visa refusal potentially represents a missed learning or business opportunity for these countries and

[12]For natural barriers to international mobility, for example geography, see Gallup et al. (1999) and Diamond (1999).
[13]See Lawson and Lemke (2012) for an exposition to the political economy of visas.
[14]For example, to prevent high profile criminals to flee from the country during the trial.
[15]East Germany, in recent history, is an extreme example of exit control by a repressive regime.
[16]https://travel.state.gov.
[17]Student visas include visa applications in the category of F1 and J1.

disconnects them from the rest of the world, consequently hindering the personal interaction and technology transfer towards the home countries.

How do barriers to mobility affect technology diffusion across countries? Barriers to mobility impede human interaction, which is a key source to diffuse international technologies.[18] Human interaction is required to transmit a part of knowledge that cannot be codified. Research shows that human interaction increases the chance of doing business and promotes international trade.[19] Frankel and Romer (1999) associate greater human interaction with more international trade.[20] Barriers to mobility, on the other hand, impede business travel and subsequently prevent technologies to diffuse across countries.

Moreover, barriers to mobility negatively affect business travel. Business travel increases interaction with foreigners and helps firms to obtain knowledge about international technologies, learn new ideas, and organizational strategies from their partner, which can increase their productivity. Dowrick and Tani (2011) associate international business trips with higher productivity gains for Australian firms, and these gains benefit firms in both countries. Tani and Joyeux (2013) argue that businessmen are highly educated individuals, and international business trips help them access the knowledge produced somewhere else. Hovhannisyan and Keller (2015) find that international business trips promote local innovation, patenting, and growth for both countries. If business travel promotes technology diffusion, then any barriers to mobility across borders obstruct technology transfer.

In addition, barriers to mobility hinder ideas and innovations to diffuse across borders. Only a fraction of countries invest in R&D and innovate new products and processes. These innovations and technologies transfer to other countries through international trade and mobility of people (Keller, 2004). Le (2008, 2012) find that knowledge diffuses across countries due to the mobility of highly skilled workers. Oettl and Agrawal (2008) and Kim et al. (2009) find that the movement of researchers promotes the exchange of scientific knowledge among countries. Andersen and Dalgaard (2011) and Tani and Joyeux (2013) find that international travel promotes technology diffusion across countries. If international mobility promotes technology diffusion, then any barriers to international mobility hinder the diffusion of ideas across borders.

Barriers to international mobility also impose additional costs of time and resources to travelers; travelers must go through much paperwork, submit an application, pay a visa fee, and wait for a visa before traveling. This process also carries the uncertainty that a traveler may not get a visa from the host country. This increased cost along with the uncertainty decreases the flow of people among countries. As noted above, business trips promote international trade. Business visas are generally granted for one year, and the process takes several months, which can delay business deals and give a comparative advantage to the firms located in countries requiring no visa to enter the potential market. Hence, barriers to international mobility hinder technologies to diffuse across borders by negatively affecting international human interaction.

3 Data

This section presents data descriptions and sources in detail. This paper uses annual bilateral data of 30 host and 161 home countries during the period 2001-2012.[21]

TFP Gap: TFP Gap is the total factor productivity gap between the host country j and the home country i at time t. It is calculated as the difference between the TFP of the home and the host country.

$$TFP\ Gap_{i,jt} = ln\left(\frac{TFP_{j,t}}{TFP_{i,t}}\right)$$

Notice that if $TFP_i = TFP_j$ then the TFP gap will be zero. This paper uses an improved measure of TFP[22] reported in the Penn World Table version 9.0 (PWT 9.0). PWT 9.0 reports TFP data accounting

[18] See, for example, Lucas Jr (1988) and Irwin and Klenow (1994). Foster and Rosenzweig (1995), Almeida and Kogut (1999), and Agrawal et al. (2006) provide empirical evidence in favor of knowledge diffusion by personal contact.

[19] For example, Cristea (2011) argues that personal human interaction promotes international trade.

[20] Transfer of technology via international trade has been extensively studied in the economic literature, see for example, Keller (1998), Edmond (2001), and Lee (2006).

[21] See the list of countries and summary statistics (table 1) in the Appendix. These home and host countries lists are based on the availability of data.

[22] Variable 'ctfp' in Penn World Table version 9.0.

Table 1: Descriptive Statistics

VARIABLES	(1) N	(2) mean	(3) sd	(4) min	(5) max
ln(TFP $\text{Gap}_{i,jt}$)	30,960.00	0.39	0.61	-1.68	2.72
Visa Refusal $\text{Rate}_{i,jt}$	7,228.00	14.82	13.43	1.00	100.00
Visa Requirement $\text{Index}_{i,jt}$	36,964.00	0.81	0.40	0.00	1.00
Institution $\text{Gap}_{i,jt}$	44,688.00	0.60	0.32	-0.10	1.00
ln(Capital Intensity $\text{Gap}_{i,jt}$)	50,970.00	2.71	1.91	0.00	10.25
ln(Human Capital $\text{Gap}_{i,jt}$)	52,800.00	0.35	0.27	-0.23	1.26
ln($\text{Distance}_{i,j}$)	53,592.00	8.71	0.63	5.19	9.88
Common Spoken $\text{Language}_{i,j}$	51,840.00	0.14	0.22	0.00	1.00
Common WTO $\text{Status}_{i,jt}$	57,810.00	0.74	0.44	0.00	1.00
Genetic $\text{Distance}_{i,j}$	51,446.00	0.03	0.02	0.00	0.07
Genetic Distance in 1500 $\text{AD}_{i,j}$	51,446.00	0.04	0.02	0.00	0.08
Visa Restriction $\text{Index}_{i,jt}$	35,577.00	0.80	0.40	0.00	1.00
Number of Country Pairs	1,154	1,154	1,154	1,154	1,154

for variable labor share in GDP and variable depreciation rates across countries.[23] These data are different from earlier studies. For example, Hall and Jones (1999) and Caselli (2005) constructed TFP by assuming a constant depreciation rate across countries and over time.

Here α is the output elasticity of capital, K is capital, and L is labor in the respective country.

Visa Refusal Rate: The visa refusal rate is calculated as the number of visas refused divided by the total number of applications received and the data are taken from Hobolth (2012). This variable shows the intensity of barriers to mobility and is arguably a better indicator of barriers to mobility than other measures. The visa requirement index, for example, shows whether the visa is required to enter a country or not but does not show the extent of barriers to mobility. If the citizens of two countries need a visa to travel to a host country, the citizens of the first country may get a visa very easily while excessive paperwork may be required for the citizens of the second country, where most of the visas are denied. Thus, the barriers to mobility will be higher for the second country. The visa refusal rate, on the other hand, captures these effects and shows the extent of barriers to mobility. Data for visa refusal rate are available between 2001 and 2012.

Visa Restriction Index: This index is constructed by Hobolth (2012) and covers three dimensions of the barriers to mobility: visa requirements, visa issuing practice, and consular services. Visa requirement shows whether citizens of the home country need a visa to enter the host country. The visa issuing practice shows the intensity of restrictions and how many visas were granted as a share of total applications, and the consular service shows whether a visa application can be submitted in the home country. All of these dimensions are given equal weight to calculate the visa restriction index. Hobolth (2012) reported this index on a scale ranging from 0 to 3, where 0 implies no barriers to mobility from the home country to the host country, and 3 implies high barriers to mobility from the home to the host country. To simplify the results, this paper makes this index a dummy variable by merging categories 1, 2, and 3. This dummy variable takes the value of 1 if the citizens of the home country face any barriers from the host country and 0 otherwise.

Visa Requirement Index: This index shows whether the citizens of the home country need a valid visa to enter the host country. This index is a binary variable and takes the value of 1 if the citizens of the home country require a visa to enter the host country and 0 otherwise. The data for this dummy variable are taken from Hobolth (2012).

Institution Gap: This paper uses the Polity IV index as a measure of institutional quality in a country, normalizing this index on a scale ranging from 0 to 1,[24] where 0 indicates weak institutions and 1 indicates

[23] See Inklaar and Timmer (2013) and Feenstra et al. (2015) for a complete discussion.

[24] Spilimbergo (2009) and Barro (1999) also normalize this index on a scale ranging from 0 to 1.

better quality institutions. The institution gap is calculated as the difference between the institutional quality in the host and the home country. Polity IV is reported by the Center for Systemic Peace and covers all major and independent states over the period 1800-2015 using a scale ranging from -10 to 10, where 10 indicates a consolidated democracy and -10 indicates an autocracy.

Human Capital Gap: This paper uses the Human Development Index (HDI) to measure the differences in human capital between a country pair. The HDI is a summary measure of average achievement in the key dimensions of human development: a long and healthy life, assessed by life expectancy at birth; being knowledgeable, measured by mean of years of schooling for adults aged 25 years and more and expected years of schooling for children of school entering age; and a decent standard of living, measured by gross national income per capita. The HDI is the geometric mean of normalized indices for each of these three dimensions. The data for the HDI are taken from United Nations Development Program.

Common Spoken Language (CSL): CSL is the probability that two individuals selected at random from two countries will understand each other. The data for CSL are taken from CEPII.[25]

Capital Intensity Gap: This variable is calculated as the difference between the capital stocks of the host and the home country. This variable captures the difference in the stocks of knowledge in a country pair and is taken from Penn World Table version 9.0.

Other Variables: Other variables include the physical distance between a country pair, genetic distance, and a dummy variable showing whether two countries share a common WTO/GATT status.[26] Genetic distance is the probability that two randomly selected individuals from two populations will be genetically different. The genetic distance between two populations is zero if and only if the two populations are genetically identical. Data for the United Nations General Assembly voting are taken from Bailey et al. (2017), and the data for genetic distance are taken from Spolaore and Wacziarg (2009). Data for common border and common WTO status are taken from the CEPII.

Table 2: Correlation Matrix

ln(TFP Gap$_{i,jt}$)	1.00											
Visa Refusal Rate$_{i,jt}$	0.26	1.00										
Visa Requirement Index$_{i,jt}$	0.26	0.00	1.00									
Visa Restriction Index$_{i,jt}$	0.26	0.00	1.00	1.00								
Institution Gap$_{i,jt}$	0.10	0.08	-0.40	-0.41	1.00							
ln(Human Capital Gap$_{i,jt}$)	0.62	0.34	0.43	0.44	-0.13	1.00						
ln(Capital Intensity Gap$_{i,jt}$)	0.32	0.16	0.13	0.13	0.00	0.27	1.00					
ln(Distance$_{i,j}$)	0.05	-0.01	-0.19	-0.18	0.21	0.02	0.11	1.00				
Common Spoken Language$_{i,j}$	-0.06	0.06	-0.15	-0.15	0.25	-0.19	0.15	0.10	1.00			
Common WTO Status$_{i,jt}$	-0.01	0.15	-0.24	-0.24	0.37	0.00	-0.01	0.14	0.03	1.00		
Genetic Distance$_{i,j}$	0.26	0.19	0.18	0.19	0.07	0.48	0.29	0.52	0.12	0.12	1.00	
Genetic Distance in 1500 AD$_{i,j}$	0.15	0.18	-0.16	-0.16	0.30	0.22	0.23	0.73	0.17	0.27	0.71	1.00

4 Bilateral Data Analysis

4.1 Partial Correlations

Figure 1 plots the average TFP gap and average visa refusal rate of each country during the sample period. Visually, the average TFP gap and average visa refusal rate show a high positive correlation. The average TFP gap and average visa refusal rate show a correlation coefficient of about 0.30 and a regression coefficient of about 0.30. The average visa refusal rate explains about 19 percent of the variation in the average TFP gap. Table 2 presents a quick view of partial correlations between the dependent variable, TFP gap, and the regressors. The correlation coefficient between the bilateral TFP gap and the visa refusal rate is 0.26. We find the same correlation coefficients between bilateral TFP gap and the other two measures of barriers

[25] See Melitz and Toubal (2014) for a complete exploration.
[26] The results are consistent if we replace WTO status with trade flows and foreign direct investment.

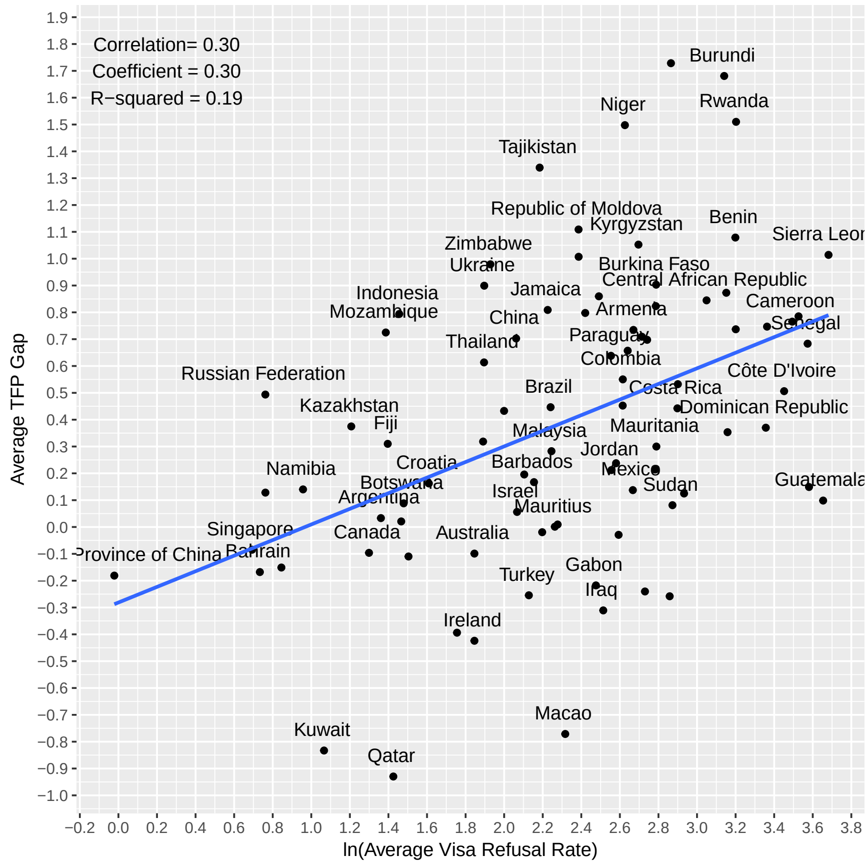

Figure 1: Relationship between average visa refusal rate and average TFP gap

to mobility, the visa restriction index and the visa requirement index. This provides the first evidence that the visa refusal rate, as a measure of barriers to mobility, slows the process of technology diffusion across countries.

4.2 Specification

The next step is to explore empirical evidence on the relationship between the TFP gap and barriers to international mobility. In that respect, this paper features the percent gap between the total factor productivity of a country pair as the dependent variable and visa refusal rate as the main explanatory variable. Other key factors that affect bilateral technology diffusion include the differences between the institutions, human capital, and capital intensities.

Institutions are important because insecure property rights may allow powerful groups to prevent the adoption of new technologies due to the fear of losing economic and political influence (Parente and Prescott, 1999; Acemoglu and Robinson, 2001). In this case, many producers will not be willing to adopt new technologies. On the other hand, good institutions decrease transaction cost (North, 1990) and stimulate economic growth (Knack and Keefer, 1995; Dawson, 1998; Acemoglu et al., 2002; Acemoglu and Johnson, 2005).

Technologies may differ across countries due to differences in human capital. Human capital comprises of factors such as differences in education levels, education quality, and level of health. To capture bilateral differences in human capital, this paper uses the Human Development Index (HDI) which is a summary measure of average achievement in key dimensions of human development: a long and healthy life, assessed by life expectancy at birth; being knowledgeable, measured by mean of years of schooling; and a decent standard of living, measured by gross national income per capita.

Technology diffusion may also depend on the geographic location of a country; countries in proximity to the technological hubs may adopt more technologies due to a lower transportation cost.[27] To control for this factor, this paper uses the geographic distance between a country pair. In addition, technology transfer may depend on the volume of international trade and foreign direct investment.[28] This paper uses common WTO/GATT status to account for international trade and foreign direct investment. Finally, language can play a key role in the diffusion of technologies across countries. Countries speaking the same language may share more technologies due to the ease of communication.

To account for the above determinants of technology diffusion, this paper uses the institution gap, the difference between the institution quality in a country pair; human capital gap, the difference between the human capital; capital intensity gap, the difference between the capital stocks of two countries; the physical distance between two countries; common spoken language, and; common WTO status as control variables. Specifically, the following model is used

$$TFP\ Gap_{i,jt} = \beta_0 + \beta_1\ Visa\ Refusal\ Rate_{i,jt}\ + X'_{i,jt}\ \beta_2 + \beta_i + \beta_j + \beta_t + \epsilon_{ijt} \tag{1}$$

where the $TFP\ Gap$ is the total factor productivity gap between the host country j and the home country i at time t. $Visa\ Refusal\ Rate_{i,jt}$ indicates the barriers to mobility faced by the citizens of country i from country j in year t. β_1 is the elasticity of the bilateral TFP gap with respect to the visa refusal rate. If visa refusal rate changes by one percent, we would expect the bilateral TFP gap to change by β_1 percent. $X_{i,jt}$ is the vector of control variables. β_i, β_j, and β_t are origin, destination, and time fixed effects, respectively. Finally, ϵ_{ijt} captures the omitted variables and noise.

4.3 OLS Estimation

Table 3 shows OLS estimates for the TFP gap as the dependent variable and visa refusal rate as the main explanatory variable. Columns 1-3 report estimation results for visa refusal rate as the only explanatory variable; column 1 does not include any time or country fixed effects; column 2 adds time fixed effects, and; column 3 adds time, host, and home country fixed effects in the model. Visa refusal rate explains about 7 percent of the variation in the dependent variable in column 1, 5 percent in column 2, and 96 percent in column 3. Visa refusal rate has a positive and statistically significant coefficient in columns 1-3.

Column 4 presents the estimation results for the visa refusal rate, as the main explanatory variable, and includes time-variant control variables in the model. The explanatory power of this model is about 96 percent. The main explanatory variable, visa refusal rate, has a positive and statistically significant coefficient with an elasticity of about 0.02, indicating that a 10 percent increase in the visa refusal rate increases the bilateral TFP gap by 0.20 percent.

Column 5 shows the estimation results for the visa refusal rate, as the main explanatory variable, and includes other time-invariant control variables in the model. The explanatory power of this model is about 96 percent. The main explanatory variable, visa refusal rate, has a positive and statistically significant coefficient with an elasticity of about 0.02, showing that a 10 percent increase in the visa refusal rate increases the bilateral TFP gap by 0.20 percent. Starting from a zero bilateral TFP gap, if the visa refusal rate increases by 10 percent, the bilateral TFP gap increases from 0 to about 0.20 percent. The average visa refusal rate in the sample is about 15 percent, revealing that the average bilateral TFP gap increases by about 0.30 percent due to the visa refusal rate. The average annual visa refusal rate for the top 20 most restricted countries is about 40 percent; which reveals that the TFP gap increases by about 0.80 percent for these countries. These results suggest that there is a relationship between barriers to mobility and technology gap.

Table 4 reports OLS estimation results for two additional measures of barriers to mobility: the visa restriction index and the visa requirement index. Column 1 presents the visa restriction index as the main explanatory variable. Visa restriction index is a dummy variable, where 0 implies no barriers and 1 implies barriers to mobility from the home to the host country. Column 2 presents the visa requirement index as the main explanatory variable. Visa requirement index is a dummy variable and takes the value of 1 if a visa is

[27]See Gallup et al. (1999).
[28]See Keller (2004) for a complete discussion.

Table 3: Dependent Variable: Bilateral TFP Gap (OLS Estimation)

VARIABLES	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS
Visa Refusal Rate$_{i,jt}$	0.056***	0.029***	0.017***	0.017***	0.016***
	(0.006)	(0.004)	(0.003)	(0.003)	(0.003)
Institution Gap$_{i,jt}$				0.318***	0.318***
				(0.034)	(0.034)
ln(Capital Intensity Gap$_{i,jt}$)				0.004	0.001
				(0.044)	(0.044)
ln(Human Capital Gap$_{i,jt}$)				-0.110	-0.101
				(0.242)	(0.242)
ln(Distance$_{i,j}$)					0.004***
					(0.002)
Common Spoken Language$_{i,j}$					-0.045***
					(0.012)
Common WTO Status$_{i,jt}$					-0.108***
					(0.021)
Observations	7,228	7,228	7,228	7,228	7,228
R-squared	0.07	0.05	0.96	0.96	0.96
Time FE	No	Yes	Yes	Yes	Yes
Home Country FE	No	No	Yes	Yes	Yes
Host Country FE	No	No	Yes	Yes	Yes

Notes: *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered at the country pair level. Ordinary least squares estimates. The dependent variable is the bilateral total factor productivity gap between the host and the home country. Visa refusal rate is the number of visa applications denied as a share of total applications. The sample is an unbalanced panel, comprising annual bilateral data between 2001-2012.

required to travel from the home to the host country. Both visa restriction index and visa requirement index show negative and statistically significant coefficients. However, these OLS estimation results may be biased and inconsistent due to reverse causality in the model. The next section addresses this potential endogeneity problem by using an instrumental variable method.

4.4 Instrumental Variables Estimation

4.4.1 Dealing with Endogeneity

As we mentioned in the previous section, our main explanatory variable, the visa refusal rate, may be endogenous with the TFP gap. A low TFP home (developing) country may face high barriers to mobility from a high TFP (developed) host country; A developed country may impose high barriers to mobility on the citizens of a developing country to stop illegal immigration. In this case, we have a reverse causality issue. To address this issue, we employ the instrumental variables method by using two instrumental variables for visa refusal rate.

Our first instrumental variable is the bilateral ideal point gap which is based on the UN general assembly voting data taken from Bailey et al. (2017), who identify voting blocs as indicators for common foreign policy. Bailey et al. (2017) present a dynamic model that estimate ideal points of each country and calculate ideal point difference to show state preference gaps. Bailey et al. (2017) argue that ideal points are the best indicators of state preferences. Therefore, we use the ideal point gap as an instrumental variable for visa refusal rate. Ideal point gap, based on the voting patterns, shows similarity or dissimilarity of two countries, and a more similar country pair reveals similarity of foreign policy. We expect proximity in foreign policy

Table 4: Dependent Variable: Bilateral TFP Gap (OLS Estimation–Alternative Explanatory Variables)

VARIABLES	(1) OLS	(2) OLS
Visa Restriction Index$_{i,jt}$	-0.056***	
	(0.013)	
Visa Requirement Index$_{i,jt}$		-0.054***
		(0.011)
Institution Gap$_{i,jt}$	0.240***	0.257***
	(0.025)	(0.026)
ln(Capital Intensity Gap$_{i,jt}$)	-0.000	-0.001
	(0.000)	(0.000)
ln(Human Capital Gap$_{i,jt}$)	0.647***	0.501***
	(0.134)	(0.136)
ln(Distance$_{i,j}$)	-0.004	-0.000
	(0.003)	(0.003)
Common Spoken Language$_{i,j}$	-0.006**	-0.014***
	(0.003)	(0.004)
Common WTO Status$_{i,jt}$	-0.139***	-0.119***
	(0.023)	(0.020)
Observations	15,220	15,951
R-squared	0.97	0.96
Time FE	Yes	Yes
Home Country FE	Yes	Yes
Host Country FE	Yes	Yes

Notes: *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered at the country pair level. Ordinary least squares estimates. The dependent variable is the bilateral total factor productivity gap between the host and the home country. Visa restriction index is a dummy variable and takes the value of 0 if there are no barriers to mobility from the home to the host country. Visa Requirement index is a dummy variable and takes the value 1 if visa is required to travel from the home country to the host country. The sample is an un- balanced panel, comprising annual bilateral data between 2001-2012.

implies fewer visa restrictions.[29].

Our second instrumental variable is the genetic distance between two populations. Genetic distance is the probability that two randomly selected individuals from two populations will be different. The genetic distance between two populations is zero if and only if the two populations are identical.[30] The underlying assumption is that genetic dissimilarity, a larger genetic distance between two populations, increases mistrust between populations and, hence, increases barriers to mobility.[31] A further concern is that current genetic distance may be correlated with the TFP gap. This may be due to factors such as European colonization and migration. For example, European colonizers settled in the regions suitable to them. This migration pattern may explain not only the current TFP gap but also the genetic distance between populations today. Thus, we use genetic distance in 1500 AD as an instrumental variable for visa refusal rate. Genetic distance in 1500 is from the period before the industrial revolution and great migration. We can argue that genetic distance in 1500 does not affect bilateral TFP gap today.

[29]See Mckay and Tekleselassie (2018).

[30]See Spolaore and Wacziarg (2009) for a complete exposition of genetic distance and its effect on barriers to technology transfer.

[31]See for example Guiso et al. (2009) to explore genetic difference and mistrust. Moreover, Ashraf and Galor (2013) explore genetic diversity and cultural fragmentation.

4.4.2 Instrumental Variables Estimation Results

Table 5 reports instrumental variables estimates for TFP gap as a dependent variable and visa refusal rate as the main independent variable. The bilateral ideal points gap based on the UN General Assembly voting patterns and genetic distance in 1500 are used as instrumental variables for visa refusal rate. Columns 1-2 do not include any control variables in the model; columns 3-4 add time-variant control variables, and; columns 5-6 add both time-variant and time-invariant control variables in the model. Columns 1-6 use UN voting ideal points gap as an instrumental variable for visa refusal rate; columns 2, 4, and 6 include an additional instrumental variable, genetic distance in 1500.

Table 5: Dependent Variable: Bilateral TFP Gap (Two-stage Least Squares Estimation)

	Instrumental Variables					
VARIABLES	UN voting	UN voting + genetic distance	UN voting	UN voting + genetic distance	UN voting	UN voting + genetic distance
	(1)	(2)	(3)	(4)	(5)	(6)
Visa Refusal Rate$_{i,jt}$	0.159***	0.157***	0.241***	0.228***	0.233***	0.225***
	(0.050)	(0.045)	(0.063)	(0.056)	(0.063)	(0.057)
Institution Gap$_{i,jt}$			0.334***	0.333***	0.333***	0.332***
			(0.034)	(0.032)	(0.033)	(0.032)
ln(Capital Intensity Gap$_{i,jt}$)			0.014	0.014	0.012	0.012
			(0.026)	(0.025)	(0.025)	(0.024)
ln(Human Capital Gap$_{i,jt}$)			0.173	0.156	0.170	0.160
			(0.145)	(0.136)	(0.142)	(0.135)
ln(Distance$_{i,j}$)					0.000	0.000
					(0.003)	(0.003)
Common Spoken Language$_{i,j}$					-0.079***	-0.078***
					(0.021)	(0.020)
Common WTO Status$_{i,jt}$					-0.066	-0.068*
					(0.042)	(0.041)
Observations	7,179	7,179	7,179	7,179	7,179	7,179
R-squared	0.934	0.935	0.896	0.903	0.901	0.905
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Home Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Host Country FE	Yes	Yes	Yes	Yes	Yes	Yes
1st stage F-stat	20.10	12.01	19.42	11.56	18.74	10.88
Over-id (p-value)		0.948		0.603		0.744

Notes: *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered at the country pair level. Two-stage least squares estimates. The dependent variable is the bilateral total factor productivity gap between the host and the home country. Visa refusal rate is the number of visa applications denied as a share of total applications. The instrument in columns 1-6 is the UN voting ideal point distance between two nations from Bailey et al. (2017); columns 2, 4, and 6 contain an additional instrument—genetic distance in 1500 taken from Spolaore and Wacziarg (2009). Over-id p-value tests that instruments are correctly excluded. The sample is an unbalanced panel comprising annual bilateral data between 2001-2012.

In columns 1-6, visa refusal rate has a positive and statistically significant coefficient with an elasticity ranging from 0.16—0.24. To quantify the magnitude of these coefficients, let's start from a zero bilateral TFP gap, if visa refusal rate increases by 10 percent, the bilateral TFP gap increases between 1.6 to 2.4 percent. The average visa refusal rate in the sample is about 15 percent, indicating that the average bilateral TFP gap increases in the range of 2.4 to 3.6 percent due to the visa refusal rate. The average annual visa refusal rate for the top 20 most restricted countries is about 40 percent; which reveals that the TFP gap increases by about 6.4—9.6 percent for these countries.

These results strengthen the main hypothesis of this paper that barriers to mobility hinder technology diffusion across countries. We also note that F-statistic in columns 1-6 exceeds 10, suggesting that our instruments are not weak (Stock and Yogo, 2002). Furthermore, over id p-values indicate that our instruments are correctly excluded.

4.4.3 Controlling for Other Factors

In both OLS and 2SLS settings, institution gap which shows the bilateral difference in institutional arrangements have a positive and statistically significant effect on the TFP gap, indicating the important role of institutions in the diffusion of technologies. Capital intensity and human capital gap have statistically insignificant coefficient values. In OLS settings, the distance between a country pair has a positive coefficient, showing that geographic location is crucial for technology diffusion; countries located near the technology hubs have a higher technology adoption rate. However, distance has a statistically insignificant coefficient in 2SLS settings. Finally, both common spoken language and common WTO status have negative coefficient values.[32] Common language shows the ease of communication which facilitates the diffusion of technologies across countries, which results in a lower bilateral TFP gap. Common WTO status captures the effect of international trade and foreign direct investment. The results show that countries with a high volume of bilateral trade and foreign direct investment, on average, have lower TFP gap.

5 Cross-section Data Analysis

Since innovations play a crucial role in economic growth, this paper tests the effect of barriers to international mobility on innovations, which are proxied by using log patents per million population data taken from the Economic Intelligence Unit. Because of the cross-sectional nature of innovation data, the above bilateral model cannot be used. Thus, this paper uses cross-sectional data to support the claim that barriers to international mobility slow down technology diffusion and innovations. This study calculates average TFP gap, the average difference between the TFP of the home and *all* the host countries; and average visa refusal rate, the average visa refusal rate faced by the home country from *all* the host countries during the sample period. Specifically,

$$Average\ TFP\ Gap_i = \frac{1}{JT}\sum_{j=1}^{J}\sum_{t=1}^{T} TFP\ Gap_{ij,t}$$

$$Average\ Visa\ Refusal\ Rate_i = \frac{1}{JT}\sum_{j=1}^{J}\sum_{t=1}^{T} Visa\ Refusal\ Rate_{ij,t}$$

Next, this study tests the effect of average visa refusal rate on two dependent variables: log TFP and log patent per million. TFP data are taken from PWT 9.0 for the year 2014, patent per million of population data are from the Economist Intelligence Unit (2007, 2009). Table 6 reports regression results of log TFP in 2014 and log patent per million as dependent variables, respectively. This table presents IV estimation results with extended control variables.

For TFP as a dependent variable, the main explanatory variable, visa refusal rate, has a negative and statistically significant coefficient with an elasticity of about 0.04, indicating that a 10 percent increase in the visa refusal rate decreases the TFP of a country by about 0.40 percent. For patents per million as a dependent variable, the main explanatory variable, visa refusal rate, has a negative and statistically significant coefficient with an elasticity of about 0.20, indicating that a 10 percent increase in the visa refusal rate decreases the patents per million by about 2 percent. This cross-sectional evidence further strengthens our claim that the barrier to international mobility hurts TFP and innovations in a country.

[32]These results are consistent if we replace the WTO status variable with trade flows and foreign direct investment.

Table 6: Cross-sectional IV Estimation

VARIABLES	(1) ln(TFP)	(2) ln(patents per million)
Visa Refusal Rate	-0.038**	-0.202***
	(0.017)	(0.043)
Ethnic Fractionalization	0.101	-1.861*
	(0.174)	(1.116)
Year of Schooling	-0.049	0.458*
	(0.038)	(0.265)
Distance from the UK	-0.261	-2.538***
	(0.209)	(0.823)
Trust	-0.000	-0.013
	(0.002)	(0.010)
Protection Against Expropriation Risk	0.001	0.301***
	(0.013)	(0.101)
Share of Europeans 1900	-0.005**	-0.057***
	(0.002)	(0.015)
Intensive Margin	-1.303**	-6.873***
	(0.583)	(2.224)
Extensive Margin	0.024***	0.065*
	(0.005)	(0.035)
First-stage: Regression of Genetic Distance on IV		
Genetic Distance	5.278***	11.810***
	(1.840)	(3.030)
1st stage F-stat	8.22	15.19
1st stage Partial R^2	0.21	0.57
Observations	56	45
Continent Dummies	Yes	Yes
Legal Origin Dummies	Yes	Yes
Religious Adherence Controls	Yes	Yes
Geography Controls	Yes	Yes

Notes: *** p<0.01, ** p<0.05, * p<0.1. Standard errors in parentheses. The dependent variable is total factor productivity from PWT 9.0 in column 1 and log patents per million of the population taken from the Economist Intelligence Unit (2007, 2009) in column 2. Visa refusal rate is the average visa refusal rate between the origin and all host countries during 2001-2012. Genetic distance from the US is used as an instrument for visa refusal rate in columns 1-2. Genetic distance is the probability that two randomly selected individuals from two populations will be different. The data for genetic distance are taken from Spolaore and Wacziarg (2009). Ethnic fractionalization is from Fearon (2003). Years of schooling is the average number of years of schooling for the 15+ population in 1970 taken from Barro and Lee (2013). Distance from the UK is population-weighted distance taken from the CEPII database. Trust is the percent of people agreeing that strangers can generally be trusted from the World Values Survey. Protection against expropriation risk is taken from the International Country Risk Guide. Acemoglu and Robinson (2001) used this variable to approximate the strength of a country's institutions. The share of Europeans in 1900 is from Acemoglu and Robinson (2001). Intensive and Extensive margins of technology diffusion are from Comin and Ferrer (2013). Legal origin dummies are from La Porta et al. (1998); British legal origin is the omitted category. Religious adherence controls are from Barro and McCleary (2003). They include the proportion of Protestants, Catholics, Orthodox Christians, adherents of other Christian religions, Jews, Muslims, Hindus, Buddhists, and other Eastern religions. Geography controls include (i) a dummy variable for landlocked countries and (ii) absolute values of longitude and latitude of a country.

To summarize the above results, overall evidence suggests that there is a strong relationship between barriers to international mobility and technology diffusion; the international TFP gap increases as the barrier to international mobility increases. This relationship is robust across dyadic and cross-sectional data as well as across different estimation techniques: OLS and 2SLS. Hence, this paper sheds new light on factors contributing to the slow diffusion of global technologies.

6 Concluding Remarks

International mobility plays a crucial role in exposing societies to superior technologies and production processes outside their national borders and, hence, facilitates the diffusion of technologies. On the other hand, any barriers to international mobility can slow the spread of technologies across countries. Our results indicate that barriers to international mobility impede the spread of technologies across countries, and the bilateral TFP gap increases as the visa refusal rate increases. These results are robust across different estimation methods. This paper, thus, builds a case that the global TFP gap increases as barriers to international mobility increase. To find the above results, this paper uses bilateral visa restrictions data of 30 host countries and 161 home countries during the period 2001-2012.

Important policy implications include initiating visa facilitation programs with advanced countries. These visa facilitation programs could promote cultural and scientific exchange and stimulate technology diffusion across countries. The present paper focuses on the one-way effects of barriers to mobility—technology diffusion from the host to the home country. Future research could incorporate two-way effects to explore, how the bilateral barriers to mobility affect bilateral technology diffusion.

References

Acemoglu, D. and Johnson, S. (2005). Unbundling institutions. *Journal of Political Economy*, 113(5):949–995.

Acemoglu, D., Johnson, S., and Robinson, J. A. (2002). Reversal of fortune: Geography and institutions in the making of the modern world income distribution. *Quarterly Journal of Economics*, 117(4):1231–1294.

Acemoglu, D. and Robinson, A. (2001). The colonial origins of comparative development: An empirical investigation. *American Economic Review*, 91(5):1369–1401.

Agrawal, A., Cockburn, I., and McHale, J. (2006). Gone but not forgotten: Knowledge flows, labor mobility, and enduring social relationships. *Journal of Economic Geography*, 6(5):571–591.

Almeida, P. and Kogut, B. (1999). Localization of knowledge and the mobility of engineers in regional networks. *Management Science*, 45(7):905–917.

Andersen, T. B. and Dalgaard, C.-J. (2011). Flows of people, flows of ideas, and the inequality of nations. *Journal of Economic Growth*, 16(1):1–32.

Ashraf, Q. and Galor, O. (2013). Genetic diversity and the origins of cultural fragmentation. *American Economic Review*, 103(3):528–533.

Bailey, M. A., Strezhnev, A., and Voeten, E. (2017). Estimating dynamic state preferences from United Nations voting data. *Journal of Conflict Resolution*, 61(2):430–456.

Barro, R. J. (1999). Determinants of democracy. *Journal of Political Economy*, 107(S6):S158–S183.

Barro, R. J. and Lee, J. W. (2013). A new data set of educational attainment in the world, 1950–2010. *Journal of Development Economics*, 104:184–198.

Barro, R. J. and McCleary, R. M. (2003). Religion and economic growth across countries. *American Sociological Review*, pages 760–781.

Caselli, F. (2005). Accounting for cross-country income differences. *Handbook of Economic Growth*, 1:679–741.

Comin, D. A. and Ferrer, M. M. (2013). If technology has arrived everywhere, why has income diverged? Technical report, National Bureau of Economic Research.

Cristea, A. D. (2011). Buyer-seller relationships in international trade: Evidence from US States' exports and business-class travel. *Journal of International Economics*, 84(2):207–220.

Dawson, J. W. (1998). Institutions, investment, and growth: New cross-country and panel data evidence. *Economic Inquiry*, 36(4):603–619.

Diamond, J. (1999). *Guns, Germs, and Steel: The Fates of Human Societies*. WW Norton and Company, New York.

Dowrick, S. and Tani, M. (2011). International business visits and the technology frontier. *Economics Letters*, 110(3):209–212.

Edmond, C. (2001). Some panel cointegration models of international R&D spillovers. *Journal of Macroeconomics*, 23(2):241–260.

Fearon, J. D. (2003). Ethnic and cultural diversity by country. *Journal of Economic Growth*, 8(2):195–222.

Feenstra, R. C., Inklaar, R., and Timmer, M. P. (2015). The next generation of the Penn World Table. *American Economic Review*, 105(10):3150–3182.

Foster, A. D. and Rosenzweig, M. R. (1995). Learning by doing and learning from others: Human capital and technical change in agriculture. *Journal of Political Economy*, pages 1176–1209.

Frankel, J. A. and Romer, D. (1999). Does trade cause growth? *American Economic Review*, 89(3):379–399.

Gallup, J. L., Sachs, J. D., and Mellinger, A. D. (1999). Geography and economic development. *International Regional Science Review*, 22(2):179–232.

Guild, E. (2009). *Security and Migration in the 21st Century*. Polity.

Guiso, L., Sapienza, P., and Zingales, L. (2009). Cultural biases in economic exchange? *The Quarterly Journal of Economics*, 124(3):1095–1131.

Hall, R. E. and Jones, C. I. (1999). Why do some countries produce so much more output per worker than others? *The Quarterly Journal of Economics*, 114(1):83–116.

Hobolth, M. (2012). Researching mobility barriers: The European visa database. Technical report, LSE Migration Studies Unit Working Paper Series. No. 3/2012. London: London School of Economics and Political Science.

Hovhannisyan, N. and Keller, W. (2015). International business travel: An engine of innovation? *Journal of Economic Growth*, 20(1):75–104.

Howitt, P. (2000). Endogenous growth and cross-country income differences. *American Economic Review*, pages 829–846.

Inklaar, R. and Timmer, M. (2013). Capital, labor and TFP in PWT 8.0.

Irwin, D. A. and Klenow, P. J. (1994). Learning-by-doing spillovers in the semiconductor industry. *Journal of Political Economy*, pages 1200–1227.

Keller, W. (1998). Are international R&D spillovers trade-related?: Analyzing spillovers among randomly matched trade partners. *European Economic Review*, 42(8):1469–1481.

Keller, W. (2004). International technology diffusion. *Journal of Economic Literature*, 42:752–782.

Kim, J., Lee, S. J., and Marschke, G. (2009). International knowledge flows: Evidence from an inventor-firm matched data set. In *Science and Engineering Careers in the United States: An Analysis of Markets and Employment*, pages 321–348. University of Chicago Press.

Klenow, P. and Rodriguez-Clare, A. (1997). The neoclassical revival in growth economics: Has it gone too far? In *NBER Macroeconomics Annual 1997, Volume 12*, pages 73–114. MIT Press.

Klenow, P. J. and Rodriguez-Clare, A. (2005). Externalities and growth. *Handbook of Economic Growth*, 1:817–861.

Knack, S. and Keefer, P. (1995). Institutions and economic performance: Cross-country tests using alternative institutional measures. *Economics & Politics*, 7(3):207–227.

La Porta, R., Lopez-de Silanes, F., Shleifer, A., and Vishny, R. (1999). The quality of government. *Journal of Law, Economics, and Organization*, 15(1):222–279.

La Porta, R., Lopez-de Silanes, F., Shleifer, A., and Vishny, R. W. (1998). Law and finance. *Journal of Political Economy*, 106(6).

Lawson, R. A. and Lemke, J. S. (2012). Travel visas. *Public Choice*, 153(1-2):17–36.

Lawson, R. A. and Roychoudhury, S. (2016). Do travel visa requirements impede tourist travel? *Journal of Economics and Finance*, 40(4):817–828.

Le, T. (2008). Brain drain or brain circulation: Evidence from OECD's international migration and R&D spillovers. *Scottish Journal of Political Economy*, 55(5):618–636.

Le, T. (2012). R&D spillovers through student flows, institutions, and economic growth: What can we learn from African countries? *Scottish Journal of Political Economy*, 59(1):115–130.

Lee, G. (2006). The effectiveness of international knowledge spillover channels. *European Economic Review*, 50(8):2075–2088.

Lucas Jr, R. E. (1988). On the mechanics of economic development. *Journal of Monetary Economics*, 22(1):3–42.

Mckay, A. and Tekleselassie, T. G. (2018). Tall paper walls: The political economy of visas and cross-border travel. *World Economy*, 41(11):2914–2933.

Melitz, J. and Toubal, F. (2014). Native language, spoken language, translation and trade. *Journal of International Economics*, 93(2):351–363.

Neumayer, E. (2010). Visa restrictions and bilateral travel. *The Professional Geographer*, 62(2):171–181.

Neumayer, E. (2011). On the detrimental impact of visa restrictions on bilateral trade and foreign direct investment. *Applied Geography*, 31(3):901–907.

North, D. C. (1990). *Institutions, Institutional Change and Economic Performance.* Cambridge University Press.

Oettl, A. and Agrawal, A. (2008). International labor mobility and knowledge flow externalities. *Journal of International Business Studies*, 39(8):1242–1260.

Parente, S. L. and Prescott, E. C. (1999). Monopoly rights: A barrier to riches. *American Economic Review*, pages 1216–1233.

Piva, M., Tani, M., and Vivarelli, M. (2018). Business visits, knowledge diffusion and productivity. *Journal of Population Economics*, 31(4):1321–1338.

Spilimbergo, A. (2009). Democracy and foreign education. *American Economic Review*, 99(1):528–543.

Spolaore, E. and Wacziarg, R. (2009). The diffusion of development. *The Quarterly Journal of Economics*, 124(2):469–529.

Stock, J. H. and Yogo, M. (2002). Testing for weak instruments in linear IV regression.

Tani, M. and Joyeux, R. (2013). Do business visits cause productivity growth? *IZA Discussion Paper No. 7827.*

Valette, J. (2018). Do migrants transfer productive knowledge back to their origin countries? *Journal of Development Studies*, 54(9):1637–1656.

7 Appendix

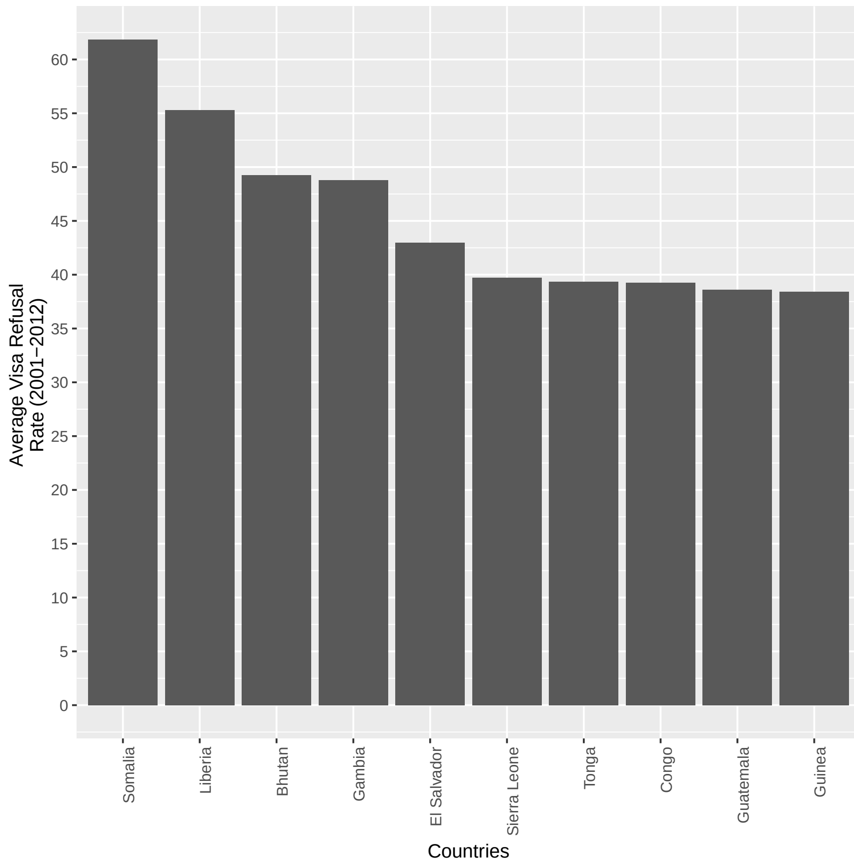

Figure 2: Most Restricted Countries of the World

Table A1: World Passport Ranking

Most Powerful Passports		**Weakest Passports**	
Country	No. of visa free entries	Country	No. of visa free entries
Germany	158	Afghanistan	22
Sweden	158	Pakistan	27
Finland	157	Iraq	30
France	157	Somalia	31
Switzerland	157	Syria	32
Spain	157	Bangladesh	35
United Kingdom	157	Iran	35
Denmark	156	Libya	35
Italy	156	South Sudan	36
Netherlands	156	Ethiopia	36
Belgium	156	Sudan	36
South Korea	156	Palestinian	38
Norway	156	Eritrea	38
Singapore	155	Sri Lanka	39
Luxembourg	155	Congo (DR.)	39
Austria	155	Nepal	40
Portugal	155	Lebanon	40
USA	155	Kosovo	41
Greece	154	North Korea	41
Ireland	154	Yemen	42

Notes: see www.passportindex.org for the latest ranking of passports.

Table A2: List of Host Countries in the Sample

Austria	Belgium	Bulgaria	Cyprus	Czech Republic	Denmark
Estonia	Finland	France	Germany	Greece	Hungary
Iceland	Italy	Latvia	Lithuania	Luxembourg	Malta
Netherlands	Norway	Poland	Portugal	Romania	Slovakia
Slovenia	Spain	Sweden	Switzerland	United Kingdom	USA

Table A3: List of Origin Countries in the Sample

Afghanistan	Ghana	Pakistan
Albania	Grenada	Palau
Algeria	Guatemala	Palestinian Authority
Angola	Guinea	Panama
Antigua and Barbuda	Guinea-Bissau	Papua New Guinea
Argentina	Guyana	Paraguay
Armenia	Haiti	Peru
Australia	Holy See	Philippines
Azerbaijan	Honduras	Qatar
Bahamas	Hong Kong SAR	Russia
Bahrain	India	Rwanda
Bangladesh	Indonesia	Saint Kitts and Nevis
Barbados	Iran	Saint Lucia
Belarus	Iraq	Saint Vincent and the Grenadines
Belize	Ireland	Samoa
Benin	Israel	Sao Tome and Principe
Bhutan	Jamaica	Saudi Arabia
Bolivia	Japan	Senegal
Bosnia and Herzegovina	Jordan	Serbia
Botswana	Kazakhstan	Seychelles
Brazil	Kenya	Sierra Leone
Brunei Darussalam	Kiribati	Singapore
Burkina Faso	Korea (North)	Solomon Islands
Burma	Korea (South)	Somalia
Burundi	Kuwait	South Africa
Cambodia	Kyrgyzstan	Sri Lanka
Cameroon	Laos	Sudan
Canada	Lebanon	Suriname
Cape Verde	Lesotho	Swaziland
Central African Republic	Liberia	Syria
Chad	Libya	Taiwan
Chile	Macao SAR	Tajikistan
China	Macedonia	Tanzania
Colombia	Madagascar	Thailand
Comoros	Malawi	Timor-Leste
Congo	Malaysia	Togo
Congo (DR)	Maldives	Tonga
Costa Rica	Mali	Trinidad and Tobago
Côte d'Ivoire	Mauritania	Tunisia
Croatia	Mauritius	Turkey
Cuba	Mexico	Turkmenistan
Djibouti	Moldova	Tuvalu
Dominica	Mongolia	Uganda
Dominican Republic	Montenegro	Ukraine
Ecuador	Morocco	United Arab Emirates
Egypt	Mozambique	Uruguay
El Salvador	Namibia	Uzbekistan
Equatorial Guinea	Nauru	Vanuatu
Eritrea	Nepal	Venezuela
Ethiopia	New Zealand	Vietnam
Fiji	Nicaragua	Yemen
Gabon	Niger	Zambia
Gambia	Nigeria	Zimbabwe
Georgia	Oman	