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A Gravity Model Estimation of the Bi-Directional Relationship between International Trade and Migration

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Abstract

The relationships between migration and trade are a continuing source of debate in the academic literature. Some studies have found that migration and trade are complements, while other studies have found them to be substitutes. Still other studies have found that there is no statistically significant relationship between them. However, the majority of previous empirical studies have focused on the relationship between trade and migration in either a single country, a single region, or within a single trade agreement. This paper examines the bi-directional relationship between trade and migration using international bilateral trade and migration flows data for 248 countries over the period 1990-2010. We also account for other relevant covariates within a seemingly-unrelated regression gravity model framework. Our findings suggest that trade and migration are complements - larger migration flows are associated with larger trade flows, and vice versa. The relationships with other relevant covariates are as expected, with the exception that distance is positively and statistically significantly related to migration. Although our results do not definitively demonstrate causality, they suggest that, if world trade decreases due to countries acting on current protectionist sentiments, migration flows might also be expected to decline.

1. Introduction

The relationships between international migration and trade are a continuing source of debate in the academic literature. Many studies on these relationships have been conducted (for example, Steingress 2015, Serrano-Domingo and Requena-Silvente 2013). If migration flows increase with increases in trade (or vice versa) that would demonstrate that they are complements, whereas if they are negatively correlated, they will be substitutes. The question of whether trade and migration are complements or substitutes has been the source of much academic research.

The question of the relationship between trade and migration has increased in importance. International trade and migration flows have increased in recent years due to globalization. Economic research on globalization suggests that it has occurred in three waves (Robertson 2003) and we are now currently in the midst of the third wave of globalization (Rodrik 1998, Holton 2000). A general definition of globalization is the growing flows through national borders of trade, capital, investment, community, information, way of life, and even diseases, or in other words, more economic interdependence among countries (Scholte 2005), include the exchanging of cultures, attitudes, and people (Bergstrand 2013).

After the inter-war years where trade barriers rose substantially, trade became more liberal after 1947, when 23 countries signed the first worldwide multilateral free trade agreement, the General Agreement on Tariffs and Trade (GATT). This evolved into the World Trade Organization (WTO) on 1st January 1995. The main purpose of GATT and the WTO has been to increase international trade by eliminating and reducing trade protectionism, i.e. various types of tariffs and quotas, as well as non-tariff trade barriers. Since the 1970s, open borders have lured huge amounts of foreign direct investment, financial flows, and increased international migration flows, as well as increased the trade of services and goods (Poot 2013).

The world has become more interconnected and besides trade, this has also affected the magnitude of migration flows across national boundaries. Every year, millions of people are willing to leave their home countries and cross national borders in search of greater opportunities and better livelihoods for themselves and their families. The world population in 1990 was 5.3 billion and the number of international migrants was 152 million (2.8 percent of the global population). By 2010, the world population had increased to 6.9 billion[1] with 221 million international migrants globally (3.2 percent).[2]

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[1] https://data.worldbank.org/

[2] https://www.oecd.org/World-Migration-in-Figures

The growing magnitude of international migration flows has attracted a lot of researchers to study whether it is associated with increases in trade. The majority of previous empirical studies have focused on the relationship between trade and migration in a single country, a single region, or between countries within a single trade agreement. Many of these previous studies have found that trade and migration have a positive relationship (for example, Mundra 2005, Wong 1983; Genç 2014, Akkoyunlu and Siliverstovs 2009, White 2007). Other studies have found that there is no relationship between trade and migration (Hatzigeorgiou and Lodefalk 2015) or that trade and migration are substitutes (for example, Wickramasekera 2002, Markusen1983).

Countries openness to cross-border flows has reduced both transaction costs and migration costs (Genç 2014). However, some studies have found that governments only favor opening their borders for trade but not for migration (Mayda 2007, Genç 2014). Why are governments willing to open borders for trade, but less willing to do so for migration? Will open boarders for trade be more beneficial than open boarders for migration? Doesn't migration stimulate trade? These questions help to motivate this research.

The main motivation is to unpack the contradictions surrounding trade and migration by empirically examining whether international trade flows are positively related to international migration flows, and vice versa. The hypothesis for the study is that an increase in international trade flows is associated with an increase in international migration flows. The novelty of the research comes from the use of an extensive dataset of bilateral migration and trade flows, in particular a newly available international bilateral migration flows dataset that has yet to be fully exploited in this area of study.

The remainder of the paper is structured as follows. Section 2 reviews relevant literature on the relationship between trade and migration, focusing on studies that have evaluated whether they are substitutes or complements. In Section 3, we describe the data and methodology. Section 4 presents and discusses our empirical results, and Section 5 concludes.

2. Literature Review

Many studies have been conducted on the relationship between trade and migration. If migration flows and trade flows are positively correlated that would demonstrate that they are complements, whereas if they are negatively correlated, they are substitutes. On this question, the empirical literature yields rather contradictory conclusions. Most of the literature to date has examined the relationship between trade flows and either immigration flows or emigration flows separately, instead of studying both types of migration flows simultaneously or considering migration flows in the same direction as trade flows.

In one of the first studies of this type, Mundell (1957) used the Heckscher-Ohlin-Samuelson Model to describe theoretically whether international trade and factor mobility are substitutes or complements. Mundell determined that trade and factor movements are expected to be substitutes. Markusen (1983), by relaxing some of the underlying assumptions of the standard Heckscher–Ohlin model, noted that there is theoretical support for both relationships (substitutes *and* complements). One of their explanations was that, if trade increases alongside international factor mobility, then factor mobility and trade are theoretically complements. Razin and Sadka (1992) expanded the study of Markusen (1983) by using the Hecksher-Ohlin Proposition Model.[3] They concluded that if the only difference between countries was in their relative abundance of labour, then commodity trade and labour are substitutes.

Morrison (1982) studied how U.S. foreign assistance, international trade and foreign direct investment influence migration flows for countries that send large numbers of migrants to the U.S., especially countries in the Caribbean, Central and South America, and Mexico. They found that trade and immigration are complementary. Collins, O'Rourke, and Williamson (1997) analyzed trade and factor (labour and capital) movements between several countries for the years 1870 to 1940. Using panel data, they found that trade and capital flows were rarely substitutes and most of the time were complements, and between trade and migration flows they found that there is a strong complementary link.

Bruder (2004) studied whether trade and factor movements (migration) were substitutes or complements between Germany and each of Spain, Portugal, Greece, Italy, and Turkey, the five biggest foreign worker sources for Germany. They found that there is no significant impact of labor migration on trade, but on the other hand increasing trade volume has significant negative effects on labour migration. Panagariya and Panagariya (1992) proposed a North-South (richer to poorer countries) model driven by scale economies in the modern sector. They divided migration into two subgroups – skilled and unskilled labour. They found that the movement of factors of production, like capital and skilled labour in particular, leads to an expansion of trade, while the movement of unskilled labour may or may not lead to any effect on trade. They concluded that trade and unskilled factor mobility are substitutes, while trade and both skilled labour and capital are complements. Likewise, López and Schiff (1998) and Felbermayr and Jung (2009) used skilled and unskilled labour, international labour mobility, migration costs, and financial constraints in their studies. In contrast with Panagariya and Panagariya (1992), both studies found that trade flows and migration of unskilled workers were complements, while the migration of skilled workers was unrelated to trade flows.

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[3] This is a 'type of model relating the inter economy factor movement to inter economy factor price differentials' (Smith 1975 p.165), which means that labour-abundant countries will specialize in labour intensive merchandise and capital-abundant countries will specialize in capital intensive merchandise for export.

The most widely used method to analyze international trade and migration individually is the gravity model approach, initiated by Ravenstein (1885). Inspired by Newton's Law of Universal Gravitation, Tinbergen (1962) described the patterns of bilateral aggregate trade flows between two countries as being directly proportionate to the level of GDP for both countries, but inversely related to the distance between them. Studies using panel data gravity models have shown that migration is positively associated with trade flows in terms of imports and exports between the host and home countries. For example, Gould (1994) studied about forty seven United States trading partners. They analyzed producer goods and consumers goods separately and found that both imports and exports were strongly positively influenced by immigration.

Head and Ries (1998) studied Canadian trade with one hundred and thirty six trading partners from 1980 to 1992. They found that immigration (which they divided into three primary categories: *family*; *refugee*; and *independent*) positively affects both imports and exports. They added that independent immigrants tend to be more skilled, with more knowledge, and lead to greater impacts on trade flows than other immigrant groups. Hong and Santhapparaj (2006) studied the impact on Malaysia's bilateral trade flows of ASEAN and non-ASEAN skilled immigration. They found that skilled immigration positively affects both Malaysian imports and exports, but that the link is stronger between Malaysia and ASEAN countries than between Malaysia and non-ASEAN countries. Combes, Lafourcade, and Mayer (2005) investigated how migrants influence trade between French regions, considering the network effects of migrants. They found that migrants were able to increase trade but with the presence of network effects, migration will increase trade more that without network effects. One natural experiment about migrant networks and trade on Vietnamese boat people in the U.S., by Parsons and Vézina (2018), showed that U.S. exports to Vietnam grew larger in 1995 to 2010 and mostly in those states with greater Vietnamese populations.

The study that most closely resembles ours, using comprehensive international trade and migration data, is Fagiolo and Mastrorillo (2014). Using migrant stock data, they applied a complex-network approach for 226 countries, and found evidence that international migration network size and merchandise trade are strongly positively related, with pooled OLS as their estimator. Our study differs in our use of the Poisson-Pseudo-Maximum Likelihood (PPML) estimator combined with Seemingly Unrelated Regression (SUR). We discuss the advantages of our approach in the following section.

Recent research has suggested that immigration has a positive relationship with trade only until the migrant stock reaches a certain threshold, and then migration–trade links become exhausted (Egger, Von Ehrlich and Nelson 2012). According to Serrano-Domingo and Requena-Silvente (2013), potential bilateral export value reaches its maximum point when the array of immigrants of a certain nationality or ethnicity living in the same zone reaches a specific level (70

immigrants from the same nationality for Italy, and 100 for Spain). Similarly, Gould (1994) estimated the impact of immigrant links to their home countries to U.S. bilateral trade. They found that the influenced is exhausted at a considerably higher level of immigrants for imports (370,879 immigrants) than for exports (12,016 immigrants).

To summarize: Some studies have suggested that migration and trade are complements, but there are arguments that migration and trade have no direct relationship, while other studies have found that they are substitutes. Some studies have found that migration only affects exports and not imports, and some have found that the relationship differs between skilled and unskilled migrants. We contribute this literature by providing a study of the relationship between trade and migration using flows between all countries (where data are available), an approach that has been mostly lacking in the extant research.

3. Data and Methods
Data
We use data for 248 countries over four five-yearly periods (1990-2010). A list of the included countries is in the Appendix, Table A2. The data are bilaterally structured, with each observation referring to a specific flow from origin i to destination j in a given five-year period.

Bilateral trade flows (in nominal US$1000s) were obtained from the Center for International Data at the University of California – Davis (Baxter and Kouparitsas 2006, Feenstra, Lipsey, Deng, Ma and Mo 2005).[4] To ensure data quality, this dataset uses source data reported by the importer as much as possible, because importers have more incentive to properly record all transactions than exporters, due to duties and tariffs (Fouquin and Hugot 2016).

Bilateral migration flows data were obtained from a newly assembled global dataset developed by Abel and Sander (2014). The dataset consists of bilateral migration flows at country level for each five-year period from 1990-2010. It was developed from the changes in stock migration from mid-year to mid-year, based on place-of-birth answers to census questions, information obtained from population registers, and refugee statistics (Abel and Sander 2014). This dataset effectively captures the total number of people who change their country of residence during each five-year period.

Our analysis also controls for relevant covariates. Gross domestic product (GDP) is a common variable employed in gravity models (Vicente 2003). We obtained data on gross domestic product (GDP) in international dollars using purchasing power parity from the World Bank

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[4] http://cid.econ.ucdavis.edu.

database.[5] Population data were obtained from the United Nations Population Division,[6] being mid-year estimates of the total population (headcount) counting all residents of each country regardless of legal status or citizenship. Population is another variable that previous researchers have found to positively affect trade and migration (Bove and Elia 2017). This is theorized to be due to an increased pool of potential migrants as the origin country population increases, while destination countries with larger populations offer more amenities and opportunities to attract migrants (Lee 1966).

Data on common official language (as a dummy variable) was obtained from French Centre d'Etudes Prospectives et d'Informations Internationales (CEPII) (Mayer and Zignago 2011).[7] Common language is expected to be positively related to both bilateral trade flows and bilateral migration flows (Ball 1967, di Giovanni 2005). If the majority of the residents in a country are able to speak the language of its trading partners, it is hypothesized that the trade volume will be higher among these countries due to lower trading, transaction and information costs, as previous research has consistently shown (Gould 1994, Wagner, Head and Ries 2002, Egger and Lassmann 2018). Distance between countries was calculated as the geographical distance between their respective capital cities in kilometers. Trade and migration are expected to be negatively affected by geographical distance. Distance is one of the defining variables of the gravity model (Montanari 2005, Blomqvist 2004, White 2007, McCallum 1995).

Additional dummy variables were created for adjacency, landlockedness, and common colonial heritage. Data for these variables were obtained from CEPII database. Adjacency denotes whether countries i and j share a common border, and has also been used by Baier and Bergstrand (2009). Neighboring countries have easier trade and migration due to lower transportation costs (Wong and Wong 2008). Landlocked countries face constraints accessing world markets (Faye *et al.* 2004), so landlocked countries might have poor international trade performance (Paudel and Burke, 2015), since the means to transport goods and services are limited. Common colonial heritage is also often used by economists (Mayer, Head and Ries 2008, Ekkayokkaya, Foojinphan and Wolff 2017) to represent similarities in cultural, political or legal institutions. Previous research has shown that countries that share a common culture are more likely feel comfortable trading among each other since common culture will develops trust between people in those countries (Guiso, Sapienza and Zingales 2009).

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[5] This is the total gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. Data are in current international dollars. For most economies, PPP figures are extrapolated from the 2011 International Comparison Program (ICP) benchmark estimates, or imputed using a statistical model based on the 2011 ICP estimates, see http://databank.worldbank.org/data/reports.aspx.

[6] https://esa.un.org/unpd/wpp/

[7] http://www.cepii.fr/CEPII/en/bdd_modele/bdd_modele.asp

Trade between two countries will likely increase if both countries are part of a Regional Trade Agreement (RTA) due to lower costs of trade (Baier and Bergstrand 2009). Hence, it is essential to include an indicator of RTAs in the model. It is expected that countries that belong to the same trade block will have greater trade volumes (Bendjilal 2000 Ball 1967). Data on RTAs were obtained from the World Trade Organization (WTO).[8] Of all the explanatory variables, RTAs are the only variable that is used in the trade model but not in the migration model. This is because RTAs do not typically include agreement on migration flows between countries.

Multilateral resistance is an important consideration in the gravity model. Anderson and van Wincoop (2003) introduced the concept of multilateral resistance (MR) as a measure of the transaction costs of trade flows between countries i and j, relative to those between country i *and* other countries. It is important to include MR in gravity model estimations. To see why, consider a simple example. If country i and j are trade partners and the trade resistance between countries i and k reduces, the trade flow between i and j might fall. This may happen regardless of any of the other characteristics of countries i and j, leading to an omitted variable bias (Adam and Cobham, 2007). According to Alberto and Nelson (2012), bilateral trade costs are important but MR gives enormous impact to trade between paired countries since trade flows will definitely respond to a change in trade resistance among other trading partners. The same MR arguments apply equally to the gravity model of migration flows as well as that of trade flows.

Table 1: Descriptive Summary of Variables

Variable	Observations	Mean	Std. Dev.	Min	Max
Trade (Trde)	123,313	359,008	3,948,634	0.001	3.83E+08
Migration (Mig)	47,367	3314	32,578	1	2,677,763
Distance (Dist)	179,445	7839	4556	1.881	19,951
GDP (GDP)	169,870	4.39E+11	1.35E+12	2.13E+07	1.53E+13
Population (Pop)	184,900	3.62E+07	1.32E+08	9004	1.34E+09
Official language (Offlang)	205,180	0.109	0.311	0	1
Common colonizer (Cc)	205,180	0.188	0.390	0	1
Adjacency (Adjcc)	205,180	0.052	0.222	0	1
Regional Trade Agreement (RTA)	205,180	0.137	0.344	0	1
Landlocked country (Lcns)	205,180	0.180	0.384	0	1

Notes
The unit of the variables used. Trade (US$1000s), Migration (total number of people). Distance (kilometers between cities). GDP (current international $). Population (total headcount). All others are dummies variables (yes=1, otherwise=0).

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[8] http://rtais.wto.org/UI/PublicAllRTAList.aspx

Methods

The main objective of this paper is to investigate the relationships between inter-country trade flows and migration flows. For this, we apply a classical gravity model approach. The equation below describes the basic gravity model of trade:

$$T_{ij} = A \frac{GDP_i \, GDP_j}{D_{ij}} \tag{1}$$

where T_{ij} is the trade flow from country i to country j, A is the gravitational constant, GDP_i represents the economic mass of country i and GDP_j represent the economic mass of country j. D_{ij} is the distance between country i and country j. Re-specified in natural logarithms and with the addition of regression coefficients, the regression equation becomes:

$$lnT_{ij} = A + \beta_1 \, ln(GDP_i \, . \, GDP_j) + \beta_2 \, ln(D_{ij}) + \varepsilon_{ij} \tag{2}$$

where the betas are the coefficients of interest, and ε_{ij} is an idiosyncratic error. We estimate two main gravity model equations, for: (1) bilateral trade flows; and (2) bilateral migration flows:

$$ln(\text{Trde}_{ijt}) = \beta_0 + \beta_1 \, ln(\text{Mig}_{ijt}) + \beta_2 \, \text{RTA}_{ijt} + \beta \, Z_{ijt} + \varepsilon_{ijt} \tag{3}$$

$$ln(\text{Mig}_{ijt}) = \delta_0 + \delta_1 \, ln(\text{Trde}_{ijt}) + \delta \, Z_{ijt} + u_{ijt} \tag{4}$$

where o and d are represent origin and destination respectively, i and j indicates countries, and t indicates years. Trde_{ijt} is nominal trade value. Mig_{ijt} is the total of people who change their country of residence. Z_{ijt} represent the rest of control variables and u_{ijt}, ε_{ijt} represent idiosyncratic error terms. β_1 and δ_1 capture the impacts of migration flows on trade flows and trade flows on migration flows respectively.

Our data is an unbalanced panel. Since panel data are used, there are three models that can be chosen (pooled OLS, fixed effects and random effects). We begin with the simplest (pooled OLS) model. According to Hong and Santhapparaj (2006), even if some independent variables are correlated with the dependent variable, pooled OLS outcomes may still be valid. However, the result of pooled OLS will be biased because the error term across countries is correlated and heteroscedastic due to omitted (and unobserved) time-invariant differences between countries. Therefore, we next move to panel data models, with robust standard errors to account for both heteroscedasticity and autocorrelation. A Hausman test ($p<0.001$) indicated that the fixed effects model was more appropriate (Hsiao 2014).

However, both fixed effects and pooled OLS ignore the system interrelationships between the two equations (trade and migration). In our third specification, we use a seemingly unrelated regression (SUR) gravity model framework, building on the approach proposed by Zellner (1962). Observably, there is a link between trade and migration and so we expect that the errors in Equations 3 and 4 will be correlated. Both variables (migration and trade) appear as an explanatory variable in the equation for the other variable. SUR captures the efficiency due to the correlation of the disturbances across equations (Moon and Perron 2006).

In the simplest SUR application, each equation is estimated twice, with the residuals from the estimated equations in the first stage used as explanatory variables in the other equation in the second stage in order to account for the cross-equation correlations. That is, the error in Equation 3.1 becomes an explanatory variable in Equation 3.2, and the error in Equation 3.2 becomes an explanatory variable in Equation 3.1. Rather than the simple two-stage approach, we estimate the system iteratively until convergence is achieved. Concerning the error terms, in the basic SUR model, it is assumed that there is homoscedasticity within individuals (standard deviation not indexed by t) and heteroscedasticity across individuals (standard deviation indexed by i).

Bilateral trade and migration data often have zero values, particularly for pairs of small and distant countries. Unfortunately, in a logarithmic regression specification these data points are undefined. Adding one before computing the logarithm solves the technical issue, but potentially biases the results. Therefore, we move to the Poisson-Pseudo-Maximum Likelihood (PPML) estimator, since it accommodates observations of zero. Silva and Tenreyro (2005) and Santos and Tenreyro (2011) also note that all estimators of log-linear models that overlook heteroscedasticity are generally not consistent, and non-linear estimators such as PPML should be use instead. Moreover, since PPML doesn't require the condition of constant variance, it is able to handle inefficiencies caused by heteroscedasticity (Silva and Tenreyro 2005). We obtain incidence rate ratios by exponentiating the Poisson regression coefficients. In the PPML model, the MR terms are omitted as their inclusion would re-introduce problems of heteroscedasticity (Silva and Tenreyro, 2005). Therefore, following Silva and Tenreyro (2005) and Anderson and van Wincoop (2003), we use origin and destination fixed effects in our PPML specifications to deal with multilateral resistance.

Finally, since we still need to consider the interrelationships between the two equations, we combine SUR and PPML together. To achieve this, we adopt the original two-stage SUR procedure. That is, we obtain the residuals from first-stage PPML models, and add each residual as an additional variable in the opposite PPML model in the second stage. This is our preferred model because it captures the advantages of both the PPML model and the SUR specification.

Limitations

There are two main limitations to our approach. First, there is likely to be some endogeneity between trade and migration flows. We estimate reduced form models, as the focus of the research is to illustrate the correlation between those two flows, and not to analyze the potential causality, which we leave for future research. The second limitation is that the dataset has a number of missing values. Since we are using global datasets with fourteen variables, it is difficult to get complete data, especially for small countries like Kiribati, Latvia, Marshall Islands, Tuvalu or recently-independent countries like Montenegro or South Sudan. The trade and migration flows for small countries are likely to themselves be small, so we believe that any resulting bias in our estimates is likely to be small, and our results to be representative of the relationship between trade and migration flows between larger countries.

3. Result and Discussion

Table 2 presents the coefficients results for pooled OLS (columns 1 and 2), fixed effects (columns 3 and 4), SUR (column 5 and 6), PPML (columns 7 and 8), and PPML-SUR (columns 9 and 10) models. In each pair of columns, the first column has trade as the dependent variable, and the second column has migration as the dependent variable.

The pooled OLS results show that one percent higher bilateral migration flows are associated with 0.158 percent higher bilateral trade flows, while one percent higher bilateral trade flows are associated with 0.194 percent higher bilateral migration flows. In other words, the pooled OLS results demonstrate that migration and trade are complements. Interestingly, the fixed effects model results show no statistically significant relationship between trade and migration (in either direction). However, according to Cameron and Poot (2018), the coefficients obtained with OLS and Fixed Effects gravity models can't be compared directly due to differences in the way the variables should be interpreted. Moreover, like pooled OLS, the fixed effects models ignores the system interrelationships between the two equations. The SUR results show that one percent higher bilateral migration flows are associated with 0.780 percent higher bilateral trade flows, while one percent higher bilateral trade flows are associated with a 0.802 bilateral migration flows. Again, the relationships between trade and migration are complementary.

The coefficients on the control variables in the first six columns are mostly as expected. However, the SUR model shows some odd results, such as positive distance and landlockness elasticities in the migration equation. For the contradicted coefficient sign of landlockness, Grigoriou and Carrere (2008) note that a dummy variable alone is insufficient to capture how landlockedness affects trade because overland transportation costs, bargaining power with transit countries, and the infrastructure of the transit countries are important matters influencing trade in landlocked countries. However, in the first three models a larger concern is the treatment of observations of zero.

Table 2: Gravity Model Regression Results

Variables	(Pooled OLS) Trade	(Pooled OLS) Migration	(Fixed Effect) Trade	(Fixed Effect) Migration	(SUR) Trade	(SUR) Migration	(PPML)IRR Trade	(PPML) IRR Migration	(PPML-SUR) IRR Trade	(PPML-SUR) IRR Migration
Migration	0.158*** (0.007)		-0.006 (0.006)		0.780*** (0.002)		1.017*** (20.68)		1.011*** (13.52)	
Trade		0.194*** (0.008)		-0.011 (0.010)		0.802*** (0.002)		1.064*** (41.11)		1.254*** (5.87)
GDP Origin	1.086*** (0.014)	-0.074*** (0.018)	1.582*** (0.072)	0.047 (0.096)	0.578*** (0.009)	-0.483*** (0.01)	1.125*** (73.02)	0.954*** (-16.17)	1.106*** (60.64)	0.334*** (-13.63)
GDP Destination	1.309*** (0.017)	0.573*** (0.021)	1.062*** (0.068)	-0.681*** (0.091)	0.645*** (0.004)	0.321*** (0.004)	1.151*** (73.97)	1.122*** (35.60)	1.039*** (12.75)	0.599*** (-3.95)
Distance	-0.333*** (0.049)	-0.256*** (0.055)			-1.693*** (0.015)	0.675*** (0.015)	0.909*** (-32.48)	0.863*** (-35.54)	0.997 (-0.49)	1.198 (1.20)
Population Origin	-0.340*** (0.017)	0.506*** (0.017)	0.054* (0.028)	0.067* (0.037)	0.611*** (0.013)	0.716*** (0.013)	0.964*** (-20.23)	1.149*** (51.92)	0.909*** (-43.13)	2.405*** (19.15)
Population Destination	-0.338*** (0.018)	-0.232*** (0.018)	0.105*** (0.018)	-0.025 (0.024)	0.055*** (0.004)	-0.002 (0.004)	0.966*** (-18.15)	0.954*** (-16.84)	1.000 (-0.19)	1.210** (2.60)
Common Language	0.420*** (0.066)	0.931*** (0.076)			0.739*** (0.017)	1.121*** (0.017)	1.082*** (12.19)	1.272*** (27.36)	0.932*** (-9.73)	1.011 (0.05)
Common Colonizer	0.341*** (0.048)	0.443*** (0.058)			0.206*** (0.014)	0.009 (0.013)	1.020*** (3.84)	1.080*** (10.57)	0.949*** (-9.75)	0.650* (-2.39)
Adjacency	-0.159** (0.062)	0.600*** (0.079)			0.684*** (0.018)	0.861*** (0.018)	0.988 (-1.72)	1.083*** (8.27)	0.895*** (-15.10)	2.028*** (3.95)
RTA	0.783*** (0.042)				0.261*** (0.014)		1.083*** (16.01)		1.049*** (9.43)	
Multilateral Resistance	-0.816*** (0.06)	-0.587*** (0.067)			1.253*** (0.016)	-0.663*** (0.016)				
Landlocked Origin	-0.279*** (0.046)	0.116** (0.054)			-0.933*** (0.043)	0.549*** (0.044)	0.962*** (-6.53)	1.047*** (5.60)	0.961*** (-6.80)	1.430* (2.15)
Landlocked Destination	-0.118*** (0.046)	0.111** (0.046)			-0.596*** (0.012)	0.272*** (0.012)	0.981*** (-3.32)	1.028*** (3.38)	0.977*** (-4.06)	0.882 (-0.83)
N	30,359	30,359	30,359	30,359	30,359	30,359	30,359	30,359	30,359	30,359
R-squared (or Pseudo R-squared)	0.679	0.397	0.216	0.010			0.167	0.1505		

Notes: Result for data without zero added in the dependent variable. Columns 1 to 6 have clustered standard errors by countries of origin and destination in parentheses. Column 7 to 10 consists the exponentiated coefficients; t statistics in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

As noted in the previous section, the PPML model does a better job of dealing with zeroes in the dependent variable. The results in column 7 show that each additional migrant per year from country i to country j is associated with an increase in trade flows from country i to country j of 1.7 percent, ceteris paribus. In column 8, the results show that an increase of USD1000 in trade flows from country i to country j is associated with a 6.4 percent increase in migration flows from country i to country j. Finally, the PPML-SUR results show that each additional migrant from country i to country j is associated with a 1.1 percent increase in trade flows from country i to country j, while an increase in trade flows from country i to country j of USD1000 is associated with a 25.4 percent increase in migration flows from country i to country j. In other words, the positive relationships in the PPML+SUR results demonstrate that migration and trade are complements.

The models presented in Table 2 may suffer from missing data. Data on inter-country trade or migration flows may be missing because the data or unknown, or because the flow is genuinely zero. A careful examination of the dataset reveals that most missing values are for pairs of countries that are small and/or distant from each other, which suggests that the missing values are really zero flows (for example, consider the migration flows between Kiribati and Latvia). However, that is not always the case. As a robustness check, we ran another set of regressions models by replacing missing values with zero. These results are reported in the Appendix, Table A1. The signs and significance of most coefficients remain the same as for the results in Table 1, although the coefficients are smaller for our preferred PPML-SUR model. The coefficients on trade and migration being larger for the smaller sample (excluding missing data) is likely due to those results omitting consideration of the extensive margin.

5. Conclusions

In this paper, we analyzed the relationship between global bilateral trade flows and migration flows. There has been a lot of inconsistency in the results in previous studies and not many before have made use of large global datasets of trade and migration flows. Thus, our paper contributes to this literature by using a more expansive set of data than previous studies, as well as exploiting the system structure of the relationships between migration and trade through seemingly unrelated regression.

We found that trade and migration have positive coefficients in all of the specifications except for the fixed effects model (where, as noted above, the interpretation of the coefficients is challenging). That is, trade and migration are complements. In our preferred PPML-SUR specification, an additional migrant from country i to country j is associated with 1.7 percent higher trade flows from country i to country j, while an additional USD1000 in trade flows from country i to country j is associated with 25.4 percent higher migration flows from country i to country j.

These results have important implications based on current events. For instance, the United States is currently engaged in a period of economic nationalism by imposing new trade barriers, such as on aluminum and steel imports.[9] Moreover, the United States has also proposed to increase barriers to the movement of people through their borders, by limiting the granting of guest-worker visas and green cards, restrictions on H-1B visas and family-based immigration, and imposing travel bans.[10]. Similarly, the 'Brexit' deal suggests a period of economic nationalism in the U.K. as well. Meanwhile, the EU mini-summit on migration which was held in Brussels in 2018, recommended stronger protections on external borders, and management of migration flows.[11]

Although our results are not causal, our findings could be interpreted as implying that more trade protection should be associated with a decrease in migration flows. Similarly, the reverse is true – countries that restrict migration flows should expect lower trade flows. Given that international trade and migration are sources of wealth and wellbeing for countries, our results argue against such migration and trade restrictions. However, these policy implications could be strengthened in future work, which extends our analysis and further examines the causal relationships between international trade and migration.

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Table A1: Gravity Model Regression Results
with Added Zeros in Dependent Variables

Variables	(Pooled OLS) Trade	(Pooled OLS) Migration	(Fixed Effect) Trade	(Fixed Effect) Migration	(SUR) Trade	(SUR) Migration	(PPML)IRR Trade	(PPML)IRR Migration	(PPML-SUR) Trade	(PPML-SUR) Migration
Migration	0.113***		-0.006		0.745***		1.129***		1.347***	
	(0.004)		(0.004)		(0.002)		(26.72)		(20.12)	
Trade		0.056***		-0.003		0.781***		1.165***		1.078***
		(0.002)		(0.002)		(0.002)		(25.81)		(58.20)
GDP Origin	1.082***	0.009*	0.189***	0.201***	0.591***	-0.463***	1.002*	0.979***	0.926*	0.975**
	(0.007)	(0.005)	(0.032)	(0.024)	(0.009)	(0.010)	(2.29)	(-9.07)	(-2.23)	(-2.80)
GDP Destination	1.341***	0.410***	0.034	-0.613***	0.660***	-0.314***	1.002	1.001	0.930*	0.979*
	(0.007)	(0.005)	(0.032)	(0.022)	(0.004)	(0.004)	(1.61)	(0.52)	(-1.19)	(-2.08)
Distance	-0.212***	-0.027			-1.665***	0.805***	1.010***	1.042***	1.046*	1.028*
	(0.025)	(0.016)			(0.014)	(0.015)	(4.88)	(9.53)	(0.40)	(2.30)
Population Origin	-0.232***	0.212***	0.140***	0.034***	-0.591***	0.679***	1.014***	1.039***	1.092*	1.027***
	(0.008)	(0.005)	(0.016)	(0.013)	(0.012)	(0.013)	(12.01)	(14.96)	(1.65)	(4.41)
Population Destination	-0.278***	-0.245***	0.115***	-0.113***	-0.063***	0.001	1.002	0.996	1.100*	1.002
	(0.008)	(0.005)	(0.016)	(0.013)	(0.004)	(0.004)	(1.60)	(-1.46)	(2.06)	(0.32)
Common Language	0.721***	0.338***			-0.686***	1.031***	1.034***	0.968**	1.395**	0.980
	(0.031)	(0.021)			(0.017)	(0.017)	(7.03)	(-3.05)	(1.93)	(-0.88)
Common Colonizer	0.481***	0.181***			0.211***	-0.001	1.006	1.023**	0.920	0.993
	(0.025)	(0.017)			(0.013)	(0.013)	(1.64)	(2.74)	(-0.71)	(-0.40)
Adjacency	-0.522***	0.809***			0.654***	0.853***	1.011	1.001	0.985	0.994
	(0.041)	(0.027)			(0.018)	(0.018)	(1.68)	(0.04)	(-0.06)	(-0.24)
RTA	1.507***				0.147***		1.019***		1.387*	
	(0.028)				(0.012)		(4.32)		(2.31)	
Multilateral Resistance	-1.395***	-0.503***			-1.160***	-0.726***				
	(0.029)	(0.019)			(0.016)	(0.016)				
Landlocked Origin	-0.681***	-0.056***			-0.909***	0.561***	0.928***	1.052***	0.601**	1.040*
	(0.022)	(0.015)			(0.042)	(0.043)	(-21.23)	(6.76)	(-3.12)	(2.37)
Landlocked Destination	-0.578***	0.098***			-0.596***	0.300***	0.989**	1.010	0.925	1.009
	(0.023)	(0.015)			(0.012)	(0.012)	(-3.27)	(1.36)	(-0.61)	(0.56)
N	132,474	132,474	132,474	132,474	132,474	132,474	132,474	132,474	132,474	132,474
R-squared pseudo R-squared	0.572	0.219	0.249	0.152			0.058	0.146		

Notes:

Result for data with zero added in dependent variable. Column 1 to 6 have clustered standard errors by countries of origin and destination in parentheses. Column 7 to 10 consists the exponentiated coefficients; t statistics in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A2: List of Countries Used in the Data

	Countries		Countries		Countries
1	Aruba	84	Ghana	167	New Zealand
2	Afghanistan	85	Gibraltar	168	Oman
3	Angola	86	Guinea	169	Pakistan
4	Anguila	87	Guadeloupe	170	Panama
5	Albania	88	Gambia	171	Fmr Pacific Isds
6	Andorra	89	Guinea-Bissau	172	Pitcairn
7	Netherlands Antilles	90	Equatorial Guinea	173	Peru
8	United Arab Emirates	91	Greece	174	Philippines
9	Argentina	92	Grenada	175	Palau
10	Armenia	93	Greenland	176	Papua New Guinea
11	American Samoa	94	Guatemala	177	Poland
12	Antarctica	95	French Guiana	178	Puerto Rico
13	Fr. So. Ant. Tr	96	Guam	179	Korea, Dem. Rep.
14	Antigua and Barbuda	97	Guyana	180	Portugal
15	Australia	98	Hong Kong, China	181	Paraguay
16	Austria	99	Heard and McDonald Islands	182	Occ. Palestinian Terr.
17	Azerbaijan	100	Honduras	183	French Polynesia
18	Burundi	101	Croatia	184	Qatar
19	Belgium	102	Haiti	185	Reunion
20	Benin	103	Hungary	186	Romania
21	Burkina Faso	104	Indonesia	187	Russian Federation
22	Bangladesh	105	India	188	Rwanda
23	Bulgaria	106	British Indian Ocean Ter.	189	Saudi Arabia
24	Bahrain	107	Ireland	190	Serbia and Montenegro
25	Bahamas	108	Iran, Islamic Rep.	191	Sudan
26	Bosnia & Herzegovina	109	Iraq	192	Senegal
27	Belarus	110	Iceland	193	Singapore
28	Belgium-Luxembourg	111	Israel	194	South Georgia and the South Sandwich Islands
29	Belize	112	Italy	195	Saint Helena
30	Bermuda	113	Jamaica	196	Solomon Islands
31	Bolivia	114	Jordan	197	Sierra Leone
32	Brazil	115	Japan	198	El Salvador
33	Barbados	116	Kazakhstan	199	San Marino
34	Brunei	117	Kenya	200	Somalia
35	Br. Antarctic Terr.	118	Kyrgyz Republic	201	Saint Pierre and Miquelon
36	Bhutan	119	Cambodia	202	Serbia
37	Bouvet Island	120	Kiribati	203	South Sudan
38	Botswana	121	St. Kitts and Nevis	204	Sao Tome and Principe
39	Central African RP	122	Korea, Republic	205	Suriname
40	Canada	123	Kuwait	206	Slovak Republic
41	Cocos (Keeling) Islands	124	Lao PDR	207	Slovenia
42	Switzerland	125	Lebanon	208	Soviet Union
43	Channel Islands	126	Liberia	209	Sweden

44	Chile	127	Libya	210	Swaziland
45	China	128	St. Lucia	211	Seychelles
46	Cote d'Ivoire	129	Sri Lanka	212	Syrian Arab Republic
47	Cameroon	130	Lesotho	213	Turks and Caicos Isl.
48	DR Congo	131	Lithuania	214	Chad
49	Congo, Rep.	132	Luxembourg	215	Togo
50	Cook Islands	133	Latvia	216	Thailand
51	Colombia	134	Macao	217	Tajikistan
52	Comoros	135	Morocco	218	Tokelau
53	Cape Verde	136	Moldova	219	Turkmenistan
54	Costa Rica	137	Madagascar	220	Timor-Leste
55	Czechoslovakia	138	Maldives	221	Tonga
56	Cuba	139	Mexico	222	Trinidad and Tobago
57	Christmas Island	140	Marshall Islands	223	Tunisia
58	Cayman Islands	141	Macedonia, FYR	224	Turkey
59	Cyprus	142	Mali	225	Tuvalu
60	Czech Republic	143	Malta	226	Taiwan
61	German DRP	144	Myanmar	227	Tanzania
62	Germany	145	Montenegro	228	Uganda
63	Djibouti	146	Mongolia	229	Ukraine
64	Dominica	147	Northern Mariana Islands	230	US Minor Outlying Islands
65	Denmark	148	Mozambique	231	Uruguay
66	Dominican Republic	149	Mauritania	232	United States
67	Algeria	150	Montserrat	233	Uzbekistan
68	Ecuador	151	Martinique	234	Holy See
69	Egypt, Arab Rep.	152	Mauritius	235	St. Vincent and the Grenadines
70	Eritrea	153	Malawi	236	Venezuela
71	Western Sahara	154	Malaysia	237	British Virgin Islands
72	Spain	155	Mayotte	238	Virgin Islands (U.S.)
73	Estonia	156	Namibia	239	Vietnam
74	Ethiopia	157	New Caledonia	240	Vanuatu
75	Finland	158	Niger	241	Wallis and Futura Isl.
76	Fiji	159	Norfolk Island	242	Samoa
77	Falkland Island	160	Nigeria	243	Yemen Democratic
78	France	161	Nicaragua	244	Yemen, Rep.
79	Faeroe Islands	162	Niue	245	Yugoslavia, FR (Serbia/Montene
80	Micronesia, Fed. Sts.	163	Netherlands	246	South Africa
81	Gabon	164	Norway	247	Zambia
82	United Kingdom	165	Nepal	248	Zimbabwe
83	Georgia	166	Nauru		