LSU Doctoral Dissertations   Graduate School

2015

Essays on the Effect of Trade Facilitation on Bilateral Agricultural Trade

Trina Biswas
Louisiana State University and Agricultural and Mechanical College, tbiswa1@tigers.lsu.edu

ESSAYS ON THE EFFECT OF TRADE FACILITATION ON BILATERAL
AGRICULTURAL TRADE

A Dissertation

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

in

The Department of Agricultural Economics and Agribusiness

by
Trina Biswas
B.A., Jadavpur University, 2007
M.A., Jadavpur University, 2009
M.S., Louisiana State University, 2012
December 2015

To my parents & my brother......

Acknowledgements

I would like to express my deepest gratitude to my advisor, Dr. P. Lynn Kennedy for patiently guiding me through the academic process. He is the best mentor and advisor anyone could ever ask for. His encouragement, optimism, and involvement have been a constant source of inspiration to me. Without his continuous support, this dissertation would not have been possible.

I would also like to thank my committee members, Dr. Jeffrey M. Gillespie and Dr. Robert W. Harrison, who have always been supportive and encouraging. I am grateful to Dr. Haitao Mo as well, for agreeing to be a part of my dissertation committee. Moreover, I extend my appreciation to Dr. Gail Cramer for allowing me to join the doctoral program in the Department of Agricultural Economics and Agribusiness and for his constant encouragements.

My greatest strength and inspiration is my family. I am forever indebted to them for their unconditional love, support, sacrifice, and tremendous faith in me. I am blessed to have Jayanta Kumar Biswas and Kalika Biswas as my parents. They have always been my role models. I feel extremely fortunate to have Sayam, as my brother. He is my friend, philosopher, guide, and a constant source of encouragement. I would also like to thank my sister-in-law Sumana, for her love and support.

Furthermore, I would like to extend a special thanks to all my dear friends who made my stay in Baton Rouge memorable. Last but not least, I am thankful to my family, friends, and teachers back home whose love and support means everything to me.

Table of Contents

Abstract

This dissertation offers three independent studies that each contributes to the literature on trade facilitation. The papers are built on the gravity model framework where the relationship between trade facilitation variables and the volume of agricultural exports across the border are examined. To deal with the issue of endogeneity, instrumental variable regression is used. The study also corrects for sample-selection bias present in the trade data. The first paper examines the role of e-governance on bilateral agricultural trade. The study finds that better quality of e-governance promotes agricultural exports. Specifically, according to the findings of the paper, the quality of e-governance in the exporting country increases the volume of agricultural exports across the border. However, the quality of e-governance prevailing in the importing country does not influence agricultural exports significantly. The second paper deals with the effect of corruption on bilateral agricultural trade. Using different measures of corruption this paper examines the role of institutional quality on agricultural exports. The study finds both trade-enhancing and trade-taxing role of corruption on agricultural exports. Furthermore, according to the findings of the study, the effects are much more prominent for the degree of corruption in the exporting country than the importing country. The third paper studies the impact of Internet adoption on bilateral trade. This paper distinguishes between agricultural and non-agricultural commodities. According to the findings of the paper, Internet penetration encourages non-agricultural exports but it does not have any significant impact on agricultural trade.

Chapter 1. Introduction

International trade plays an important role in the economic well-being of a nation. With the continuing growth in international trade and falling tariff barriers in the recent years, increased concern is placed on non-tariff barriers affecting the volume of cross-border trade. Trade across borders faces obstacles in the form of capacity constraints given limited facilities, inefficient port operations, burdensome customs procedures, excessive documentation requirements, low quality of human capital, and corruption at the borders, etc. All these factors serve to increase costs and delays in international trade (Djankov et al., 2006) which in turn influences the volume of trade across the borders. To solve this problem, governments and businesses use various measures to modernize and simplify transaction procedures at national borders. Therefore, trade facilitation reform to reduce transaction costs associated with international trade has significant relevance in terms of policies. Trade facilitation can be defined as a tool to reduce the complexities of international trade in a cost-effective way while ensuring transparent and efficient trade deals. Some researchers define trade facilitation as the tool that helps reduce the "volume and impact of red tape, a term traditionally associated with wasteful and time-consuming bureaucracy found in international trade operations" (Grainger, 2011). Trade facilitation also involves reducing the transaction costs associated with the enforcement, regulation and administration of trade policies (Staples, 2002). The World Trade Organization (WTO)[1] defines trade facilitation as: "The simplification and harmonization of international trade procedures" where trade procedures are the "activities, practices and formalities involved in collecting, presenting, communicating and processing data required for the movement of goods in international trade."

The objective of this dissertation is, to study the impact of variables that can influence the transit time between origin and destination. Here an attempt has been made to quantify the probable effect of variables such as e-governance, the Internet, and corruption that can

---

[1]Visit: https://www.wto.org/english/tratop_e/tradfa_e/tradfa_e.htm

play a major role in facilitating or hindering international trade across borders. The study is conducted on trade in agricultural commodities. The perishable nature of agricultural commodities makes them more vulnerable to delays in trade (Liu and Yue, 2013). Longer waits in customs can severely degrade product quality and reduce product price. Longer waits at the customs also adversely affect exporters by increasing inventory holding costs. Thus, examining variables that can significantly affect trading time along with affecting transaction costs has important policy implications. Very little research has been done to estimate the impact of these variables on agricultural trade. Therefore, it is important to study the impact of these trade facilitation variables on the agricultural trade performance of a country.

1.1 Trade Facilitation Literature

While the existing literature studying the effect of trade facilitation on agricultural commodities are negligible, this study follows a rich existing literature on the relationship between trade facilitation and the volume of bilateral trade related to non-agricultural products. In their seminal paper Wilson et al., (2003), deviate from the traditional computable general equilibrium (CGE) approach to measure the impact of trade facilitation on trade performance and instead employ a gravity model to examine the relationship. They consider four measures of trade facilitation: port infrastructure, customs environment, regulatory environment, and e-business infrastructures and examine their effect on trade for APEC countries. They do this for a single year by applying single averages to 13 primary variables. Wilson et al., (2005), extend this model to 75 countries. They examine the effect of trade facilitation on the volume of trade in manufacturing goods for the years 2000-2001 and further investigate the stability of the estimated relationships across South-to-South and North-to-South trade. In both papers, they found increased trade in commodities from improvements in all four trade facilitation variables.

Wilson and Perez (2010) contribute to the trade facilitation literature by constructing four new aggregate indicators related to trade facilitation from a wide range of primary indicators using factor analysis. These indicators are i) Physical infrastructure; ii) Information and communications technology (ICT); iii) Border and transport efficiency; and iv) Business and regulatory environment. They also employ an augmented gravity model to assess the impact of different aspects related to trade facilitation, as measured by these four indicators, on export performance. Their results also support the previous findings that improvement in trade facilitation variables increases the volume of trade.

Iwanow and Kirkpatrick (2007) also use a gravity model to examine the effect of regulatory quality and trade facilitation on export performance. They use the gravity model to provide a quantitative assessment of the potential contribution of trade facilitation in improving export performance by reducing export costs. Their results suggest that trade facilitation reform, border reform, improved regulatory environment, and enhanced transport & communications infrastructure all facilitate export growth.

Djankov et al., (2006) find that, on average, each additional day that a product is delayed prior to being shipped reduces trade by at least 1%. They found a larger effect on time-sensitive agricultural products. According to their findings, a day's delay reduces a country's relative exports of products by 6%. Liu and Yue (2013) investigate how time delays affect product quality, product price, trade flow, and social welfare. They use data on the number of days it takes for customs clearance in different countries for agricultural commodities with different levels of perishability. Their results suggest that longer time delays at the border significantly decrease perishable agricultural products' quality and price. They further find that for highly perishable agricultural products, improved and simplified customs procedures increase trade flows and the social welfare of importing countries.

Using the World Bank's "Doing Business" database, Zaki (2015) determines the predicted time related to trade facilitation in developed and developing countries. In his paper, a gravity model is used to estimate ad valorem equivalents (AVEs) of the administrative barriers to

trade. The paper finds that the internet, bureaucracy, corruption, and geographic variables have a significant effect on the transaction time to import and to export. Also, the time to import has a higher negative impact on trade than that to export.

Using bilateral trade panel data, Francois et al., (2013), explore the influence of the infrastructure and institutional quality on patterns of trade. In a gravity model setup using a Poisson estimator, they extended the Baier and Bergstrand method for multilateral resistance, accounting for firm heterogeneity and firm selection. Their result suggests that export performance and the propensity to take part in the trading system depends on the institutional quality and access to well-developed transport and communications infrastructure of both the countries involved in the trade.

This paper also builds on the same gravity model framework where the relationship between trade facilitation variables and the volume of agricultural trade across the border is examined. Formally the paper tries to answer the following questions empirically.

Q1. What is the effect of e-governance on bilateral agricultural trade?

Q2. What is the effect of corruption on bilateral agricultural trade?

Q3. What is the effect of the Internet on bilateral agricultural trade?

1.2   Overview

The motivation of this dissertation is to examine the factors that can influence the transit time between origin and destination and can play a major role in facilitating or hindering international trade across borders. In this study, an augmented gravity model is used, and different estimation techniques are incorporated to empirically investigate the impact of trade facilitation on bilateral agricultural trade. The dissertation deals with the issue of causality by identifying appropriate instruments and also solves for the sample-selection bias. This work is accomplished and presented through a *"journal-article style"* dissertation divided into three sections. The second chapter of the dissertation is entitled "The Role of E-governance

4

on Bilateral Agricultural Trade". This is the first cross-country study in the trade literature that examines the effect of e-governance measures on agricultural exports. The paper also proposes a novel instrument to deal with the issue of endogeneity. The results suggest that the quality of e-governance has a positive and significant impact on the volume of agricultural exports.

The third chapter entitled "The Role of Corruption on Bilateral Agricultural Trade" studies the role of corruption on bilateral agricultural trade. This is the first cross-country study that establishes a relationship between agricultural commodities and the level of corruption prevailing in a country. According to the findings of this study, corruption can be trade-taxing when the protection level is low, but with the degree of protection higher than a threshold level, it becomes trade-enhancing.

The fourth chapter entitled "The Role of the Internet on Bilateral Agricultural Trade" is a cross-country study analyzing the impact of internet penetration on bilateral exports. Separate analyses were conducted on trade related to agricultural and non- agricultural commodities. The paper proposes a novel instrument to deal with the issue of endogeneity. According to the findings of the study, the Internet adoption has a significant and positive impact on non-agricultural exports. The study found weak evidence of a trade-stimulating effect of the Internet on agricultural exports.

Finally, conclusions are drawn in Chapter 5. The findings from the previous three chapters are highlighted and future directions for research are discussed.

Chapter 2. The Role of E-governance on Bilateral Agricultural Trade

2.1 Introduction

The sonorous message at the United Nations Economic Commission Global Trade facilitation conference was "Governments should embrace the digital revolution of international trade. Simplifying lengthy paper processes and cutting red tape by going digital means sustainable, faster, and more efficient trade." (Van Der Valk, 2014)[1]. Echoing the same message, many countries have introduced or improved electronic data interchange systems to make trade easier. This system allows traders to file, transfer and process customs information online. It also allows them to submit their documents and pay duties online from anywhere in the world. Therefore, this system improves transactional efficiency and also saves time by reducing the number of visits to government offices and by reducing the waiting time (Unwin, 2009). At the same time, this system reduces the probability of direct interaction between the traders and the customs officials, thereby reducing the incidence of bribery. According to a World Bank survey, to accelerate service delivery in India, fewer users were required to pay bribes to government officials under e-government projects than under manual projects (Unwin, 2009). Therefore, many developing and developed countries, find it worth investing in Information and Communication Technology (henceforth ICT) to improve the quality and efficiency of government services. For example, in China, total e-governance spending increased from $7 billion in 2006 to more than $10 billion in 2008 (Unwin, 2009).

One such variable that captures how each country has advanced in introducing or adopting the new technology over time is the e-government index constructed by United Nations. As mentioned in the E-government Survey Report (2003), the success of e-governance de-

---

[1]Visit: http://www.worldpolicy.org/blog/2014/03/11/globe-trade-going-paperless

pends upon three pre-requisites: a minimum threshold level of technological infrastructure, human capital, and e-connectivity for all the citizens. To construct the E-government Index, the study, therefore, focused on how each country relies upon information technology to provide service to its citizen. The index also measures the quality of a country's human capital. The E-government Index constructed by the United Nations has two primary indicators: i) The state of E-government Readiness; and ii) The extent of E-participation.

According to the United Nations E-government Survey Report (2003), the E-government Readiness Index is defined as follows: "The generic capacity or aptitude of the public sector to use Information and Communication Technology for encapsulating in public services and deploying to the public, high-quality information (explicit knowledge) and effective communication tools that support human development." The E-government Readiness Index is a composite index comprised of the following indices: a) The Web Measure Index; b) The Telecommunication Infrastructure Index; and c) The Human Capital Index.

The Web Measure Index captures the web presence of government in providing services to its citizens. It captures whether a public office has any official website, a national portal or an official home page and if the necessary information is available online. It measures if these websites allow users to complete entire tasks electronically at any time or to submit forms online. It takes into account whether these websites are equipped to allow citizens to pay taxes or to apply for ID cards, birth certificates/passports, licenses, etc.

The Telecommunication Infrastructure Index is a weighted average index of the following primary indices: a) Personal Computers/1,000 persons; b) Internet users/1,000 persons; c) Telephone Lines/1,000 Persons; d) On-line population/1,000 persons; e) Mobile phones/1,000 persons; and f) Televisions/1,000 persons.

The Human Capital Index is a composite measure of the adult literacy rate and the combined gross enrollment ratio, with two-third weight given to adult literacy and one-third to the gross enrollment ratio.

The same report defines the extent of E-participation as follows: "The willingness, on the part of the government, to use ICT to provide high quality information (explicit knowledge) and effective communication tools for the specific purpose of empowering people for able participation in consultations and decision-making, both in their capacity as consumers of public services and as citizens." (UN Global E-government Survey, 2003)

Table 2.1 lists the five countries with highest quality of e-governance and five countries with the lowest quality of e-governance in descending order of as measured by the E-governance Readiness Index.

Table 2.1: Quality of E-governance in the World, 2005

Rank	Country	Country Code	Trade Value (million US $)	Total GDP (billion US $)	E-government Readiness Index
Countries with highest quality of e-governance					
1.	United States	USA	48239.52	13095	0.91
2.	Denmark	DNK	13196.35	246.60	0.91
3.	Sweden	SWE	3569.51	389.00	0.90
4.	United Kingdom	GBR	12031.97	2412.0	0.88
5.	South Korea	KOR	2467.29	898.10	0.87
Countries with lowest quality of e-governance					
5.	Palau	PLW	-	0.2062	0.06
4.	Micronesia	FSM	12.883	0.2498	0.05
3.	Marshall Islands	MHL	-	0.1377	0.04
2.	Tuvulu	TUV	-	0.0218	0.04
1.	Nauru	NRU	-	-	0.04

E-government Readiness Index takes values in the range of 0 to 1. A higher value of the index implies better quality of e-governance. The data for total agricultural exports comes from United Nation's COMTRADE database.

As can be seen in the table, some of the countries with the highest quality of e-governance in the world are also among the largest exporters of agricultural commodities. For instance, according to United Nation's E-government Survey Report (2005), the United States, Den-

mark, Sweden, United Kingdom, and South Korea are amongst the top five countries in the world with highest quality of e-governance. On the other hand, countries like Palau, Micronesia, Marshall Island, Tuvalu, and Nauru are listed as the worst performing countries in terms of e-governance. The E-government Readiness Index for all the countries in the world is provided in the appendix.

As mentioned before, this system allows traders to file, transfer, and process customs information online. It also allows them to submit their documents and to pay duties online from anywhere in the world. This system improves the quality of service by reducing human error and increasing convenience. At the same time this system reduces the probability of direct interaction between the traders and the customs officials, thereby reducing the incidence of bribery and discriminatory treatment. Thus, better port efficiency in terms of technological infrastructure and the higher use of ICT for e-business in a country can result in increased volume of trade. Based on the above-mentioned facts, the following is hypothesized :

Hypothesis 1: A country's performance in agricultural exports will be affected by enhanced e-governance.

Despite being one of the most important policy indicators in the trade literature, very little research had been done to assess the effect of trade facilitation on agricultural trade. One reason behind this might be the limited cross-country data availability for e-governance. Secondly, the lack of variation in an e-governance index makes it difficult to conduct panel analyses on the relationship between e-governance and agricultural trade. This paper seeks to bridge the gap in the literature by studying the relationship between e-governance and agricultural exports. An augmented gravity model is used, and different estimation techniques are combined to empirically investigate the impact of e-governance on bilateral agricultural trade. The E-government Readiness Index constructed by United Nations is used as a proxy for e-governance. The study is conducted on total agricultural exports for the years 2003 to 2005. To analyze the data, multiple regressions are used, and results are tested for robust-

9

ness. To reduce omitted variable bias, a broad range of theoretically plausible determinants of agricultural trade are also included in the model. Furthermore, Hekman's two-step method and selection model are used to reduce the sample-selection bias present in the trade data. Also, to deal with the issue of endogeneity, instrumental variable regression is used.

This paper contributes to the trade literature in two ways. First, according to a review of the literature, this is the first systematic cross-country empirical analysis that relates e-governance to agricultural trade. Second, the paper proposes a novel instrument to deal with the issue of endogeneity of e-governance.

2.2 Empirical Strategy

The relationship between the trade facilitation parameter and export performance is examined using an augmented gravity model. A gravity model of international trade is the most commonly used approach for measuring bilateral trade between trading partners. Tinbergen (1962) pioneered the use of gravity equations in empirical estimations of bilateral trade flows. A standard gravity model assumes that the volume of trade between two countries is positively related to the size of the economies and negatively related to the trade costs between them. In its original form, the gravity model is expressed as:

$$Y_{ei} = G\frac{(M_e M_i)}{D_{ei}} \tag{2.1}$$

Where, Y_{ij} measures the trade flow between country e and i, M_e and M_i represents the market size of country e and i respectively, D is the geographical distance between the countries, and G is the gravitational constant. The market size of the economy is usually measured by the GDP of the economy. The geographical distance between the countries is used as a proxy for trade cost. Also, a number of additional dummy variables, including island economy, landlocked economy, common language, common border, colonial heritage,

income level or geographical region, are included in the model to capture trade factors. In this paper, the E-government Readiness Index is used as a proxy for the quality of e-governance in a country. Population is also included as a measure of country size. The index already takes into account the quality of variables like port efficiency in terms of technological infrastructure and the quality of human capital. It also takes into account the infrastructure of the country to enable the effective use of information and communication technology (ICT) for e-business. It considers how each country takes advantage of the Internet to ease or reduce the time and transaction costs associated with international trade. Therefore, E-government Readiness Index transforms different aspects of trade facilitation into a single indicator which helps to reduce multicollinearity in the model. According to Wilson et al., (2010), "From an econometric point of view, including variables related to trade facilitation, measuring similar aspects on the right-hand side of a model, such as a gravity specification, can be conducive to multicollinearity. A way of circumventing multicollinearity is to reduce the dimension of the data by aggregating highly correlated indicators into a single indicator."

Along with the main variable of interest, the E-government Readiness Index, this paper controls for other variables that can influence the volume of trade. Since bilateral trade involves two countries, the quality of e-governance prevailing in both countries can affect the outcome of the exchange. Therefore, a variable representing the quality of e-governance in the partner country is also included in the model. It is widely recognized that the institutions of a country play an important role in implementing policy reform measures in an economy (Francois et al., 2013). As a proxy for institutions, the variable depicting the regulatory quality in the economy is included in the model. A higher value of this variable implies better quality of institutions in an economy. The analysis also controls for variables such as bilateral tariff rate and the exchange rate that have the potential to influence the volume of agricultural trade.

11

The basic gravity equation is given by the following:

$$Y_{eit} = \beta_0 + \sum \beta_k z_{k,ei} + \epsilon_{eit} \tag{2.2}$$

where, Y_{eit} is value of trade flows or the amount of export from country e to country i at period t; $z_{k,ei}$ (k = 1, 2, . . . , K) correspond to the variables like e-governance, GDP, population, distance, exchange rate etc.

In this paper the gravity equation takes the following form:

$$
\begin{aligned}
Export_{eit} = {} & \alpha + \beta_1 Egovernance_{et} + \beta_2 Egovernance_{it} + \gamma_1 GDP_{et} \\
& + \gamma_2 \log(GDP)_{it} + \gamma_3 \log(Population)_{et} + \gamma_4 Population_{it} + \gamma_5 Distance_{ei} \\
& + \gamma_6 Landlocked_e + \gamma_7 Language_{ei} + \gamma_8 Colony_{ei} + \gamma_9 Border_{ei} + \gamma_{10} Island_e \\
& + \gamma_{11} Income_e + \gamma_{12} Region_e + \gamma_{13} ExchangeRate_{et} + \gamma_{14} Tariff_{iet} \\
& + \gamma_{15} RegQuality_{et} + \gamma_{16} RegQuality_{it} + \delta_{ei} + \epsilon_{eit} \tag{2.3}
\end{aligned}
$$

Here, e and i represents the exporting and importing countries, respectively, and t denotes time. $Export_{eit}$ denotes volume of agricultural export from country e to country i at time period t. $Egovernance_{et}$ and $Egovernance_{it}$ represents the quality of e-governance in the exporting and importing counties, respectively, at period t. GDP_{et} and GDP_{it} are the real GDP of country e and i, respectively, at time period t. $Population_{et}$ and $Population_{it}$ denote population of country e and i, respectively, at time period t. $Distance_{ei}$ gives the distance between the capital cities of the trading partners. $Land$ is a binary dummy variable that takes a value of unity if country e is landlocked. $Language_{ei}$ is a binary dummy variable which is unity if country e and country i have a common language and zero otherwise. $Colony_{ei}$ is a binary dummy which is unity if e and i had the same colonizer. $Border_{ei}$ is a binary dummy variable which is unity if the trading partners share a common border. $Island_e$ is a binary dummy taking a value of unity if country e is an island economy. $Income_e$ represents

the set of dummies representing the income group to which the exporting country belongs. $Region_e$ represents the set of dummies representing the geographical region to which country e belongs. $Tariff_{iet}$ is a weighted average tariff applied by country i on country e's exports at period t. $ExchangeRate_{et}$ represents the real exchange rate of country e quoted in the US dollar. $RegQuality_{et}$ and $RegQuality_{it}$ controls for quality of institutions in the exporting and importing country respectively. δ_{ei} represents a set of time fixed effects. ϵ_{eit} represents the error term that is assumed to be normally distributed with mean zero.

Given the multiplicative nature of the augmented gravity model, equation 2.3 is usually transformed into log-linearized form. The log-linearized augmented gravity model is given by the following equation:

$$
\begin{aligned}
\log(Export)_{eit} = {} & \alpha + \beta_1 \log(Egovernance)_{et} + \beta_2 \log(Egovernance)_{it} + \gamma_1 \log(GDP)_{et} \\
& + \gamma_2 \log(GDP)_{it} + \gamma_3 \log(Population)_{et} + \gamma_4 \log(Population)_{it} \\
& + \gamma_5 \log(Distance)_{ei} + \gamma_6 Landlocked_e + \gamma_7 Language_{ei} + \gamma_8 Colony_{ei} \\
& + \gamma_9 Border_{ei} + \gamma_{10} Island_e + \gamma_{11} Income_e + \gamma_{12} Region_e \\
& + \gamma_{13} \log(ExchangeRate)_{et} + \gamma_{14} \log(Tariff)_{iet} + \gamma_{15} \log(RegQuality)_{et} \\
& + \gamma_{16} \log(RegQuality)_{it} + \delta_{ei} + \epsilon_{eit}
\end{aligned}
\tag{2.4}
$$

The model is estimated using three-year panel data from 2003 to 2005. Real GDP is used as a proxy for the size of the economy. The larger the size of the economy, the higher will be the volume of agricultural trade between country pairs. Therefore, the coefficient of $log(GDP)$ is expected to take a positive sign. The coefficient for the log value of distance, which is used as a proxy for trade cost is expected to be negative as the higher the distance the higher will be the trade cost, thereby reducing the volume of trade between the countries. As transportation costs are higher for islands or landlocked economies compared to the countries sharing a common border, the volume of trade is expected to be higher in the last case than in the other two instances. It is also assumed that the volume of trade will be

higher between the countries sharing similar cultural or colonial heritage. The same goes for the country pairs belonging to the same income group or the same geographical region. Again, the higher the population of the countries, the higher will be the demand for the commodities. As a result, the coefficient of $log(Population)$ of the importing country is expected to have a positive sign. The more the demand at home, the lower will be the volume of exports. Therefore, with increasing population at home, the volume of export will be lower. As a result, the coefficient of log(Population) of the exporting country is expected to take a negative sign. The coefficient of regulatory quality is expected to be positive, as it is assumed that better institutional quality promotes trade. As complex tariff barriers discourage trade, the coefficient of the tariff parameter is expected to take a negative sign. The coefficient of the exchange rate is also expected to take a negative sign. A higher value of this variable implies that the value of the exporting country's currency appreciates in terms of the US dollar. Appreciation of exporting country's currency will increase the price of exports, and, therefore, the volume of exports will fall.

The log-linearized augmented gravity model is usually analyzed using Ordinary Least Square (OLS) method, assuming that the homoscedastic error term is present in the model. Panel techniques are also used to estimate the log-linearized gravity model assuming that the error is constant across the countries or country-pairs (Herrera, 2010). However, the traditional gravity model lacks the theoretical foundation that gives rise to two major implications. First, estimation results are biased due to omitted variables. Therefore, we will get inconsistent OLS estimators. Omitted variable bias can also give rise to endogeneity. Second, performing comparative statics exercises are difficult (Anderson and Wincoop, 2003). As there are countries that do not trade with each other, using the original gravity equation gives rise to sample-selection bias. Also, the standard specifications of the gravity equation impose symmetry that is inconsistent with the data resulting in biased estimates (Helpman et al., 2006). The following sections review sample-selection bias and the issue of endogeneity in details.

2.2.1 Sample-selection Bias

In trade data, missing trade values are common as zero trade flows may result from a country's decision not to trade with another economy. The missing trade value creates a problem when the log-linearized augmented gravity model is estimated using OLS. As the log of zero is undefined, zero trade flows will be automatically dropped from the equation, giving rise to sample-selection bias.[2]

To deal with the problem of sample-selection bias this paper follows Helpman et al., (2006), who use Heckman's two-step procedure to reduce the bias (Heckman, 1979). Initially, a Probit Model (Selection equation) is estimated to determine the probability that a country pair engages in trade. In the second stage, the expected values of the trade flow from the first stage, conditional on the country pairs trading (Outcome equation), are estimated using OLS. In order to correct the sample-selection bias or to identify the parameters in both equations, an identification variable is required. This variable should hold the property that it influences a country's propensity to engage in trade but should not have any effect on its volume of trade. Previous literature suggests that variables such as common religion, common border, common language, etc., satisfy this condition (Helpman et al., 2006).

Another way to deal with the sample-selection bias is to use Heckman's selection model where the selection and the outcome equations are estimated simultaneously using Maximum Likelihood Estimation. Heckman's selection model depends strongly on the model being correctly specified. Heckman's selection model can produce biased estimates if the model is not properly specified or if a specific dataset violates the model's assumptions. When the underlying goal is to predict an actual response, Hekman's two-step model is preferred. If the goal is to predict the value of the dependent variable that would be observed in the absence of selection, however, Heckman's selection model is more appropriate.

---

[2]Alternative approaches to handle the presence of zero trade includes: i) Truncating the sample by discarding the observations with zero trade values; and ii) Adding a small constant to each observation on the dependent variable before taking logarithms. This method works properly if the zeros are randomly distributed. Otherwise, this method gives rise to sample selection bias.

2.2.2 Endogeneity

A considerable amount of empirical trade literature is plagued with the problem of endogeneity, especially because of the presence of unobserved country-specific fixed factors. Endogeneity can also arise because of the possibilities of reverse causality. For example, a country facing a higher volume of trade might find it beneficial to adopt the e-platform to efficiently provide the service to the traders. Also, efficient e-governance might positively influence the volume of trade. This creates a circular causal chain between the trade facilitation variable and the volume of agricultural trade. E-governance can also be endogenous because of the possibility of omitted variable bias. In the presence of endogeneity, OLS estimation will give a biased result because the orthogonality assumption of OLS will be violated (i.e. the explanatory variable will be correlated with the error term thereby giving biased estimates).

In this paper, to deal with the problem of endogeneity, instrumental variable (IV) regression is used where a newly constructed variable on historical technological adoption from the Cross-country Historical Adoption of Technology or CHAT data-set (Comin and Hobijn; 2009) is used as an instrument. Comin et al. (2010) compute indices of technology adoption in 1000 BC, 0 AD, and 1500 AD. Out of these three time periods, they found that there is a positive and significant association between the technology adoption indices in 1500 AD and technology adoption today. This relationship was found to be robust at the sector level even after controlling for geographical and institutional factors. Also, there was a considerable level of cross-country variation in technology adoption in 1500 AD. This measure of historical technological adoption was computed in five different sectors, namely agriculture, transportation, military, industry, and communication. To identify the impact e-governance on bilateral agricultural exports, this study includes technology adoption in communication in 1500 AD as an instrument for technology adoption today (the adoption of e-governance measures in the current period). To satisfy the condition for a valid instrument, this variable

16

should hold the following properties: i) The technology adoption in communication in 1500 AD should be correlated with the potential endogenous variable e-governance; and ii) The technology adoption in communication in 1500 AD should not have any direct impact on the volume of agricultural exports during the period 2003 to 2005.

In this study, conventional Two-stage Least Square (2SLS) and Generalized Methods of Moment (GMM) techniques are used for IV analysis.

2.3 Data

For the empirical estimation, bilateral agricultural export data (quoted in constant US dollar) for the dependent variable is collected from the Commodity and Trade Database (COM-TRADE) of the United Nations Statistics Division. The paper uses cross-country data and constructs a panel data-set for 2003-2005. Agricultural goods are defined as commodities in Category 0 at the one-digit level of the Standard International Trade Classification (SITC Revision 1, Category 0).

This paper uses the e-government readiness index published by the United Nations as the main explanatory variable. This data is derived from the United Nations Global E-readiness reports and the E-government surveys which are produced by the Division for Public Administration and Development Management (DPADM) of the United Nations Department of Economic and Social Affairs (DESA). The data is used for the years 2003, 2004, and 2005. The e-government readiness index takes a value between zero and one. A value closer to zero suggests a low quality of e-governance and a value closer to one implies a better quality of the same.

Gross Domestic Product (GDP) is used as a measure of country size. The data for real GDP (in constant US dollars) has been taken from the World Development Indicators published by the World Bank. Population data also comes from the World Bank data-set. A weighted average of bilateral applied tariff rates, weighted by the values of bilateral agricul-

tural trade, is used in this paper. The tariff data were derived from the Trade Analysis and Information System (TRAINS) of the United Nations Conference on Trade and Development (UNCTAD). Real exchange rate data comes from the World Bank. It is expressed in local currency units relative to the US dollar.

Table 2.2 summarizes the relevant variables used in this paper.

Table 2.2: E-governance & Agricultural Exports: Summary Statistics

Variable	Mean	Std. Dev.	Obs.
$\log(\text{Export})_{ei}$	13.57	3.043	33865
$\log(\text{E-governance})_{e}$	-0.699	0.511	33925
$\log(\text{E-governance})_{i}$	-0.813	0.632	31783
$\log(\text{GDP})_{e}$	25.14	2.116	34236
$\log(\text{GDP})_{i}$	24.47	2.380	32681
$\log(\text{Distance})_{ei}$	3.686	0.399	30713
$\log(\text{Population})_{e}$	16.59	1.759	34236
$\log(\text{Population})_{i}$	16.07	1.945	32984
$\log(\text{Tariff})_{ie}$	0.388	1.936	21407
$\log(\text{Real Exchange Rate})_{e}$	4.535	0.142	22131
$\log(\text{Regulatory Quality})_{e}$	-0.275	1.027	20902
$\log(\text{Regulatory Quality})_{i}$	-0.319	1.001	18007
1500 Technology Adoption Index $_{e}$	0.534	0.416	26464
1500 Technology Adoption Index $_{i}$	0.521	0.409	22282

Summary statistics are presented together for the years 2003 to 2005.

Variables capturing the variation in trade costs between country pairs such as distance, common language, common border, colonial pasts, and other gravity model variables are collected from the CEPII. The data for regulatory quality comes from World Bank's World-wide Governance Indicators (WGI) database constructed by Kaufman et al. As described by Kaufmann et al., (2004), "the regulatory quality of a country reflects perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development." The value of regulatory quality ranges

18

between -2.5 to 2.5. A value closer to -2.5 indicates weak regulatory quality and a value closer to 2.5 suggests the quality of regulation is strong. The data source for the regional and income category dummy is the World Bank.

The data source for the instrument is Comin et al. (2010). As previously mentioned, a number of historical information sources are used to compute an index of cross-country technology adoption in 1000 BC, 0 AD, and 1500 AD. Technology adoption in 1500 AD was found to be an accurate predictor of technology adoption today. This measure of historical technological adoption was computed in five different sectors, namely agriculture, transportation, military, industry, and communication. In this paper, the communication index was used as an instrument for technology adoption today (e-governance). The communication index is constructed using four variables: the use of movable block printing, the use of woodblock printing, the use of books, and the use of paper. This variable takes a value between 0 and 1, where a value closer to zero suggests a lower degree of technology adoption in 1500 AD and a value closer to one suggests that the degree of technology adoption was high during 1500 AD.

2.4 Results

Empirical estimates quantifying the effect of e-governance on agricultural exports are resented in this section. Before estimating the effect of e-governance on agricultural exports, the 1% tails of log value of agricultural exports across countries are trimmed. That is, all countries are pooled and the top and bottom 1% of log value of agricultural exports in each of the pools are trimmed. The first column in each table includes standard gravity model variables along with e-governance as main explanatory variable. The model also controls for a number of variables to minimize the omitted variable bias. For example, in column 1 region and income dummies are included to rule out the possibility that these results are driven by the omission of region and income fixed factors. Column 2, controls for the effect of

variables like population, real exchange rate, and tariff structure. In column 3, two variables representing the quality of regulation in the exporting and importing country respectively are added. Finally, the last column controls for all the variables in the same specification along with time specific fixed effects. In terms of panel data, this fixed effect estimation accounts for all sources of unobserved heterogeneity that are constant for a given year across all countries. To deal with this issue of heteroscedasticity, robust clustered standard errors are used. Standard errors are clustered by distance, which is unique to each country pair but is identical for both trading partners.

2.4.1 Conventional Panel Data Techniques

As a benchmark, the gravity model is initially estimated using the Ordinary Least Square (OLS) Method. Consistency of OLS requires that the error term to be uncorrelated with the explanatory variables. Therefore, Pooled Ordinary Least Square (POLS) is consistent in the Random Effect (RE) model but is inconsistent in the Fixed Effect (FE) model. In this paper, due to the presence of time-invariant factors, the RE model is more appropriate than the FE model. Thus, the estimates from the POLS model are assumed to be consistent in this study.

The results from the POLS model are presented in Table 2.3. The coefficient of e-governance in the exporting country is highly significant in each column with the expected sign. This result suggests that e-governance of the exporting country has a positive and significant impact on the volume of exports. For example, in column 4, the coefficient of e-governance in the exporting country implies, a 1% improvement in the quality of e-governance in the exporting country will increase the volume of agricultural exports by almost 4%. However, in all the specifications, the coefficient of e-governance in the importing country remains insignificant with a negative sign. The standard gravity model variables also take the expected sign, and the results are statistically significant in almost all the cases.

20

Table 2.3: E-governance & Agricultural Exports: Pooled OLS

Dependent variable: log(Export)$_{ei}$	(1)	(2)	(3)	(4)
log(E-governance)$_e$	0.237***	1.474***	3.955***	3.998***
	(0.051)	(0.297)	(0.681)	(0.688)
log(E-governance)$_i$	-0.046	-0.021	-0.266	-0.210
	(0.034)	(0.052)	(0.361)	(0.362)
log(GDP)$_e$	0.636***	-0.008	-0.466**	-0.445*
	(0.018)	(0.104)	(0.175)	(0.176)
log(GDP)$_i$	0.674***	0.789***	0.861***	0.860***
	(0.012)	(0.032)	(0.084)	(0.085)
log(Distance)$_{ei}$	-2.511***	-2.671***	-2.510***	-2.487***
	(0.076)	(0.125)	(0.166)	(0.168)
Common Colony$_{ei}$	1.266***	1.016***	0.694*	0.692*
	(0.197)	(0.231)	(0.315)	(0.315)
Island Economy$_e$	-0.036	-0.727***	-0.452**	-0.455**
	(0.072)	(0.129)	(0.169)	(0.169)
Landlocked Economy$_e$	-0.880***	-0.756***	-0.983***	-0.989***
	(0.084)	(0.135)	(0.179)	(0.179)
Common Language$_{ei}$	0.717***	1.047***	1.426***	1.426***
	(0.081)	(0.126)	(0.180)	(0.180)
Common Border$_{ei}$	1.352***	1.034***	0.679	0.691
	-0.154	-0.268	-0.374	-0.377
log(Population)$_e$		0.557***	0.820***	0.795***
		(0.100)	(0.185)	(0.187)
log(Population)$_i$		-0.065	-0.068	-0.068
		(0.036)	(0.092)	(0.093)
log(Real Exchange Rate)$_e$		1.143***	-0.483	-0.524
		(0.329)	(0.624)	(0.624)
log(Tariff)$_{ie}$		-0.013	0.028	0.030
		(0.026)	(0.035)	(0.036)
log(Regulatory Quality)$_e$			0.205*	0.199
			(0.101)	(0.102)
log(Regulatory Quality)$_i$			0.190**	0.185**
			(0.065)	(0.066)
Region Dummy	Yes	Yes	Yes	Yes
Income Dummy	Yes	Yes	Yes	Yes
Year Fixed Effect	No	No	No	Yes
Observations	21869	6437	2598	2598
Adjusted R^2	0.429	0.424	0.522	0.522

Heteroscedasticity robust standard errors in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The first column includes standard gravity model variables along with e-governance as main explanatory variable. It also includes region and income dummies. Column 2, controls for the effect of population, real exchange rate, and tariff structure. Column 3, includes the quality of regulation in each country. The last column controls for time specific fixed effects. Constant not reported.

The results from the Pooled Feasible Generalized Least Square (PFGLS) Model are presented in Table 2.4. PFGLS estimation can lead to estimators of the parameters of the pooled model that are more efficient than POLS estimation in the presence of heteroscedasticity and auto-correlation. Also, this model works well for an infinite sample. Under the assumption that any individual-level unobserved effects are uncorrelated with regressors, PFGLS is consistent. The PFGLS model also gives similar results relative to the POLS model. The result presented in column 4 suggests that a 1% improvement in e-governance measures in the exporting country will increase the volume of agricultural exports by almost 1.13%. However, the impact of an importing country's e-governance remains insignificant. The standard gravity model variables also take the expected sign, and the results are statistically significant in almost all the cases.

2.4.2   Heckman Model Estimates

Results from the Heckman Models are presented in this section. The results from the first-step of Heckman's two-step estimates are included in the appendix. The result shows the identification variable, the probability that two randomly drawn people from a country pair speak the same language, to be an important determining factor for the country pairs to engage in trade. Econometrically, this provides the necessary exclusion restriction for identification of the second stage trade flow equation. Therefore the variable "Common Language" is used as an exclusion variable in the construction of the Inverse Mills Ratio for the second stage Heckman procedure.

Table 2.5 shows the second-stage results from Heckman's Two-step model. This model reduces the bias from missing trade values. After controlling for the selection bias, the model gives a positive and significant estimate for the e-governance measure of exporting country. This positive and significant result is true for all the specifications.

22

Table 2.4: E-governance & Agricultural Exports: Pooled FGLS

Dependent variable: log(Export)$_{ei}$	(1)	(2)	(3)	(4)
log(E-governance)$_e$	0.030	0.982***	1.129*	1.131*
	(0.030)	(0.270)	(0.540)	(0.532)
log(E-governance)$_i$	-0.010	-0.498**	-0.091	-0.118
	(0.020)	(0.169)	(0.416)	(0.422)
log(GDP)$_e$	0.563***	-0.182	-0.117	-0.092
	(0.018)	(0.101)	(0.153)	(0.180)
log(GDP)$_i$	0.636***	0.895***	0.835***	0.845***
	(0.012)	(0.060)	(0.110)	(0.111)
log(Distance)$_{ei}$	-2.306***	-2.373***	-2.163***	-2.156***
	(0.077)	(0.162)	(0.215)	(0.217)
Common Colony $_{ei}$	1.049***	0.772**	0.880**	0.876**
	(0.195)	(0.245)	(0.316)	(0.317)
Island Economy $_e$	0.012	-0.600***	-0.695**	-0.693**
	(0.077)	(0.175)	(0.216)	(0.216)
Landlocked Economy $_e$	-0.928***	-0.744***	-0.956***	-0.969***
	(0.095)	(0.169)	(0.213)	(0.214)
Common Language $_{ei}$	0.658***	0.987***	1.188***	1.188***
	(0.085)	(0.153)	(0.239)	(0.239)
Common Border $_{ei}$	1.118***	0.999**	1.566***	1.567***
	(0.142)	(0.336)	(0.446)	(0.448)
log(Population)$_e$		0.650***	0.381*	0.354
		(0.104)	(0.166)	(0.199)
log(Population)$_i$		-0.073	0.047	0.037
		(0.061)	(0.121)	(0.123)
log(Real Exchange Rate)$_e$		0.725*	0.076	0.002
		(0.283)	(0.442)	(0.452)
log(Tariff)$_{ie}$		-0.005	-0.038	-0.038
		(0.025)	(0.039)	(0.039)
log(Regulatory Quality)$_e$			0.398**	0.395*
			(0.146)	(0.155)
log(Regulatory Quality)$_i$			0.214***	0.212***
			(0.058)	(0.060)
Region Dummy	Yes	Yes	Yes	Yes
Income Dummy	Yes	Yes	Yes	Yes
Year Fixed Effect	No	No	No	Yes
Observations	17766	3780	1764	1764

Heteroscedasticity robust standard errors in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The first column includes standard gravity model variables along with e-governance as main explanatory variable. It also includes region and income dummies. Column 2, controls for the effect of population, real exchange rate, and tariff structure. Column 3, includes the quality of regulation in each country. The last column controls for time specific fixed effects. Constant not reported.

Table 2.5: E-governance & Agricultural Exports: Heckman's Two-step Model.
Second-step Estimates

Dependent variable: log(Export)$_{ei}$	(1)	(2)	(3)	(4)
log(E-governance)$_e$	0.330	1.025	3.557**	3.576**
	(0.189)	(0.718)	(1.220)	(1.225)
log(E-governance)$_i$	-0.123	-0.364	-0.622	-0.582
	(0.170)	(0.382)	(0.813)	(0.823)
log(Distance)$_{ei}$	-2.617***	-2.787***	-2.095***	-2.088***
	(0.220)	(0.361)	(0.377)	(0.376)
log(GDP)$_e$	0.613***	0.079	-0.751*	-0.743*
	(0.139)	(0.240)	(0.286)	(0.291)
log(GDP)$_i$	0.607***	0.711***	0.421	0.423
	(0.069)	(0.135)	(0.263)	(0.265)
log(Population)$_e$	0.105	0.455	1.229***	1.214**
	(0.162)	(0.275)	(0.353)	(0.360)
log(Population)$_i$	0.031	-0.162	0.311	0.307
	(0.061)	(0.124)	(0.263)	(0.267)
log(Real Exchange Rate)$_e$		3.076***	1.317	1.416
		(0.534)	(1.466)	(1.527)
log(Tariff)$_{ie}$		-0.067	0.034	0.033
		(0.069)	(0.092)	(0.091)
log(Regulatory Quality)$_e$			0.301	0.268
			(0.246)	(0.266)
log(Regulatory Quality)$_i$			0.228	0.216
			(0.190)	(0.191)
Inverse Mills Ratio	-1.749***	-1.560***	-0.983**	-0.982**
	(0.271)	(0.356)	(0.363)	(0.364)
Region Dummy	Yes	Yes	Yes	Yes
Income Dummy	Yes	Yes	Yes	Yes
Year Fixed Effect	No	No	No	Yes
Observations	2488	829	247	247
Adjusted R^2	0.457	0.466	0.725	0.722

Heteroscedasticity robust standard errors in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The first column includes standard gravity model variables along with e-governance as main explanatory variable. It also includes region and income dummies. Column 2, controls for the effect of population, real exchange rate, and tariff structure. Column 3, includes the quality of regulation in each country. The last column controls for time specific fixed effects. Constant not reported.

For example, column 4 in Table 2.5 suggests that a 1% improvement in e-governance measures in the exporting country will increase the volume of agricultural exports by almost 4%. However, the estimate for e-governance in the importing country initially suggests a positive and significant relationship, but after controlling for other relevant variables the result becomes insignificant. The standard gravity model variables also take the expected sign, and the results are statistically significant in most of the cases.

Table 2.6 presents the results from Heckman's selection model. Similar to the two-step model, this estimation strategy shows a positive and significant impact of the e-governance of exporting country on agricultural exports. The result further suggests that the e-governance measure in the importing country can also influence the volume of exports positively. This result is highly significant for all the specifications.

2.4.3   IV Estimates

Table 2.7 reports the results of the 2SLS analysis using the 1500 communication technology as an instrument for the technology adoption (e-governance) today. The coefficient for e-governance in the exporting country appears with the expected positive sign across different specifications and is statistically significant. However, the coefficient for e-governance in the importing country still remains insignificant but takes a positive sign. The coefficients from the instrumental variable regression are somewhat larger than the OLS estimates suggesting that OLS estimates were downwards biased due to the problem of endogeneity. Furthermore, the F-statistic presented at the bottom of the table suggests that the instrument is strong in each column (i.e., communication technology in 1500 AD is a significant predictor of e-governance today).

Table 2.8 reports the results from GMM analysis. The point estimates obtained using GMM are very similar to the 2SLS estimates.

Table 2.6: E-governance & Agricultural Exports: Heckman's Selection Model Estimates

Dependent variable: log(Export)$_{ei}$	(1)	(2)	(3)	(4)
log(E-governance)$_e$	0.981***	1.353***	2.666***	2.664***
	(0.082)	(0.130)	(0.324)	(0.323)
log(E-governance)$_i$	0.841***	0.550***	3.831***	3.831***
	(0.069)	(0.097)	(0.271)	(0.271)
log(Distance)$_{ei}$	0.897***	0.792***	1.572**	1.588**
	(0.089)	(0.210)	(0.480)	(0.504)
Common Colony$_{ei}$	-0.274	0.014	-0.121	-0.103
	(0.149)	(0.205)	(0.369)	(0.409)
Island Economy$_e$	0.039	0.387*	0.463	0.481
	(0.077)	(0.162)	(0.429)	(0.456)
Landlocked Economy$_e$	0.003	0.003	0.856	0.836
	(0.081)	(0.186)	(0.546)	(0.526)
Common Language$_{ei}$	-0.392***	-0.606***	-0.185	-0.205
	(0.081)	(0.172)	(0.596)	(0.611)
Common Border$_{ei}$	-0.448**	-0.481	-0.552	-0.573
	(0.137)	(0.283)	(0.444)	(0.45)
log(GDP)$_e$	-0.217***	-0.011	0.650*	0.674*
	(0.020)	(0.110)	(0.296)	(0.291)
log(GDP)$_i$	-0.319***	-0.546***	-0.720**	-0.732***
	(0.036)	(0.106)	(0.221)	(0.217)
log(Population)$_e$	-0.025	-0.222*	-1.028**	-1.055**
	(0.020)	(0.112)	(0.330)	(0.342)
log(Population)$_i$	0.044	0.176*	0.222	0.236
	(0.026)	(0.075)	(0.162)	(0.158)
log(Real Exchange Rate)$_e$		-0.532	0.442	0.363
		(0.339)	(2.007)	(2.021)
log(Tariff)$_{ie}$		0.003	-0.058	-0.057
		(0.039)	(0.062)	(0.059)
log(Regulatory Quality)$_e$			-0.801	-0.851
			(0.435)	(0.452)
log(Regulatory Quality)$_e$			0.104	0.111
			(0.170)	(0.192)
Region Dummy	Yes	Yes	Yes	Yes
Income Dummy	Yes	Yes	Yes	Yes
Year Fixed Effect	No	No	No	Yes
Rho	0.782	0.834	0.956	0.956
Inverse Mills Ratio	2.309	2.290	2.341	2.341
Observations	22728	6715	2732	2732

Heteroscedasticity robust standard errors in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The first column includes standard gravity model variables along with e-governance as main explanatory variable. It also includes region and income dummies. Column 2, controls for the effect of population, real exchange rate, and tariff structure. Column 3, includes the quality of regulation in each country. The last column controls for time specific fixed effects. Constant not reported.

Table 2.7: E-governance & Agricultural Exports: IV Analysis (2SLS)

Dependent variable: $\log(\text{Export})_{ei}$	(1)	(2)	(3)	(4)
$\log(\text{E-governance})_e$	10.05***	-31.28***	44.07***	44.09***
	(1.307)	(9.055)	(10.02)	(9.841)
$\log(\text{E-governance})_i$	2.524	3.592	-0.934	0.201
	(1.460)	(2.574)	(3.918)	(3.909)
$\log(\text{GDP})_e$	0.170*	6.305***	-6.914***	-6.653***
	(0.067)	(1.754)	(1.633)	(1.568)
$\log(\text{GDP})_i$	0.292	-0.392	1.173	1.063
	(0.263)	(0.744)	(0.664)	(0.658)
$\log(\text{Distance})_{ei}$	-3.019***	-2.299***	-3.157***	-2.946***
	(0.150)	(0.518)	(0.507)	(0.493)
Common Colony $_{ei}$	1.222***	1.804	0.536	0.530
	(0.334)	(1.006)	(0.737)	(0.729)
Island Economy $_e$	-1.670***	1.964**	0.707	0.687
	(0.225)	(0.610)	(0.558)	(0.549)
Landlocked Economy $_e$	-1.358***	-0.397	-0.216	-0.219
	(0.179)	(0.333)	(0.398)	(0.394)
Common Language $_{ei}$	0.556**	0.605	1.384**	1.423**
	(0.174)	(0.449)	(0.490)	(0.496)
Common Border $_{ei}$	2.156***	0.593	-0.373	-0.231
	(0.446)	(0.550)	(0.822)	(0.821)
$\log(\text{Population})_e$		-5.068**	7.434***	7.119***
		(1.574)	(1.675)	(1.604)
$\log(\text{Population})_i$		0.962	-0.261	-0.173
		(0.626)	(0.574)	(0.569)
$\log(\text{Real Exchange Rate})_e$		-1.832	-13.45***	-13.14***
		(1.322)	(3.782)	(3.726)
$\log(\text{Tariff})_{ie}$		-0.246**	0.281*	0.275*
		(0.094)	(0.140)	(0.137)
$\log(\text{Regulatory Quality})_e$			-1.898**	-2.086**
			(0.637)	(0.640)
$\log(\text{Regulatory Quality})_i$			0.323	0.207
			(0.245)	(0.243)
Region Dummy	Yes	Yes	Yes	Yes
Income Dummy	Yes	Yes	Yes	Yes
Year Fixed Effect	No	No	No	Yes
Observations	13234	4542	1669	1669
Wald F statistics	38.73	16.94	25.93	28.12

Heteroscedasticity robust standard errors in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Instrumented variables: $\log(\text{E-governance})_e$, $\log(\text{E-governance})_e$. The first column includes standard gravity model variables along with e-governance as main explanatory variable. It also includes region and income dummies. Column 2, controls for the effect of population, real exchange rate, and tariff structure. Column 3, includes the quality of regulation in each country. The last column controls for time specific fixed effects. Constant not reported.

Table 2.8: E-governance & Agricultural Exports: IV Analysis (GMM)

Dependent variable: log(Export)$_{ei}$	(1)	(2)	(3)	(4)
log(E-governance)$_e$	10.05***	-31.28***	44.07***	44.09***
	(1.307)	(9.055)	(10.02)	(9.841)
log(E-governance)$_i$	2.524	3.592	-0.934	0.201
	(1.460)	(2.574)	(3.918)	(3.909)
log(GDP)$_e$	0.170*	6.305***	-6.914***	-6.653***
	(0.067)	(1.754)	(1.633)	(1.568)
log(GDP)$_i$	0.292	-0.392	1.173	1.063
	(0.263)	(0.744)	(0.664)	(0.658)
log(Distance)$_{ei}$	-3.019***	-2.299***	-3.157***	-2.946***
	(0.150)	(0.518)	(0.507)	(0.493)
Common Colony $_{ei}$	1.222***	1.804	0.536	0.530
	(0.334)	(1.006)	(0.737)	(0.729)
Island Economy $_e$	-1.670***	1.964**	0.707	0.687
	(0.225)	(0.610)	(0.558)	(0.549)
Landlocked Economy $_e$	-1.358***	-0.397	-0.216	-0.219
	(0.179)	(0.333)	(0.398)	(0.394)
Common Language $_{ei}$	0.556**	0.605	1.384**	1.423**
	(0.174)	(0.449)	(0.490)	(0.496)
Common Border $_{ei}$	2.156***	0.593	-0.373	-0.231
	(0.446)	(0.550)	(0.822)	(0.821)
log(Population)$_e$		-5.068**	7.434***	7.119***
		(1.574)	(1.675)	(1.604)
log(Population)$_i$		0.962	-0.261	-0.173
		(0.626)	(0.574)	(0.569)
log(Real Exchange Rate)$_e$		-1.832	-13.45***	-13.14***
		(1.322)	(3.782)	(3.726)
log(Tariff)$_{ie}$		-0.246**	0.281*	0.275*
		(0.094)	(0.140)	(0.137)
log(Regulatory Quality)$_e$			-1.898**	-2.086**
			(0.637)	(0.640)
log(Regulatory Quality)$_i$			0.323	0.207
			(0.245)	(0.243)
Region Dummy	Yes	Yes	Yes	Yes
Income Dummy	Yes	Yes	Yes	Yes
Year Fixed Effect	No	No	No	Yes
Observations	13234	4542	1669	1669
Wald F statistics	38.73	16.94	25.93	28.12

Heteroscedasticity robust standard errors in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Instrumented variables: log(E-governance)$_e$, log(E-governance)$_e$. The first column includes standard gravity model variables along with e-governance as main explanatory variable. It also includes region and income dummies. Column 2, controls for the effect of population, real exchange rate, and tariff structure. Column 3, includes the quality of regulation in each country. The last column controls for time specific fixed effects. Constant not reported.

2.5   Conclusion

The purpose of this study was to identify the relationships between e-governance and bilateral agricultural exports. In doing so, this study used an augmented gravity model framework. The study also employed different methodologies to quantify the effect of e-governance on bilateral agricultural exports for a broad set of countries. The sample-selection bias present in the trade data was corrected using Heckman's procedures. To deal with the issue of endogeneity, the study used Instrumental Variable Regression. According to the findings of the study, the quality of e-governance in the exporting country can positively influence the volume of agricultural exports across borders. This result was robust to all the model specifications. However, the study found a significant impact of the quality of e-governance in the importing country only after correcting for sample-selection bias.

From a policy implication point of view, this study gives quite important results. Adopting information and communication technology (ICT) to provide service to the citizen improves the effectiveness and accountability of the government. Trimming down unnecessary trade impediments by applying modern techniques and technologies also plays a crucial role in facilitating trade. The initiative to make trade across border "paperless" simplifies trade procedures and improves the quality of controls. Reducing or eliminating paper documents and allowing traders to file, transfer, and process customs information online enhances the quality of service by reducing human error and increasing convenience. This system also reduces the volume and impact of red tape, associated with wasteful and time-consuming bureaucracy. At the same time, this system reduces the probability of direct interaction between the traders and the customs officials, thereby reducing the incidence of bribery and discriminatory treatment. Moreover, unlike tariff elimination that results in the loss of tariff revenues, eliminating non-tariff barriers are rewarding to all the trading partners.

Chapter 3. The Role of Corruption on Bilateral Agricultural Trade

3.1 Introduction

Corruption is an enduring phenomenon that is ingrained in a wide variety of socio-economic, cultural, and political factors. It is commonly defined as the abuse of public office for private gain[1]. Corruption can be present in various forms such as bribery, extortion, evasion, cronyism, nepotism, graft, embezzlement, etc. It unethically helps increase the private gain of an individual who is in charge of a public office. Corruption is considered as one of the major obstacles in achieving the goals of public policies for both the developing countries and developed nations. It has adverse impacts on a nation's economic growth (Shleifer and Vishny, 1993), government expenditure, or per capita GDP (Mauro, 1995, 1998). By raising the transaction cost and uncertainty, corruption also hinders long-run foreign and domestic investment in an economy (Wei, 2000). Corruption gives rise to inequality and also elevates poverty (Gupta, et al., 2002). Despite these negative impressions, many economists argue that corruption can be beneficial for the economy. Some economists (Leff, 1964; Huntington 1968; mentioned by Mauro, 1995) have suggested that corruption raises economic growth. They argue that by removing government-imposed rigidities that hinder growth, corruption enhances the efficiency of the otherwise complicated system (Leff, 1964; Meon and Weill, 2008).

Though in most of the cases detecting corruption is very difficult, there are a few international organizations that publish corruption indices based on the perception of the people. According to the corruption indices published by the Worldwide Governance Indicators and Transparency International (The Control of Corruption Index (CCI) and Corruption Per-

---

[1]Visit: http://www1.worldbank.org/publicsector/anticorrupt/corruptn/cor02.htm

ception Index (CPI) respectively), not a single country in the world is entirely free from corruption. While a large proportion of countries are comparatively less corrupt, none of the countries has a perfect score. For example, in 2010, Denmark had both the highest score in CPI, 9.30 out of the maximum possible 10 (least corrupt) and the highest score in CCI, 2.41 out of the maximum possible 2.5 (least corrupt). While in the same year, Somalia had the lowest scores, a CPI of 1.10 (the lowest possible score is 0), and a CCI of -1.74 (-2.5 is the lowest possible score). Table 3.1 lists the five least and the most corrupt countries in descending order of corruption as measured by the CCI.

Table 3.1: Least and Most Corrupt Countries in the World, 2010

Rank	Country	Country Code	Trade Value (million US $)	Control of Corruption Index	Corruption Perception Index
			Least corrupt countries according to 2010 CCI		
1.	Denmark	DNK	16006.05	2.41	9.30
2.	New Zealand	NZL	15297.78	2.40	9.30
3.	Sweden	SWE	6186.42	2.32	9.20
4.	Singapore	SGP	4002.45	2.21	9.30
5.	Finland	FIN	1488.61	2.18	9.20
			Most corrupt countries according to 2010 CCI		
5.	Turkmenistan	TKM	-	-1.45	1.60
4.	Equatorial Guinea	GNQ	-	-1.49	1.90
3.	Afghanistan	AFG	130.94	-1.62	1.40
2.	Myanmar	MMR	1420.60	-1.68	1.40
1.	Somalia	SOM	-	-1.74	1.10

The CCI takes values in the range of -2.5 to 2.5, and CPI takes values in the range of 0 to 10. A higher value of both the indices implies lower corruption. The data for total agricultural exports comes from United Nation's COMTRADE database. Trade value is measured in current US dollars.

As can be seen in the table, some of the least corrupt countries of the world are also some of the highest exporters of agricultural commodities. For instance, Denmark, New Zealand, Sweden, Singapore, and Finland are amongst the five least corrupt countries in the world

according to the 2010 Control of Corruption Index. A detailed discussion on CCI and CPI are included in the appendix.

While there is plethora of empirical literature analyzing the causes and the consequences of corruption, cross-national empirical research studying the effect of corruption on international trade is rare. The literature is even scarcer if we consider the relationship between corruption and agricultural trade. This paper contributes to the trade literature by measuring the extent to which corruption affects agricultural exports across the borders. Using an augmented gravity model, this paper investigates the role of corruption on bilateral agricultural exports for a broad set of countries, spanning five years from 2006 to 2010. According to the review of the literature, this is the first cross-country empirical analysis that relates indicators of a country's decadence to its performance in agricultural trade.

3.2   Corruption in International Trade

It is widely recognized that the institutional quality plays an important role in implementing policy measures in an economy. Efficient government institutions foster economic growth (Mauro, 1995). Institutional quality also plays a major role in determining the volume of trade across borders (Anderson and Marcouiller, 2000). Weak institutions give incentives for corrupt officials to exploit their discretionary power to extract or create rents (Aidt, 2003). The level of corruption represents the quality of institutions in an economy. In international trade, corruption prevails mostly in the form of bureaucratic corruption or government corruption where customs officers demand or accept bribes and in return sell government properties.

Two types of bribes plague the customs administrations around the world. Customs officials often demand bribes for doing something that they are supposed to do. The corrupt customs officer in authority to give customs clearance purposefully delays the process to attract more bribes. In the corruption literature, this process is known as extraction (Dutt

and Traca, 2009). Sometimes in countries with protectionist trade policies and cumbersome rules and regulations, traders offer bribes to customs officials to reduce the tariff or other regulatory barriers to trade. This situation in which customs officials accept bribes for doing something that they are not entitled to do is known as evasion (Dutt and Traca, 2009). Bribery in international trade acts as a hidden tax and results in an unreported trade. Corruption at the border reduces trade by increasing the transaction cost and also the price of the traded commodity. As mentioned by John and Bogmans (2011), "In low-income countries in which a large share of government revenue is collected through customs, corrupt customs officials reduce trade and deprive the government of revenue." According to the African Development Bank, "Every year $1 trillion is paid in bribes while an estimated $2.6 trillion are stolen annually through corruption, a sum equivalent to more than 5% of the global GDP."[2]

Trade literature suggests that the effect of corruption on international trade is mixed. Economists suggest that a protectionist trade policy leads to increased levels of bureaucratic corruption. In countries with complex tariff structure, bribes are seen as a way out from cumbersome rules and regulations. In countries with protectionist trade policy, bribes, referred to as *"speed money"*, enable individuals to avoid bureaucratic delays and help improve efficiency (Bardhan, 1997). Also, irrespective of the level of red tape in a country, if the bribe acts as a *"piece rate"*, the customs officials who are allowed to levy bribes would work harder thereby increasing the efficiency of the system (Leff, 1964; Huntington, 1968). Some economists argue that offering speed money to the officials helps establishing a custom in the economy where the officials intentionally delay the license until the bribe is paid. The corrupt customs officials intentionally introduce new rules and regulations to extract more bribes (Krueger, 1993). Therefore, although practices like paying speed money might induce government workers to work hard and help individuals avoid delays at the border, the custom of paying bribes adversely affects the economy as a whole.

---

[2]Visit: http://www.afdb.org/en/

In his paper, Dutt (2009) found evidence that countries with protectionist trade policies face a higher level of corruption. His finding supports the notion that trade liberalization can lead to better governance and thereby reduced levels of corruption. Jong and Bogmans (2011) investigate the effect of corruption on international trade for both the importing and exporting country. They found that corruption has an overall negative impact on trade but bribe-paying to customs enhances imports.

Lambsdorff (1998) found that the degree of corruption of the importing country significantly affects the export performance of a country. For some countries, his result shows a positive relationship between corruption and export performance, but for a few other nations the corruption and export performance moves in the opposite direction. Lambsdorff (1999) reinforces his earlier findings and shows that some countries have a significantly lower market share in countries which are corrupt. He concludes that these differences arise due to a different willingness of exporters to offer bribes.

Since customs procedures can considerably increase the transit time between origin and destination, the extraction and evasion at the borders can play a major role in facilitating or hindering international trade. A study by Martincus et al. (2011) finds that a 10% increase in the median time spent in customs results in a 1.8% decline in the growth rate of exports. The effects are particularly acute for exports of time-sensitive products. Therefore, it is expected that corruption at the border will have a negative impact on the volume of international trade. On the other hand, if the trade policies are cumbersome and if the quality of customs is low, corruption can facilitate international trade.

Though few economists have investigated the impact of corruption on trade related to service sectors or manufactured goods, there are scant empirical studies that address how corruption might influence the volume of agricultural trade across the borders. Agricultural commodities are usually perishable in nature, although the degree of perishability varies. Along with increasing transaction costs, delays in trade have an impact on the market price of agricultural commodities. Longer waits in customs to get clearance will influence the price

of the traded goods and, thereby, can influence the volume of exports. The exporter of a commodity that is highly perishable in nature will have a greater propensity to pay a bribe. Also to avoid the delays at the border that result in higher inventory holding costs, the exporters will be willing to pay the bribe. This propensity to pay or accept bribes increases with the level of corruption prevailing in the exporting or the importing country.

Therefore, it can be argued that the level of corruption prevailing in a country can significantly influence the volume of trade across the border. So it is important to study the impact of corruption on agricultural trade between nations. This paper tries to fill this void in the trade literature by studying the impact of corruption on bilateral agricultural exports. Specifically, this paper examines the following hypothesis:

Hypothesis 1: The level of corruption prevailing in a country will have a significant impact on the volume of agricultural trade.

This paper uses an augmented gravity model and combines different estimation techniques to empirically investigate the impact of corruption on bilateral agricultural trade. Using different measures of corruption, this paper attempts to measure the extent to which corruptions affect the trade performance of a country. In this paper the Control of Corruption (CCI) Index, constructed by Worldwide Governance Indicators, is used as the main explanatory variable. For sensitivity analysis, the Corruption Perception Index (CPI) is used as a proxy for corruption. To analyze the data, multiple regressions are used and results are tested for robustness. To reduce the omitted variable bias, a broad range of theoretically plausible determinants of agricultural trade are also included in the model. To deal with the endogeneity issue, the instrumental variable approach is used in this paper. Furthermore, Hekman's two-step and Heckman's selection models are used to reduce the sample-selection bias present in the model.

3.3 Empirical Strategy

To study the relationship between the level of corruption prevailing in a country and the volume of agricultural exports, the augmented gravity model is used in this paper. The gravity model of international trade pioneered by Tinbergen (1962) is expressed as:

$$Y_{ei} = G\frac{(M_e M_i)}{D_{ei}} \tag{3.1}$$

A standard gravity model assumes that the volume of trade between two countries is positively related to the size of the economies and negatively related to the trade costs between them. Here, Y_{ij} measures the trade flow between country e and i, M_e and M_i represents the size of country e and i respectively, D is the geographical distance between the countries, that captures trade costs. G is the gravitational constant. The market size of the economy is usually measured by the GDP of the country.

Additional dummy variables, including island economy, landlocked economy, common language, a common border, colonial heritage, income level or geographical region are included in the model to capture trade factors. The population is also included as a measure of country size. In this paper, the level of corruption in a country is used as a proxy for the quality institutions. Along with the main variable of interest, this paper controls for other variables that can influence the volume of trade. Since bilateral trade involves two countries, the quality of institutions prevailing in both the countries can affect the outcome of the exchange. Therefore, a variable representing the level of corruption prevailing in the partner country is included in the model. The model also controls for variables such as bilateral import tariff and the exchange rate that have the potential to influence the volume of agricultural trade. In this paper, a weighted average of bilateral applied tariff rates, weighted by the values of bilateral agricultural trade, is used as a measure of a country's tariff structure. This study includes two interaction term between tariff structure and the

corruption index for exporting and importing countries respectively in the model. Since a complex tariff structure gives customs officials' incentive to demand bribes and also gives incentive to the foreign exporters to offer bribes, it is necessary to include the interaction terms in the model.

In this paper the log-linearized augmented gravity equation takes the following form:

$$
\begin{aligned}
\log(Export)_{eit} = {}& \alpha + \beta_1 Corruption_{et} + \beta_2 Corruption_{it} + \gamma_1 \log(GDP)_{et} + \gamma_2 \log(GDP)_{it} \\
& + \gamma_3 \log(Population)_{et} + \gamma_4 \log(Population)_{it} + \gamma_5 \log(Distance)_{ei} \\
& + \gamma_6 Landlocked_e + \gamma_7 Language_{ei} + \gamma_8 Colony_{ei} + \gamma_9 Border_{ei} + \gamma_{10} Island_e \\
& + \gamma_{11} Income_e + \gamma_{12} Region_e + \gamma_{13} \log(ExchangeRate)_{et} + \gamma_{14} \log(Tariff)_{iet} \\
& + \gamma_{15} \log(Tariff)_{iet} \times Corruption_{et} + \gamma_{16} \log(Tariff)_{iet} \times Corruption_{it} \\
& + \delta_{ei} + \epsilon_{eit} && (3.2)
\end{aligned}
$$

Here, e and i represents the exporting and importing countries, respectively, and t denotes time. $Export_{eit}$ denotes volume of agricultural export from country e to country i at time period t. $Corruption_{et}$ and $Corruption_{it}$ denote level of corruption in country e and i, respectively, at period t. GDP_{et} and GDP_{it} are the real GDP of country e and i, respectively, at time period t. $Population_{et}$ and $Population_{it}$ denote population of country e and i, respectively, at time period t. $Distance_{ei}$ gives the distance between the capital cities of country e and i. $Land$ is a binary dummy variable that takes a value of unity if country e is landlocked. $Language_{ei}$ is a binary dummy variable which is unity if country e and country i have a common language and zero otherwise. $Colony_{ei}$ is a binary dummy which is unity if e and i had the same colonizer. $Border_{ei}$ is a binary dummy variable which is unity if e and i share a common border. $Island_e$ is a binary dummy taking a value of unity if country e is an island economy. $Income_e$ represents the set of dummies representing the income group to which country e belongs. $Region_e$ represents the set of dummies representing the geographical region to which country e belongs. $Tariff_{iet}$ is a weighted average tariff applied

by country i on country e's exports at period t. $ExchangeRate_{et}$ represents the real exchange rate of country e quoted in the US dollar. δ_{ei} is a set of time fixed effects. ϵ_{eit} is the error term that is assumed to be normally distributed with mean zero.

The model is estimated using five-year panel data from 2006 to 2010. It is expected that corruption will have a negative impact on the volume of international trade. In that case, the coefficient of the corruption parameter is expected to take a positive sign (a higher value of the corruption index implies the country is less corrupt). Therefore, the positive coefficient of the corruption index should capture the trade-taxing extortion effect. On the other hand, if the trade policies are cumbersome and if the quality of customs is low, corruption can facilitate international trade. As a result, the coefficient of the corruption index is expected to take a negative sign. Also, a negative coefficient on the (corruption $\times$ tariff) interaction term captures the trade-enhancing evasion effect. This negative coefficient implies that corruption can be trade enhancing when the level of tariffs rises above a certain threshold level (Dutt and Traca, 2009).

As mentioned earlier, GDP is used as a proxy for the size of the economy. The larger the economy, the higher will be the volume of agricultural trade between country pairs. Therefore, the coefficient of $log(GDP)$ is expected to be positive. The coefficient for the log value of distance, which is used as a proxy for trade cost is expected to be negative as higher distance increases the trade cost, thereby reducing the volume of trade between the countries. As transportation costs are higher for islands or landlocked economies compared to the countries sharing a common border, the volume of trade is expected to be higher in the last case than in the other two instances. It is also assumed that the volume of trade will be higher between the countries sharing similar cultural or colonial heritage. The same goes for the country pairs belonging to the same income group or the same geographical region. Again, the higher the population of the countries, the higher will be the demand for the commodities. As a result, the coefficient of $log(Population)$ of the importing country is expected to have a positive sign. The more the demand at home, the lower will be the

volume of exports. Therefore, with increasing population at home, the volume of export will be lower. As a result, the coefficient of $log(Population)$ of the exporting country is expected to take a negative sign. As complex tariff barriers discourage trade, the coefficient of the tariff parameter is therefore expected to take a negative sign. The coefficient of the exchange rate is also expected to take a negative sign. A higher value of this variable implies that the value of the exporting country's currency appreciates in terms of the US dollar. With an appreciation of the domestic currency, the price of its exports increases. Therefore, a higher value of a country's exchange rate will negatively influence its exports.

In this paper, the log-linearized augmented gravity model is initially estimated using the benchmark Ordinary Least Square (OLS) method. Panel estimation methods like population averaged Feasible Generalized Least Square (Pooled FGLS) and Random Effect Models are also used to study the relationship between corruption and agricultural trade. Next, sample-selection bias arising from missing trade values is then corrected using Heckman's two-step model and Heckman's Selection model. To alleviate potential endogeneity present in the model, instrumental variable regression is then used.

3.3.1 Sample-selection bias

In trade data, sample-selection bias is common due to the presence of missing trade values. Zero trade flows may result from a country's decision not to trade with another economy. As the log of zero is undefined, the missing trade value creates a problem when the log-linearized augmented gravity model is estimated using OLS. Zero trade flows will be automatically dropped from the log-linearized equation, giving rise to sample-selection bias.[3]

To alleviate sample-selection bias, this paper follows Helpman et al., (2006), who use Heckman's two-step procedure to reduce this bias (Heckman, 1979). In Heckman's two-step

---

[3]Alternative approaches to handle the presence of zero trade includes: i) Truncating the sample by discarding the observations with zero trade values; and ii) Adding a small constant to each observation on the dependent variable before taking logarithms. This method works properly if the zeros are randomly distributed. Otherwise, this method gives rise to sample selection bias.

model, Probit estimation is conducted in the first-stage to determine the probability of a country pair engaging in trade. In the second stage of the estimation, the expected values of the trade flow from the first stage, conditional on that country pairs are trading, are estimated using OLS. In this two-step model, to identify the parameters in both equations, an identification variable is required. The variable should hold the property that it influences a country's propensity to engage in trade but should not have any effect on its volume of trade. Previous literature suggests that variables like common religion, common language etc. satisfy this condition (Helpman et al., 2006).

In this paper, Heckman's selection model is also used to deal with the sample-selection bias. In this model, the selection and the outcome equations are estimated simultaneously using Maximum Likelihood Estimation. Heckman's selection model depends strongly on the model being correctly specified. Heckman's selection model can produce biased estimates if the model is not properly specified or if a specific dataset violates the model's assumptions. When the underlying goal is to predict an actual response, Hekman's two-step model is preferred. If the goal is to predict the value of the dependent variable that would be observed in the absence of selection, however, Heckman's selection model is more appropriate.

3.3.2   Endogeneity

The cross-country correlation suggests a possible causal relationship between the volume of trade and the level of corruption prevailing in a country. The level of corruption in a country and the volume of trade might be determined simultaneously. For example, a higher degree of corruption can lower the volume of trade, or larger volume of trade might reduce the level of corruption prevailing in a country. This creates a circular causal chain between corruption and the volume of agricultural trade, giving rise to endogeneity.

In the augmented gravity model, the level of corruption can also be endogenous to the volume of agricultural trade because of the possibility of omitted variable bias, especially

arising due to the presence of unobserved country-specific fixed factors. These unobserved country-specific factors pose the biggest challenge in the empirical corruption literature, owing to the invariability of corruption indices over time. This invariability of corruption indices makes it infeasible to carry out a panel study in corruption. In the presence of endogeneity, OLS estimation gives a biased result as the orthogonality assumption is violated.

To deal with the issue of endogeneity, this paper uses Instrumental Variable (IV) regression. An index of Ethnolinguistic fractionalization (ELF) is used as an instrument. The choice of instrument is guided by theoretical and economical findings by different economists. Development economists suggest that ethnic diversity or ethnolinguistic fractionalization leads to political instability and poor economic performance (Feraon, 2002). It lowers a country's economic growth rate or level of the public goods provision (Alesina et al., 1997). A higher degree of ethnic diversity also results in an increased level of corruption in an economy. Ethnically diverse societies are more likely to engage in non-collusive bribery, which is more harmful than the collusive bribery present in a homogenous society (Shleifer and Vishny, 1993). According to Mauro (1995), "Ethnic conflict may lead to political instability and, in extreme cases, to civil war. The presence of many different ethnolinguistic groups is also significantly associated with worse corruption, as bureaucrats may favor members of their same group."

Ethnolinguistic fractionalization (ELF) index measures "the probability that two randomly selected persons from a given country will not belong to the same ethnolinguistic group" (Mauro, 1995). The higher the value of ELF index, the more fragmented the country will be. For this variable to work as an instrument, it should be true that the ELF index is highly correlated with the corruption index, and it should not have any direct impact on the volume of bilateral export or import. Here it is assumed that ELF will directly influence the level of corruption in a country but will not have any direct impact on the volume of agricultural exports.

This paper uses the ELF index for 1961 constructed by Roeder (2001) as an instrument for corruption. Roeder (2001) provides ethnic diversity data for 150 countries. This ELF index is constructed mainly based on Atlas Narodov Mira, published by Soviet ethnographers in 1964 together with other Soviet ethnographic studies from the 1980s (Roeder 2001).

The ELF index given by the following equation is constructed using the Taylor and Hudson (1972) formula. A fractionalization index, FRAC, is defined as,

$$ELF = 1 - \sum_{i=1}^{n} \Pi_i^2 \tag{3.3}$$

Where, Π_i is the proportion of people belonging to the ethnic group i . Lower the value of Π_i, the higher will be the value of ELF, and the more fragmented the country will be. According to the corruption literature, higher ethnolinguistic fractionalization will lead to higher level of corruption.

3.4 Data

To undertake the empirical investigation, this paper uses cross-country data and constructs a panel dataset. The bilateral trade flow data for the dependent variable is collected from the Commodity and Trade Database (COMTRADE) of the United Nations Statistics Division for 2006 to 2010 for total agricultural exports. Agricultural goods are defined as commodities in Category 0 at the one-digit level of the Standard International Trade Classification (SITC Revision 1, Category 0). All data are expressed in current US dollar.

This paper uses the Control of Corruption Index (CCI) as the primary measure of corruption. The CCI comes from the worldwide governance indicators (WGI) constructed by Kaufmann et al., (2010). They describe the purpose of CCI in that it "Reflects perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as 'capture' of the state by elites and private interests." The CCI takes a value in the range of -2.5 (most corrupt) to 2.5 (least corrupt).

To conduct the sensitivity analysis, the paper includes the Corruption Perception Index (CPI) constructed by Transparency International as a measure of corruption. According to Transparency International, "corruption is the abuse of entrusted power for private gain. It hurts everyone who depends on the integrity of people in a position of authority." Transparency International collects data from a number of different surveys that report the perceived level of corruption in the public sector in different countries. The CPI index ranges from 0 to 10 where, zero implies a country is highly corrupt, and ten implies a country is almost clean. Table 3.2 summarizes the relevant variables used in this paper.

Table 3.2: Corruption & Agricultural Exports: Summary Statistics

Variable	Mean	Std. Dev.	Obs.
$\log(\text{Export})_{ei}$	13.98	3.138	61595
CorruptionCCI$_e$	0.307	1.062	62817
CorruptionCCI$_i$	0.139	1.062	61847
CorruptionCPI$_e$	4.864	2.313	60825
CorruptionCPI$_i$	4.461	2.285	58222
$\log(\text{GDP})_e$	25.55	2.072	61752
$\log(\text{GDP})_i$	24.82	2.345	60667
$\log(\text{Distance})_{ei}$	3.691	0.392	56777
$\log(\text{Population})_e$	16.62	1.747	62292
$\log(\text{Population})_i$	16.07	1.964	61890
$\log(\text{Real Exchange Rate})_e$	4.589	0.076	39172
$\log(\text{Tariff})_{ie}$	2.097	1.294	29365
Ethnolinguistic Fractionalization Index$_e$	0.417	0.273	53146
Ethnolinguistic Fractionalization Index$_i$	0.436	0.267	57256

Summary statistics are presented together for the years 2006 to 2010.

The tariff data were derived from the Trade Analysis and Information System (TRAINS) of the United Nations Conference on Trade and Development (UNCTAD). Real exchange rate data comes from the World Bank. It is expressed in local currency units relative to the US dollar. The data for GDP has been taken from World Development Indicators published

43

by the World Bank. Population data also comes from the World Bank data-set. Variables capturing the variation in trade costs between country pairs such as distance, common language, common border, colonial pasts, and other gravity model variables comes from the CEPII. The data for ethnolinguistic fractionalization index, which is used as an instrument for corruption is provided by Roeder (2001).

3.5 Results

In this section, the full regression results quantifying the effect of corruption on agricultural exports are presented. Here, Control of Corruption Index (CCI) is used as a proxy for the level of corruption. Before estimating equation 3.2, the 1% tails of log value of agricultural exports across countries are trimmed. That is, all countries are pooled and the top and bottom 1% of log value of agricultural exports in each of the pools are trimmed. The first column in each table includes standard gravity model variables along with the level of corruption as the main explanatory variable. Next, the model controls for a number of variables to minimize the omitted variable bias. Column 1 also includes region and income dummies to rule out the possibility that these results are driven by the omission of region and income fixed factors. Column 2, controls for the effect of variables such as population, real exchange rate, and tariff structure. Column 3 includes the interaction terms between tariff structure and the level of corruption in the exporting and importing countries respectively. Finally, the last column presents results of regressions which control for all the variables in the same specification along with time specific fixed effects. In terms of panel data, this fixed effect estimation accounts for all sources of unobserved heterogeneity that are constant for a given year across all countries. To deal with this issue of heteroscedasticity, robust clustered standard errors are used. Standard errors are clustered by distance, which is unique to each country pair but is identical for both trading partners.

3.5.1 Conventional Panel Data Techniques

Initially, the gravity model is estimated using the benchmark Ordinary Least Square (OLS) method. Consistency of OLS requires the error term to be uncorrelated with the explanatory variables. Therefore, Pooled Ordinary Least Square (POLS) is consistent in the Random Effect (RE) model but is inconsistent in the Fixed Effect (FE) model. In this paper, due to the presence of time-invariant factors, the RE model is more appropriate than the FE model. Thus, the estimates from the POLS model are assumed to be consistent in this study.

The results from POLS model are presented in Table 3.3. The coefficient of corruption in the exporting country is highly significant in each column with the expected positive sign. This result suggests that the level of corruption in the exporting country has a significant and negative impact on the volume of exports (i.e., the more corrupt a country is, the lower will be the volume of agricultural exports). For example, in column 4, the coefficient of corruption in the exporting country suggests that an increase in the corruption ranking by one (becoming less corrupt) will increase the volume of agricultural exports by almost 84%. However, the corruption level in the importing country does not significantly affect the volume of agricultural exports. This can be true because the exporters will have a higher propensity to pay a bribe as they have to sell their product. Irrespective of the level of corruption in their own country or in the partner country, exporters will always be willing to pay a bribe. Therefore, they will be willing to trade even with a country which is highly corrupt. On the other hand the importing country has the option to choose a trading partner which is less corrupt.

As mentioned earlier, the positive coefficient of the corruption index captures the trade-taxing extortion effect. Moreover, the positive coefficient of the interaction term between tariff structure and the level of corruption does not show any evidence of a trade enhancing evasion effect.

Table 3.3: Corruption (CCI) & Agricultural Exports: Pooled OLS

Dependent variable: log(Export)$_{ei}$	(1)	(2)	(3)	(4)
CorruptionCCI$_{\_e}$	0.902***	0.759***	0.843***	0.841***
	(0.050)	(0.075)	(0.092)	(0.093)
CorruptionCCI$_{\_i}$	0.113***	0.055	-0.055	-0.057
	(0.034)	(0.054)	(0.069)	(0.069)
log(GDP)$_e$	0.146**	-0.018	-0.023	-0.018
	(0.055)	(0.089)	(0.089)	(0.093)
log(GDP)$_i$	0.610***	0.670***	0.667***	0.668***
	(0.023)	(0.034)	(0.034)	(0.034)
log(Distance)$_{ei}$	-2.772***	-2.822***	-2.808***	-2.809***
	(0.074)	(0.112)	(0.112)	(0.112)
Island Economy$_{\_e}$	-0.151*	-0.395***	-0.399***	-0.399***
	(0.068)	(0.098)	(0.098)	(0.098)
Landlocked Economy$_{\_e}$	-1.097***	-0.700***	-0.699***	-0.700***
	(0.084)	(0.130)	(0.130)	(0.130)
Common Colony$_{\_ei}$	1.267***	0.355	0.360	0.359
	(0.190)	(0.406)	(0.407)	(0.408)
Common Language$_{\_ei}$	0.699***	1.014***	1.016***	1.016***
	(0.077)	(0.102)	(0.102)	(0.102)
Common Border$_{\_ei}$	1.127***	0.911***	0.890***	0.890***
	(0.149)	(0.235)	(0.235)	(0.235)
log(Population)$_e$	0.597***	0.668***	0.673***	0.668***
	(0.059)	(0.099)	(0.099)	(0.104)
log(Population)$_i$	0.073**	0.019	0.029	0.028
	(0.026)	(0.038)	(0.038)	(0.038)
log(Tariff)$_{ie}$		-0.118***	-0.118***	-0.118***
		(0.027)	(0.034)	(0.034)
log(Real Exchange Rate)$_e$		1.992***	1.990***	1.999***
		(0.357)	(0.356)	(0.360)
log(Tariff)$_{ie}$ × CorruptionCCI$_{\_e}$			-0.039	-0.039
			(0.022)	(0.022)
log(Tariff)$_{ie}$ × CorruptionCCI$_{\_i}$			0.069**	0.069**
			(0.025)	(0.025)
Region Dummy	Yes	Yes	Yes	Yes
Income Dummy	Yes	Yes	Yes	Yes
Year Fixed Effect	No	No	No	Yes
Observations	41171	14373	14373	14373
Adjusted R^2	0.43	0.416	0.417	0.417

Heteroscedasticity robust standard errors in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The first column includes standard gravity model variables along with CCI as the main explanatory variable. It also includes region and income dummies. Column 2, controls for the effect of population, real exchange rate, and tariff structure. Column 3 includes the interaction terms between tariff structure and the level of corruption. The last column controls for time specific fixed effects. Constant not reported.

The results from the Pooled Feasible Generalized Least Square (PFGLS) model are presented in Table 3.4. PFGLS estimation can lead to estimators of the parameters of the pooled model that are more efficient than POLS estimation in the presence of heteroscedasticity and auto-correlation. Also, this model works well for an infinite sample. Under the assumption that any individual-level unobserved effects are uncorrelated with the regressors, PFGLS is consistent. The PFGLS model also gives results similar to the POLS model.

3.5.2 Heckman Model Estimates

Results from the Heckman Models are presented in this section. The results from the first-step of Heckman's two-step estimates are included in the appendix. The result shows the identification variable, the probability that two randomly drawn people from a country pair speak the same language, to be an important determining factor for the country pairs to engage in trade. Econometrically, this provides the necessary exclusion restriction for identification of the second stage trade flow equation. Therefore the variable "Common Language" is used as an exclusion variable in the construction of the Inverse Mills Ratio for the second stage Heckman procedure.

Table 3.5 shows the second-stage results from Heckman's Two-step model. After correcting for the selection bias arising due to missing trade values, the coefficient for the level of corruption in the exporting country takes the expected positive sign. The positive coefficient for the corruption index captures the trade-taxing extortion effect and suggests that the level of corruption in the exporting country will reduce the volume of exports. The negative coefficient of the interaction term between tariff structure and the level of corruption suggests that trade enhancing evasion effect can be present in the model, but the result is not highly significant. However, the estimate for corruption in the importing country still remains insignificant but takes a positive sign after controlling for other variables.

47

Table 3.4: Corruption (CCI) & Agricultural Exports: Pooled FGLS

Dependent variable: $\log(\text{Export})_{ei}$	(1)	(2)	(3)	(4)
CorruptionCCI$_{\_e}$	0.412***	0.293***	0.358***	0.458***
	(0.038)	(0.069)	(0.081)	(0.086)
CorruptionCCI$_{\_i}$	0.019	0.038	-0.009	0.039
	(0.028)	(0.052)	(0.065)	(0.067)
$\log(\text{GDP})_e$	0.557***	0.595***	0.593***	0.329***
	(0.036)	(0.079)	(0.079)	(0.099)
$\log(\text{GDP})_i$	0.640***	0.661***	0.661***	0.610***
	(0.019)	(0.035)	(0.035)	(0.037)
$\log(\text{Distance})_{ei}$	-2.579***	-2.648***	-2.641***	-2.647***
	(0.073)	(0.133)	(0.133)	(0.133)
Island Economy$_{\_e}$	-0.131	-0.256*	-0.260*	-0.233
	(0.073)	(0.122)	(0.122)	(0.122)
Landlocked Economy$_{\_e}$	-1.087***	-0.812***	-0.812***	-0.734***
	(0.092)	(0.148)	(0.148)	(0.149)
Common Language$_{\_ei}$	0.676***	1.086***	1.080***	1.062***
	(0.078)	(0.121)	(0.120)	(0.120)
Common Border$_{\_ei}$	0.928***	0.706**	0.683**	0.632*
	(0.138)	(0.251)	(0.251)	(0.251)
Common Colony$_{\_ei}$	1.007***	0.463	0.470	0.523
	(0.200)	(0.428)	(0.434)	(0.423)
$\log(\text{Population})_e$	0.059	-0.008	-0.006	0.267*
	(0.042)	(0.088)	(0.088)	(0.107)
$\log(\text{Population})_i$	0.022	0.014	0.016	0.062
	(0.023)	(0.039)	(0.039)	(0.041)
$\log(\text{Tariff})_{ie}$		-0.122***	-0.104***	-0.106***
		(0.025)	(0.031)	(0.031)
$\log(\text{Real Exchange Rate})_e$		-0.126	-0.121	-0.001
		(0.219)	(0.219)	(0.224)
$\log(\text{Tariff})_{ie} \times$ CorruptionCCI$_{\_e}$			-0.030	-0.029
			(0.019)	(0.019)
$\log(\text{Tariff})_{ie} \times$ CorruptionCCI$_{\_i}$			0.031	0.030
			(0.022)	(0.023)
Region Dummy	Yes	Yes	Yes	Yes
Income Dummy	Yes	Yes	Yes	Yes
Year Fixed Effect	No	No	No	Yes
Observations	35099	9542	9542	9542

Heteroscedasticity robust standard errors in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The first column includes standard gravity model variables along with CCI as the main explanatory variable. It also includes region and income dummies. Column 2, controls for the effect of population, real exchange rate, and tariff structure. Column 3 includes the interaction terms between tariff structure and the level of corruption. The last column controls for time specific fixed effects. Constant not reported.

Table 3.5: Corruption (CCI) & Agricultural Exports: Heckman's Two-step Model. Second-step Estimates

Dependent variable: log(Export)$_{ei}$	(1)	(2)	(3)	(4)
CorruptionCCI$_e$	0.987***	1.198***	1.463***	1.463***
	(0.182)	(0.231)	(0.248)	(0.252)
CorruptionCCI$_i$	-0.176	-0.008	0.099	0.104
	(0.111)	(0.144)	(0.191)	(0.194)
log(GDP)$_e$	0.278	0.123	0.092	0.086
	(0.154)	(0.230)	(0.232)	(0.244)
log(GDP)$_i$	0.717***	0.716***	0.717***	0.716***
	(0.069)	(0.102)	(0.101)	(0.103)
log(Distance)$_{ei}$	-2.836***	-3.040***	-2.974***	-2.974***
	(0.230)	(0.375)	(0.383)	(0.384)
log(Population)$_e$	0.493**	0.414	0.451	0.458
	(0.182)	(0.267)	(0.269)	(0.282)
log(Population)$_i$	-0.083	-0.033	-0.025	-0.023
	(0.078)	(0.106)	(0.105)	(0.106)
log(Real Exchange Rate)$_e$		1.347	1.365	1.321
		(0.715)	(0.712)	(0.730)
log(Tariff)$_{ie}$		0.067	0.140	0.142
		(0.074)	(0.089)	(0.089)
log(Tariff)$_{ie}$ × CorruptionCCI$_e$			-0.122*	-0.123*
			(0.050)	(0.050)
log(Tariff)$_{ie}$ × CorruptionCCI$_i$			-0.048	-0.049
			(0.077)	(0.074)
Inverse Mills Ratio	-1.556***	-1.253**	-1.247**	-1.249**
	(0.248)	(0.469)	(0.470)	(0.470)
Region Dummy	Yes	Yes	Yes	Yes
Income Dummy	Yes	Yes	Yes	Yes
Year Fixed Effect	No	No	No	Yes
Observations	4636	1944	1944	1944
Adjusted R^2	0.450	0.450	0.452	0.452

Heteroscedasticity robust standard errors in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The first column includes standard gravity model variables along with CCI as the main explanatory variable. It also includes region and income dummies. Column 2, controls for the effect of population, real exchange rate, and tariff structure. Column 3 includes the interaction terms between tariff structure and the level of corruption. The last column controls for time specific fixed effects. Constant not reported.

The standard gravity model variables also take the expected sign, and the results are statistically significant in most of the cases.

Table 3.6 presents the results from Heckman's selection model. Similar to the two-step model, this estimation strategy shows a positive and significant impact of corruption of exporting country on agricultural exports. The result further suggests that the e-governance measure in the importing country can also influence the volume of exports positively. This result is highly significant for all specifications.

3.5.3   IV Estimates

Table 3.7 reports the results of the 2SLS analysis using ethnolinguistic fractionalization (ELF) index as an instrument for corruption. The coefficient for corruption in the exporting country appears with the expected positive sign across different specifications and is statistically significant. After controlling for causality and omitted variable bias, the coefficient for corruption in the importing country becomes significant and takes the expected positive sign. The positive coefficient of the corruption index captures the trade-taxing extortion effect and suggests that the higher level of corruption prevailing in the exporting country will reduce the volume of exports. Also, the negative and significant coefficient for the interaction term between tariff structure and the level of corruption, suggests corruption can be trade enhancing in the presence of complex tariff structures. Here the coefficients from the instrumental variable regression are somewhat larger than the OLS estimates suggesting that OLS estimates were downwards biased due to the problem of endogeneity. Furthermore, the F-statistic presented at the bottom of the Table 3.7 suggests that the instrument is strong in each column (i.e., the more fragmented a country is in terms of ethnicity, the more severe will be the level of corruption). Table 3.8 reports the results from GMM analysis. The point estimates obtained from using GMM are very similar to the 2SLS estimates.

Table 3.6: Corruption (CCI) & Agricultural Exports: Heckman's Selection Model

Dependent variable: log(Export)$_{ei}$	(1)	(2)	(3)	(4)
CorruptionCCI$_{\_e}$	0.401***	0.261***	0.261***	0.261***
	(0.025)	(0.038)	(0.038)	0(0.038)
CorruptionCCI$_{\_i}$	0.434***	0.399***	0.399***	0.399***
	(0.028)	(0.050)	(0.050)	(0.050)
log(Distance)$_{ei}$	0.826***	0.797***	0.799***	0.799***
	(0.077)	(0.171)	(0.169)	(0.168)
Common Colony$_{\_ei}$	-0.272	-0.236	-0.267	-0.266
	(0.147)	(0.248)	(0.252)	(0.250)
Island Economy$_{\_e}$	-0.011	0.052	0.075	0.076
	(0.054)	(0.117)	(0.115)	-0.115
Landlocked Economy$_{\_e}$	-0.07	-0.122	-0.103	-0.100
	(0.058)	(0.127)	(0.131)	(0.132)
Common Language$_{\_ei}$	-0.260***	-0.481***	-0.502***	-0.500***
	(0.072)	(0.129)	(0.128)	(0.128)
Common Border$_{\_ei}$	-0.518***	-0.489*	-0.453*	-0.452*
	-0.114	-0.219	-0.220	-0.220
log(GDP)$_e$	-0.202***	-0.106	-0.101	-0.097
	(0.025)	(0.061)	(0.061)	(0.061)
log(GDP)$_i$	-0.181***	-0.320***	-0.318***	-0.316***
	(0.023)	(0.043)	(0.043)	(0.043)
log(Population)$_e$	-0.044	-0.269***	-0.280***	-0.284***
	(0.027)	(0.073)	(0.073)	(0.073)
log(Population)$_i$	-0.102***	-0.025	-0.035	-0.036
	(0.024)	(0.046)	(0.047)	(0.047)
log(Real Exchange Rate)$_e$		-0.803	-0.751	-0.733
		(0.421)	(0.410)	(0.424)
log(Tariff)$_{ie}$		0.015	-0.002	-0.002
		(0.033)	(0.042)	(0.042)
log(Tariff)$_{ie}$ × CorruptionCCI$_{\_e}$			0.056*	0.056*
			(0.023)	(0.024)
log(Tariff)$_{ie}$ × CorruptionCCI$_{\_i}$			-0.032	-0.032
			(0.025)	(0.026)
Region Dummy	Yes	Yes	Yes	Yes
Income Dummy	Yes	Yes	Yes	Yes
Year Fixed Effect	No	No	No	Yes
Rho	0.726	0.763	0.771	0.771
Inverse Mills Ratio	2.227	2.184	2.209	2.206
Observations	43404	15049	15049	15049

Heteroscedasticity robust standard errors in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The first column includes standard gravity model variables along with CCI as the main explanatory variable. It also includes region and income dummies. Column 2, controls for the effect of population, real exchange rate, and tariff structure. Column 3 includes the interaction terms between tariff structure and the level of corruption. The last column controls for time specific fixed effects. Constant not reported.

Table 3.7: Corruption (CCI) & Agricultural Exports: IV Analysis (2SLS)

Dependent variable: log(Export)$_{ei}$	(1)	(2)	(3)	(4)
CorruptionCCI_e	3.378**	2.720***	4.360***	4.498***
	(1.206)	(0.707)	(1.206)	(1.205)
CorruptionCCI_i	9.664	2.688**	2.946**	2.515**
	(7.496)	(1.035)	(0.997)	(0.906)
log(GDP)$_e$	-0.846	-1.203**	-1.357**	-1.543**
	(0.469)	(0.427)	(0.478)	(0.515)
log(GDP)$_i$	-4.382	-0.421	0.0668	0.158
	(3.925)	(0.441)	(0.218)	(0.202)
log(Distance)$_{ei}$	-4.293***	-3.796***	-3.750***	-3.722***
	(0.990)	(0.266)	(0.242)	(0.228)
Common Colony_ei	-1.878	1.022	0.843	0.786
	(2.546)	(0.578)	(0.548)	(0.530)
Island Economy_e	-0.224	-0.147	-0.154	-0.113
	(0.151)	(0.115)	(0.115)	(0.120)
Landlocked Economy_e	-2.101**	-1.181***	-1.060***	-1.061***
	(0.671)	(0.183)	(0.160)	(0.155)
Common Language_ei	0.688***	0.776***	0.736***	0.739***
	(0.122)	(0.109)	(0.111)	(0.108)
Common Border_ei	0.241	0.158	0.043	0.0224
	(0.558)	(0.230)	(0.252)	(0.249)
log(Population)$_e$	1.890**	2.143***	2.370***	2.574***
	(0.592)	(0.524)	(0.593)	(0.631)
log(Population)$_i$	5.599	1.243*	0.753**	0.646**
	(4.341)	(0.490)	(0.252)	(0.232)
log(Real Exchange Rate)$_e$		2.110***	2.090***	1.595***
		(0.381)	(0.385)	(0.438)
log(Tariff)$_{ie}$		0.115	0.721**	0.642**
		(0.098)	(0.264)	(0.239)
log(Tariff)$_{ie}$ × CorruptionCCI_e			-0.595**	-0.596***
			(0.184)	(0.178)
log(Tariff)$_{ie}$ × CorruptionCCI_i			-0.680**	-0.570**
			(0.244)	(0.220)
Region Dummy	Yes	Yes	Yes	Yes
Income Dummy	Yes	Yes	Yes	Yes
Year Fixed Effect	No	No	No	Yes
Observations	32378	11962	11962	11962
Wald F statistics	0.951	10.02	13.76	15.42

Heteroscedasticity robust standard errors in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Instrumented variables: CorruptionCCI_e, CorruptionCCI_i. The first column includes standard gravity model variables along with CCI as the main explanatory variable. It also includes region and income dummies. Column 2, controls for the effect of population, real exchange rate, and tariff structure. Column 3 includes the interaction terms between tariff structure and the level of corruption. The last column controls for time specific fixed effects. Constant not reported.

Table 3.8: Corruption (CCI) & Agricultural Exports: IV Analysis (GMM)

Dependent variable: log(Export)$_{ei}$	(1)	(2)	(3)	(4)
CorruptionCCI_e	3.378**	2.720***	4.360***	4.498***
	(1.202)	(0.710)	(1.196)	(1.192)
CorruptionCCI_i	9.664	2.688**	2.946**	2.515**
	(7.346)	(1.039)	(1.008)	(0.911)
log(GDP)$_e$	-0.846	-1.203**	-1.357**	-1.543**
	(0.473)	(0.432)	(0.477)	(0.512)
log(GDP)$_i$	-4.382	-0.421	0.067	0.158
	(3.846)	(0.441)	(0.221)	(0.204)
log(Distance)$_{ei}$	-4.293***	-3.796***	-3.750***	-3.722***
	(0.974)	(0.269)	(0.247)	(0.232)
Common Colony_ei	-1.878	1.022*	0.843*	0.786*
	(2.489)	(0.419)	(0.380)	(0.369)
Island Economy_e	-0.224	-0.147	-0.154	-0.113
	(0.151)	(0.114)	(0.111)	(0.117)
Landlocked Economy_e	-2.101**	-1.181***	-1.060***	-1.061***
	(0.665)	(0.190)	(0.166)	(0.161)
Common Language_ei	0.688***	0.776***	0.736***	0.739***
	(0.119)	(0.108)	((0.105)	(0.101)
Common Border_ei	0.241	0.158	0.043	0.0224
	(0.554)	(0.226)	(0.245)	(0.243)
log(Population)$_e$	1.890**	2.143***	2.370***	2.574***
	(0.595)	(0.530)	(0.591)	(0.628)
log(Population)$_i$	5.599	1.243*	0.753**	0.646**
	(4.254)	(0.492)	(0.257)	(0.235)
log(Real Exchange Rate)$_e$		2.110***	2.090***	1.595***
		(0.373)	(0.385)	(0.431)
log(Tariff)$_{ie}$		0.115	0.721**	0.642**
		(0.100)	(0.270)	(0.243)
log(Tariff)$_{ie}$ × CorruptionCCI_e			-0.595**	-0.596***
			(0.184)	(0.177)
log(Tariff)$_{ie}$ × CorruptionCCI_i			-0.680**	-0.570**
			(0.247)	(0.221)
Region Dummy	Yes	Yes	Yes	Yes
Income Dummy	Yes	Yes	Yes	Yes
Year Fixed Effect	No	No	No	Yes
Observations	32378	11962	11962	11962
Wald F Statistics	1.005	9.338	14.48	16.49

Heteroscedasticity robust standard errors in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Instrumented variables: CorruptionCCI_e, CorruptionCCI_i. The first column includes standard gravity model variables along with CCI as the main explanatory variable. It also includes region and income dummies. Column 2, controls for the effect of population, real exchange rate, and tariff structure. Column 3 includes the interaction terms between tariff structure and the level of corruption. The last column controls for time specific fixed effects. Constant not reported.

3.5.4 Sensitivity Analysis

Table 3.9 to 3.14 presents the results with an alternative measure of corruption, the Corruption Perception Index (CPI), published by Transparency International. CPI takes values between 1 to 10 where a higher value implies a lower level of corruption and vice–versa. The point estimates obtained using the CPI as a measure of corruption are very similar to the estimates from the regressions using CCI. This significant and comparable estimates using CPI strengthens the confidence in the estimated coefficients from the previous sections.

3.6   Conclusion

This paper investigated the effect of corruption on bilateral agricultural exports. The augmented gravity model was used to identify the relationship between corruption and agricultural trade. The study found a trade-taxing extortion effect of corruption prevailing in the exporting country that suggests that the higher level of corruption is associated with reduced agricultural exports. However, the trade-taxing extortion effect was insignificant for the corruption in the importing country. After correcting for sample selection bias and endogeneity, the study found that the level of corruption in both the exporting and importing country will have a significant and negative impact on the volume of agricultural exports. Also, the negative and significant coefficient for the interaction term between the tariff structure and the level of corruption suggest that corruption can be trade enhancing in the presence of complex tariff structures. Therefore, according to the findings of this paper, corruption can be trade-taxing when the protection level is low, but with the degree of protection higher than a threshold level, it becomes trade-enhancing. The results were robust for different measures of corruption.

Table 3.9: Corruption (CPI) & Agricultural Exports: Pooled OLS.

Dependent variable: log(Export)$_{ei}$	(1)	(2)	(3)	(4)
CorruptionCPI_e	0.288***	0.284***	0.321***	0.320***
	(0.022)	(0.033)	(0.041)	(0.041)
CorruptionCPI_i	0.073***	0.066**	0.006	0.005
	(0.016)	(0.025)	(0.032)	(0.032)
log(GDP)$_e$	0.243***	-0.046	-0.051	-0.044
	(0.059)	(0.096)	(0.095)	(0.099)
log(GDP)$_i$	0.602***	0.642***	0.635***	0.636***
	(0.024)	(0.035)	(0.035)	(0.035)
log(Distance)$_{ei}$	-2.662***	-2.782***	-2.762***	-2.764***
	(0.079)	(0.117)	(0.118)	(0.118)
Island Economy_e	-0.138	-0.419***	-0.422***	-0.422***
	(0.071)	(0.101)	(0.101)	(0.101)
Landlocked Economy_e	-1.062***	-0.730***	-0.730***	-0.732***
	(0.088)	(0.135)	(0.135)	(0.135)
Common Colony_ei	1.248***	0.394	0.405	0.402
	(0.189)	(0.419)	(0.419)	(0.420)
Common Language_ei	0.674***	1.006***	1.010***	1.010***
	(0.081)	(0.107)	(0.107)	(0.107)
Common Border_ei	1.229***	0.903***	0.882***	0.882***
	(0.155)	(0.245)	(0.245)	(0.245)
log(Population)$_e$	0.465***	0.677***	0.681***	0.674***
	(0.063)	(0.105)	(0.105)	(0.108)
log(Population)$_i$	0.073**	0.045	0.057	0.056
	(0.027)	(0.039)	(0.039)	(0.039)
log(Tariff)$_{ie}$		-0.118***	-0.215*	-0.215*
		(0.028)	(0.097)	(0.097)
log(Real Exchange Rate)$_e$		2.027***	2.024***	2.037***
		(0.369)	(0.368)	(0.372)
log(Tariff)$_{ie}$ × CorruptionCPI_e			-0.018	-0.018
			(0.011)	(0.011)
log(Tariff)$_{ie}$ × CorruptionCPI_i			0.040***	0.040***
			(0.012)	(0.012)
Region Dummy	Yes	Yes	Yes	Yes
Income Dummy	Yes	Yes	Yes	Yes
Year Fixed Effect	No	No	No	Yes
Observations	37892	13469	13469	13469
Adjusted R^2	0.424	0.411	0.413	0.413

Heteroscedasticity robust standard errors in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The first column includes standard gravity model variables along with CPI as the main explanatory variable. It also includes region and income dummies. Column 2, controls for the effect of population, real exchange rate, and tariff structure. Column 3 includes the interaction terms between tariff structure and the level of corruption. The last column controls for time specific fixed effects. Constant not reported.

Table 3.10: Corruption (CPI) & Agricultural Exports: Pooled FGLS

Dependent variable: log(Export)$_{ei}$	(1)	(2)	(3)	(4)
CorruptionCPI$_{\_e}$	0.048**	0.029	0.024	0.031
	(0.016)	(0.029)	(0.039)	(0.040)
CorruptionCPI$_{\_i}$	0.022*	0.019	-0.021	-0.014
	(0.009)	(0.016)	(0.027)	(0.027)
log(GDP)$_e$	0.626***	0.643***	0.633***	0.474***
	(0.038)	(0.083)	(0.082)	(0.106)
log(GDP)$_i$	0.631***	0.654***	0.658***	0.633***
	(0.018)	(0.032)	(0.033)	(0.034)
log(Distance)$_{ei}$	-2.449***	-2.511***	-2.494***	-2.483***
	(0.078)	(0.140)	(0.140)	(0.140)
Island Economy$_{\_e}$	-0.129	-0.271*	-0.271*	-0.262*
	(0.076)	(0.127)	(0.126)	(0.127)
Landlocked Economy$_{\_e}$	-1.008***	-0.796***	-0.802***	-0.763***
	(0.098)	(0.160)	(0.160)	(0.160)
Common Language$_{\_ei}$	0.636***	1.034***	1.038***	1.027***
	(0.083)	(0.126)	(0.126)	(0.125)
Common Border$_{\_ei}$	1.000***	0.736**	0.734**	0.711**
	(0.143)	(0.259)	(0.259)	(0.259)
Common Colony$_{\_ei}$	1.058***	0.556	0.561	0.595
	(0.193)	(0.447)	(0.443)	(0.441)
log(Population)$_e$	-0.046	-0.101	-0.092	0.066
	(0.045)	(0.093)	(0.092)	(0.114)
log(Population)$_i$	0.010	-0.014	-0.018	0.002
	(0.022)	(0.038)	(0.038)	(0.039)
log(Tariff)$_{ie}$		-0.124***	-0.235**	-0.236**
		(0.026)	(0.086)	(0.087)
log(Real Exchange Rate)$_e$		-0.157	-0.152	-0.087
		(0.233)	(0.233)	(0.237)
log(Tariff)$_{ie}$ × CorruptionCPI$_{\_e}$			0.003	0.004
			(0.009)	(0.009)
log(Tariff)$_{ie}$ × CorruptionCPI$_{\_i}$			0.019	0.018
			(0.011)	(0.011)
Region Dummy	Yes	Yes	Yes	Yes
Income Dummy	Yes	Yes	Yes	Yes
Year Fixed Effect	No	No	No	Yes
Observations	32132	8879	8879	8879

Heteroscedasticity robust standard errors in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The first column includes standard gravity model variables along with CPI as the main explanatory variable. It also includes region and income dummies. Column 2, controls for the effect of population, real exchange rate, and tariff structure. Column 3 includes the interaction terms between tariff structure and the level of corruption. The last column controls for time specific fixed effects. Constant not reported.

Table 3.11: Corruption (CPI) & Agricultural Exports: Heckman's Two-step Model. Second-step Estimates

Dependent variable: $\log(\text{Export})_{ei}$	(1)	(2)	(3)	(4)
CorruptionCPI$_{\_e}$	0.270**	0.403***	0.502***	0.502***
	(0.083)	(0.110)	(0.124)	(0.126)
CorruptionCPI$_{\_i}$	-0.059	0.029	0.067	0.066
	(0.051)	(0.063)	(0.091)	(0.091)
$\log(\text{GDP})_e$	0.337*	0.125	0.103	0.119
	(0.161)	(0.247)	(0.250)	(0.262)
$\log(\text{GDP})_i$	0.717***	0.706***	0.705***	0.708***
	(0.071)	(0.104)	(0.103)	(0.105)
$\log(\text{Distance})_{ei}$	-2.845***	-2.862***	-2.820***	-2.830***
	(0.249)	(0.416)	(0.421)	(0.424)
$\log(\text{Population})_e$	0.435*	0.398	0.423	0.406
	(0.188)	(0.282)	(0.284)	(0.296)
$\log(\text{Population})_e$	0.099	0.046	0.033	0.034
	(0.083)	(0.113)	(0.112)	(0.113)
$\log(\text{Real Exchange Rate})_e$		1.640*	1.662*	1.637*
		(0.762)	(0.761)	(0.780)
$\log(\text{Tariff})_{ie}$		0.088	0.420	0.422
		(0.080)	(0.293)	(0.294)
$\log(\text{Tariff})_{ie} \times$ CorruptionCPI$_{\_e}$			-0.048	-0.049
			(0.027)	(0.027)
$\log(\text{Tariff})_{ie} \times$ CorruptionCPI$_{\_i}$			-0.017	-0.017
			(0.036)	(0.036)
Inverse Mills Ratio	-1.660	-1.458	-1.445	-1.435
	(0.254)	(0.485)	(0.486)	(0.487)
Region Dummy	Yes	Yes	Yes	Yes
Income Dummy	Yes	Yes	Yes	Yes
Year Fixed Effect	No	No	No	Yes
Observations	4223	1787	1787	1787
Adjusted R^2	0.445	0.432	0.434	0.433

Heteroscedasticity robust standard errors in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The first column includes standard gravity model variables along with CPI as the main explanatory variable. It also includes region and income dummies. Column 2, controls for the effect of population, real exchange rate, and tariff structure. Column 3 includes the interaction terms between tariff structure and the level of corruption. The last column controls for time specific fixed effects. Constant not reported.

Table 3.12: Corruption (CPI) & Agricultural Exports: Heckman's Selection Model

Dependent variable: log(Export)$_{ei}$	(1)	(2)	(3)	(4)
CorruptionCPI$_e$	0.188***	0.126***	0.126***	0.126***
	(0.012)	(0.018)	(0.018)	(0.017)
CorruptionCPI$_i$	0.240***	0.252***	0.252***	0.252***
	(0.013)	(0.024)	(0.024)	(0.024)
log(Distance)$_{ei}$	0.868***	0.820***	0.820***	0.821***
	(0.078)	(0.172)	(0.170)	(0.170)
Common Colony$_{ei}$	-0.274	-0.167	-0.196	-0.196
	(0.144)	(0.258)	(0.264)	(0.263)
Island Economy$_e$	-0.014	0.077	0.096	0.097
	(0.055)	(0.121)	(0.119)	(0.119)
Landlocked Economy$_e$	-0.130*	-0.156	-0.135	-0.133
	(0.062)	(0.136)	(0.140)	(0.140)
Common Language$_{ei}$	-0.228**	-0.469***	-0.481***	-0.481***
	(0.073)	(0.132)	((0.130)	(0.130)
Common Border$_{ei}$	-0.489***	-0.480*	-0.451*	-0.450*
	(0.115)	(0.220)	(0.221)	(0.221)
log(GDP)$_e$	-0.243***	-0.172**	-0.171**	-0.170**
	(0.025)	(0.053)	(0.053)	(0.053)
log(GDP)$_i$	-0.187***	-0.294***	-0.289***	-0.289***
	(0.023)	(0.043)	(0.043)	(0.043)
log(Population)$_e$	-0.012	-0.197***	-0.203***	-0.204***
	(0.025)	(0.058)	(0.058)	(0.058)
log(Population)$_i$	-0.107***	-0.052	-0.063	-0.063
	(0.024)	(0.046)	(0.046)	(0.046)
log(Real Exchange Rate)$_e$		-0.849*	-0.791	-0.787
		(0.423)	(0.412)	(0.417)
log(Tariff)$_{ie}$		0.009	-0.005	-0.005
		(0.035)	(0.114)	(0.115)
log(Tariff)$_{ie}$ × CorruptionCPI$_e$			0.022*	0.022*
			(0.011)	(0.011)
log(Tariff)$_{ie}$ × CorruptionCPI$_i$			-0.021	-0.020
			(0.012)	(0.012)
Region Dummy	Yes	Yes	Yes	Yes
Income Dummy	Yes	Yes	Yes	Yes
Year Fixed Effect	No	No	No	Yes
Rho	0.723	0.748	0.756	0.756
Inverse Mills Ratio	2.214	2.129	2.154	2.154
Observations	40041	14116	14116	14116

Heteroscedasticity robust standard errors in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The first column includes standard gravity model variables along with CPI as the main explanatory variable. It also includes region and income dummies are included. Column 2, controls for the effect of population, real exchange rate, and tariff structure. Column 3 includes the interaction terms between tariff structure and the level of corruption. The last column controls for time specific fixed effects. Constant not reported.

Table 3.13: Corruption (CPI) & Agricultural Exports: IV Analysis (2SLS)

Dependent variable: log(Export)$_{ei}$	(1)	(2)	(3)	(4)
CorruptionCPI $_e$	1.185***	1.347***	2.250***	2.309***
	(0.152)	(0.307)	(0.581)	(0.582)
CorruptionCPI $_i$	0.745*	0.954**	1.332**	1.199**
	(0.322)	(0.313)	(0.407)	(0.382)
log(GDP)$_e$	-0.723***	-1.468***	-1.627**	-1.797***
	(0.178)	(0.425)	(0.509)	(0.542)
log(GDP)$_i$	-0.152	-0.151	0.070	0.134
	(90.36)	(0.287)	(0.194)	(0.184)
log(Distance)$_{ei}$	-3.188***	-3.671***	-3.765***	-3.751***
	(0.126)	(0.202)	(0.239)	(0.232)
Common Colony $_{ei}$	0.871***	0.753*	0.662	0.619
	(0.241)	(0.354)	(0.391)	(0.392)
Island Economy $_e$	0.057	0.027	0.021	0.061
	(0.049)	(0.137)	(0.149)	(0.155)
Landlocked Economy $_e$	-1.420***	-1.179***	-1.037***	-1.051***
	(0.102)	(0.164)	(0.152)	(0.152)
Common Language $_{ei}$	0.586***	0.800***	0.705***	0.703***
	(0.052)	(0.095)	(0.109)	(0.108)
Common Border $_{ei}$	0.924***	0.361	0.063	0.038
	(0.105)	(0.189)	(0.249)	(0.250)
log(Population)$_e$	1.604***	2.375***	2.596***	2.778***
	(0.201)	(0.499)	(0.604)	(0.639)
log(Population)$_e$	0.900*	0.928**	0.752***	0.677**
	(0.396)	(0.313)	(0.221)	(0.209)
log(Real Exchange Rate)$_e$		1.171**	1.121*	0.632
		(0.451)	(0.519)	(0.608)
log(Tariff)$_{ie}$		0.071	3.464***	3.283***
		(0.076)	(1.005)	(0.946)
log(Tariff)$_{ie}$ × CorruptionCPI $_e$		-0.340***	-0.342***	
		(0.095)	(0.095)	
log(Tariff)$_{ie}$ × CorruptionCPI $_i$			-0.292**	-0.260**
			(0.099)	(0.092)
Region Dummy	Yes	Yes	Yes	Yes
Income Dummy	Yes	Yes	Yes	Yes
Year Fixed Effect	No	No	No	Yes
Observations	30093	11390	11390	11390
Wald F Statistics	19.39	20.76	17.48	18.75

Heteroscedasticity robust standard errors in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Instrumented variables: CorruptionCPI $_e$, CorruptionCPI $_i$. The first column includes standard gravity model variables along with CPI as the main explanatory variable. In column 2, region and income dummies are included. Column 3, controls for the effect of population, real exchange rate, and tariff structure. Column 4 includes the interaction terms between tariff structure and the level of corruption. The last column controls for time specific fixed effects. Constant not reported.

Table 3.14: Corruption (CPI) & Agricultural Exports: IV Analysis (GMM)

Dependent variable: log(Export)$_{ei}$	(1)	(2)	(3)	(4)
CorruptionCPI$_{\_e}$	1.185***	1.347***	2.144***	2.309***
	(0.152)	(0.307)	(0.548)	(0.582)
CorruptionCPI$_{\_i}$	0.745*	0.954**	1.143**	1.199**
	(0.322)	(0.313)	(0.353)	(0.382)
log(GDP)$_e$	-0.723***	-1.468***	-1.627**	-1.797***
	(0.178)	(0.425)	(0.509)	(0.542)
log(GDP)$_i$	-0.152	-0.151	0.0701	0.134
	(90.36)	(0.287)	(0.194)	(0.184)
log(Distance)$_{ei}$	-3.188***	-3.671***	-3.765***	-3.751***
	(0.126)	(0.202)	(0.239)	(0.232)
Common Colony$_{\_ei}$	0.871***	0.753*	0.662	0.619
	(0.241)	(0.354)	(0.391)	(0.392)
Island Economy$_{\_e}$	0.057	0.027	0.021	0.061
	(0.049)	(0.137)	(0.149)	(0.155)
Landlocked Economy$_{\_e}$	-1.420***	-1.179***	-1.037***	-1.051***
	(0.102)	(0.164)	(0.152)	(0.152)
Common Language$_{\_ei}$	0.586***	0.800***	0.705***	0.703***
	(0.052)	(0.095)	(0.109)	(0.108)
Common Border$_{\_ei}$	0.924***	0.361	0.063	0.038
	(0.105)	(0.189)	(0.249)	(0.250)
log(Population)$_e$	1.604***	2.375***	2.596***	2.778***
	(0.201)	(0.499)	(0.604)	(0.639)
log(Population)$_e$	0.900*	0.928**	0.752***	0.677**
	(0.396)	(0.313)	(0.221)	(0.209)
log(Real Exchange Rate)$_e$		1.171**	1.121*	0.632
		(0.451)	(0.519)	(0.608)
log(Tariff)$_{ie}$		0.0711	3.464***	3.283***
		(0.076)	(1.005)	(0.946)
log(Tariff)$_{ie}$ × CorruptionCPI$_{\_e}$			-0.340***	-0.342***
			(0.095)	(0.095)
log(Tariff)$_{ie}$ × CorruptionCPI$_{\_i}$			-0.292**	-0.260**
			(0.099)	(0.092)
Region Dummy	Yes	Yes	Yes	Yes
Income Dummy	Yes	Yes	Yes	Yes
Year Fixed Effect	No	No	No	Yes
Observations	30093	11390	11390	11390
Wald F Statistics	19.39	20.76	17.87	18.75

Heteroscedasticity robust standard errors in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Instrumented variables: CorruptionCPI$_{\_e}$, CorruptionCPI$_{\_i}$. The first column in each table includes standard gravity model variables along with CPI as the main explanatory variable. It also includes region and income dummies. Column 2, controls for the effect of population, real exchange rate, and tariff structure. Column 3 includes the interaction terms between tariff structure and the level of corruption in the exporting and importing countries respectively. Finally, the last column controls for time specific fixed effects. Constant not reported.

For trade and institutional reforms, these results have important policy implications. The presence of protectionist trade policies provides bureaucrats with the opportunity to extract bribes. It also increases the incentive for foreign firms to evade tariffs by offering bribes to the customs officials. In such situations, one option for the government is to liberalize international trade. Trade liberalization has the potential to alleviate corruption by removing opportunities for rent-seeking activities. Moreover, the government can adopt trade facilitation reforms to reduce the volume and impact of red tape and to enhance the transparency of the system. By applying modern techniques and technologies, trade facilitation measures help lessen the probability of direct interaction between the traders and the customs officials, thereby deterring corrupt activities. Unlike tariff elimination that results in the loss of tariff revenues, embracing trade facilitation measures are rewarding for all the trading partners. Similarly, an improvement of the governance structure, an increase in the quality of human capital, or increased freedom of press, among other actions that have the potential to dissuade corruption can be trade-enhancing.

Chapter 4. The Role of the Internet on Bilateral Agricultural Trade

4.1 Introduction

The Internet, a comparatively new mode of contact, has changed forever the way people communicate around the globe. The Internet plays a pivotal role in matching buyers and sellers and thereby reducing search costs. It acts as a new medium of advertising and helps in providing information to the potential buyers. It plays a significant role in exchanging information or ideas among agents. The Internet offers a platform for technological advancement and improves infrastructure, thereby reducing fixed costs. Lower fixed costs can help existing players as well as encourage new entrants in the markets (Freund and Weinhold, 2004). Another crucial impact of the Internet is its growing role in improving human capital by giving better and more diverse access to information. The Internet is also believed to play a significant role in enabling innovation and productivity. By reducing transaction costs, it enables businesses to better utilize existing resources. Therefore, the Internet helps integrate the global economy by allowing countries to acquire and share ideas, knowledge, expertise, services, and technologies (Unwin, 2009).

The past few years have experienced an unprecedented growth in the use of the Internet. While, in 1995, only 0.4% of the world population had access to the Internet, by the end of 2014 this figure reached 42.4%[1]. With the growing popularity of the Internet in the past few decades, exploring the impact of the Internet has become necessary from the perspective of the policymakers. Given the benefits of using the Internet as a medium of communication, it can be argued that the Internet has an enormous potential in facilitating trade. By lowering fixed costs, the Internet can facilitate trade for existing players as well as encourage new

---

[1]Visit: http://www.internetworldstats.com/emarketing.htm

traders in the markets. Also, by making communication faster and information more easily available, the Internet can influence the transit time between the origin and the destination. Though important, studies analyzing the impact of Internet access on bilateral trade are rare. The central idea of this paper is to fill this void in the trade literature by quantifying the probable effect of the Internet on bilateral trade, both in agricultural commodities and non-agricultural goods. Using an augmented gravity model, this paper combines different estimation techniques to empirically investigate the impact of Internet penetration on bilateral trade for a broad set of countries, spanning five years from 2006 to 2010.

Table 4.1 lists five countries with the highest Internet users and five countries with the lowest Internet users per 100 population in descending order, based on 2010 World Bank data. The table also lists the number of Internet users during 2003 and 1996 for those ten countries.

Table 4.1: Internet Users in the World

Rank	Country	World Bank Code	Internet Users 1996	Internet Users 2003	Internet Users 2010
	Countries with highest Internet adoption, 2010				
1.	Iceland	ISL	14.1	83.1	93.39
2.	Norway	NOR	18.25	78.13	93.39
3.	Netherlands	NLD	9.649	64.35	90.72
4.	Luembourg	LUX	5.552	54.55	90.62
5.	Sweden	SWE	9.004	79.13	90.00
	Countries with lowest Internet adoption, 2010				
5.	Guinea	GIN	0.002	0.451	1.000
4.	Niger	NER	0.001	0.156	0.830
3.	Ethiopia	ETH	0.002	0.106	0.750
2.	Congo, Dem. Rep.	COD	0.000	0.135	0.720
1.	Sierra Leone	SLE	0.003	0.190	0.580

Internet adoption is measured by the number of Internet users/100 population.
The data is collected from World Bank's World Development Indicators data-set.

4.2 Bilateral Trade and the Internet

The Internet has become a crucial platform for trade between buyers and sellers located in different parts of the world (Meltzer, 2013). Several studies have found a trade promoting role of the Internet. Most of the previous studies have analyzed the impact of Internet adoption on the total volume of trade without differentiating agricultural goods from manufactured commodities. Researchers also established the trade stimulating role of the Internet in the service sector. Studies by Freund and Weinhold (2002, 2004); Clarke and Wallsten, (2006); and Timmis (2012) suggest that the use of the Internet can stimulate trade. For example, Freund and Weinhold (2002) found that the Internet adoption by the trading partner abroad facilitates exports of services to the United States. Freund and Weinhold (2004) use a gravity model to examine the effect of the internet on trade among 56 countries. They found no evidence of Internet effect on total trade flows in 1995 and only weak evidence of an effect in 1996. However, they found an increasing and significant impact from 1997 to 1999. Their results suggest that the impact of the internet on trade is stronger for poor countries than for rich countries.

Clarke and Wallsten, (2006) found that access to the Internet improves export performance in developing countries, but not in developed countries. They also found that this direction of trade goes from developing countries with high Internet penetration to high-income developed countries, but not towards developing countries with a lower degree of Internet adoption.

Using a gravity model framework, Timmis (2012) examined the effect of internet adoption on trade for OECD countries for the period 1990-2010. The results suggest that the country pairs with relatively higher Internet adoption rates trade more with each other as compared to country pairs with lower adoption rates.

Fink et al. (2005) and Tang (2006) explored the role of communication costs in trade. They used different means of communication and found that adopting the Internet as a

medium of communication helps in reducing trade costs and therefore increases the volume of trade. In other words, they found a positive relationship between the Internet as a means of communication and the trade performance of a country. Fink et al. (2005) further found that, along with lowering the fixed cost, the internet tends to reduce the variable cost of trade and thereby augments the trade volume.

Rauch and Trindade (2003) also support the above-mentioned findings. They argue that the Internet makes substitution among buyers or among sellers easier by providing information quickly and promptly. They note that "Improved information allows home firms to rule out more potential foreign trade partners in advance of attempting to form a match" (Rauch and Trindade, 2003).

Compared to the existing literature analyzing the role of the Internet on manufactured goods and services, literature showing a link between agricultural trade and the Internet is rare. One exception is a study by Wheatly and Roe (2005) who examine the effect of the Internet on US bilateral trade for the years 1995 to 2003. Their work differentiates between agricultural and horticultural commodities and examines the impact of Internet penetration on trade. Their results suggest a negative relationship between the degree of Internet penetration and trade costs. They also found this relationship to be more significant for imports rather than exports.

This study also seeks to determine the effect of Internet penetration on agricultural exports. The study differs from Wheatly and Roe (2005) and supports the finding by Park (2005). Park (2005) estimated the effect of the Internet as a measure of telecommunication on bilateral trade in agricultural and non-agricultural goods among the OECD countries between 1997 to 2001. According to the findings of the study, improved telecommunication had a significant effect on trade in non-agricultural commodities than in agricultural goods.

Similarly, this study argues that the effect of the Internet as a medium of communication on agricultural exports is limited; Whereas, the Internet is more capable of enhancing trade in the non-agricultural sector. In this paper, the following is hypothesized:

Hypothesis 1: The Internet as a medium of communication, is a more efficient predictor of trade in non-agricultural exports than in agricultural commodities.

Agriculture is considered to be a more important component in the developing economies than in developed nations. Most of the developing countries are net exporters of agricultural commodities. Yet, the agricultural sector in developing countries is discouraged not only by agricultural protection policies in high-income countries but also by domestic policies favoring manufacturing and service sectors (Hertel et al., 2000). The agricultural sector tends to be neglected as an accelerator of growth because investment in the industry provides higher economic stimulus. The agricultural sector also suffers from a lack of infrastructure that can boost production and improve terms of trade. To come out of this trap, massive investment and a minimum threshold level of technological infrastructure is necessary so that the agricultural sector can integrate with non-agricultural industry and take advantage of available technologies. Until that threshold level is reached, the trade promoting role of the Internet will be restricted to developed sectors like manufacturing and services. However, once that threshold level is reached, the Internet as a medium of communication can boost agricultural exports by providing nations with the ability to gain competitive and comparative advantages.

This paper uses an augmented gravity model to examine whether Internet penetration, as measured by the number of Internet users per hundred population, can significantly affect bilateral trade. To analyze the commodity specific impact of the Internet on bilateral trade, the study is conducted separately on total agricultural and non-agricultural exports for the years 2006 to 2010. To analyze the data, multiple regressions are used and results are tested for robustness. To reduce omitted variable bias, a broad range of theoretically plausible determinants of trade are also included in the model. Furthermore, Hekman's two-step method and Heckman's selection model are used to correct for the sample-selection bias present in the trade data. Also, to deal with the endogeneity issue the instrumental variable approach is used. This paper contributes to the trade literature in two ways. Firstly,

according to a review of the literature, this is the first systematic cross-country empirical analysis that relates the Internet to agricultural exports. Secondly, the paper proposes a novel instrument to deal with the issue of endogeneity.

4.3 Empirical Strategy

In order to assess the relationship between internet penetration and international trade, this paper adopts the gravity model technique. The gravity model, pioneered by Tinbergen (1962), is an essential tool for measuring the size and impact of tariff and non-tariff barriers on bilateral trade. In its original form the gravity model is expressed by the following:

$$Y_{ei} = G\frac{(M_e M_i)}{D_{ei}} \tag{4.1}$$

A standard gravity model assumes that the volume of trade between two countries is positively related to the size of the economies and inversely related to the trade costs. Here, Y_{ij} measures the volume of trade between country e and i, M_e and M_i represents the size of economies. D is the geographical distance between the countries, capturing trade costs. G is the gravitational constant.

In the augmented gravity model adopted to analyze the relationship between Internet penetration and the volume of exports, GDP is included to capture the market size of the economy. Population is also included as a measure of country size. Geographical distance between the countries captures trade costs. To capture trade factors, a number of additional dummy variables, such as island economy, landlocked economy, common language, the common border, colonial heritage, income level or geographical region, are included in the model. For the gravity model, Internet penetration measured by number of Internet users per 100 population, is included as a main variable of interest. To reduce the omitted variable bias,

this model controls for other variables that can facilitate trade. Since bilateral trade involves two countries, the quality of extent of Internet penetration in both the countries can affect the volume of trade. Therefore, a variable measuring the number of internet users in the partner country is also included in the model. The augmented gravity model includes variables such as the bilateral tariff rate and the exchange rate, that have the potential to influence the volume of agricultural trade. The model also controls for the average trade-cost incurred by exporters and importers in each country.

The log-linearized augmented gravity model is given by the following equation:

$$
\begin{aligned}
\log(Export)_{eit} = {} & \alpha + \beta_1 \log(Internet)_{et} + \beta_2 \log(Internet)_{it} + \gamma_1 \log(GDP)_{et} \\
& + \gamma_2 \log(GDP)_{it} + \gamma_3 \log(Population)_{et} + \gamma_4 \log(Population)_{it} \\
& + \gamma_5 \log(Distance)_{ei} + \gamma_6 Landlocked_e + \gamma_7 Language_{ei} + \gamma_8 Colony_{ei} \\
& + \gamma_9 Border_{ei} + \gamma_{10} Island_e + \gamma_{11} Income_e + \gamma_{12} Region_e \\
& + \gamma_{13} \log(ExchangeRate)_{et} + \gamma_{14} \log(Tariff)_{iet} + \gamma_{15} \log(Export_C)_{eit} \\
& + \gamma_{16} \log(Import_C)_{iet} + \delta_{ei} + \epsilon_{eit}
\end{aligned}
\tag{4.2}
$$

Here, e and i represents the exporting and importing countries respectively, and t denotes time. $Export_{eit}$ denotes volume of agricultural export from country e to country i at time period t. $Internet_{et}$ and $Internet_{it}$ gives the number of Internet users per 100 population in country e and i, respectively, at period t. GDP_{et} and GDP_{it} are the real GDP of country e and i respectively at time period t. $Population_{et}$ and $Population_{it}$ denote population of country e and i, respectively, at time period t. $Distance_{ei}$ gives the distance between the capital cities of country e and i. $Land$ is a binary dummy variable that takes a value of unity if country e is landlocked. $Language_{ei}$ is a binary dummy variable which is unity if country e and country i have a common language and zero otherwise. $Colony_{ei}$ is a binary dummy which is unity if e and i had the same colonizer. $Border_{ei}$ is a binary dummy variable which is unity if e and i share a common border. $Island_e$ is a binary dummy taking a value of unity

if country e is an island economy. $Income_e$ represents the set of dummies representing the income group to which country e belongs. $Region_e$ represents the set of dummies representing the geographical region to which country e belongs. $Tariff_{iet}$ is a weighted average tariff applied by country i on country e's exports at period t. $ExchangeRate_{et}$ represents the real exchange rate of country e quoted in US dollars. $Export_C$ gives the trade-cost associated with exporting a commodity from country e to country i at period t. Similarly, $Import_C$ gives the trade-cost associated with importing a commodity from country e to country i at period t. δ_{ei} is a set of time fixed effects. ϵ_{eit} is the error term that is assumed to be normally distributed with mean zero.

The model is estimated using three-year panel data from 2006 to 2010. GDP is used as a proxy for the size of the economy. The larger the size of the economy, the higher will be the volume of agricultural trade between country pairs. Therefore, the coefficient of $log(GDP)$ is expected to be positive. The coefficient for the log value of distance, which is used as a proxy for trade cost is expected to be negative as higher distance increases the trade cost, thereby reducing the volume of trade between the countries. As transportation costs are higher for islands or landlocked economies compared to the countries sharing a common border, the volume of trade is expected to be higher in the last case than in the other two instances. It is also assumed that the volume of trade will be higher between the countries sharing similar cultural or colonial heritage. The same goes for the country pairs belonging to the same income group or the same geographical region. Again, the higher the population of the countries, the higher will be the demand for the commodities. As a result, the coefficient of $log(population)$ of the importing country is expected to have a positive sign. The same will be true for the coefficient of $log(population)$ of the exporting country. As complex tariff barriers discourage trade, the coefficient of the tariff parameter is expected to take a negative sign. The coefficient of the exchange rate is also expected to take a negative sign. A Higher value of this variable implies the value of the exporting country's currency appreciates in terms of the US dollar. With an appreciation of exporting country's currency, the price of

its exports increases, which decreases the volume of exports. Both the coefficients of export and import costs are expected to take a negative size as higher cost should inversely affect the volume of trade.

In this paper, initially the log-linearized augmented gravity model is analyzed using the benchmark Ordinary Least Square (OLS) method. Panel estimation methods like population averaged Feasible Generalized Least Square (Pooled FGLS), and Random Effect models are also used to study the relationship between the Internet and bilateral trade. Sample selection bias is corrected using Heckman's two-step model and Heckman's selection model. To alleviate potential endogeneity present in the data, instrumental variable analysis is conducted.

4.3.1 Sample-selection Bias

In trade data, missing trade values are common as zero trade flows may result from a country's decision not to trade with another economy. The missing trade value creates a problem when the log-linearized augmented gravity model is estimated using OLS. As the log of zero is undefined, zero trade flows will be automatically dropped from the equation, giving rise to sample-selection bias.[2]

To deal with the problem of sample-selection bias, this study follows Heckman's two-step procedure to reduce the bias (Heckman, 1979). In the first stage, a Probit Model (Selection equation) is estimated to determine the probability of a country engaging in trade. In the second stage, the expected values of the trade flow from the first stage, conditional on whether country pairs are trading (Outcome equation), are estimated using ordinary least squares. For identification of the second-stage trade-flow equation, an identification variable is required. For the validity of this identification variable two conditions must be satisfied:

---

[2]Alternative approaches to handle the presence of zero trade includes: i) Truncating the sample by discarding the observations with zero trade values; and ii) Adding a small constant to each observation on the dependent variable before taking logarithms. This method works properly if the zeros are randomly distributed. Otherwise, this method gives rise to sample selection bias.

i) This variable should hold the property that it influences a country's propensity to engage in trade; and ii) This variable should not have any direct effect on the volume of trade. Previous literature suggests that variables like common religion, common border, common language, etc., satisfy this condition (Helpman et al., 2006).

Another way to deal with the sample-selection bias is to use Heckman's selection model where the selection and the outcome equations are estimated simultaneously using Maximum Likelihood Estimation. Heckman's selection model depends strongly on the model being correctly specified. Heckman's selection model can produce biased estimates if the model is not properly specified or if a specific data-set violates the model's assumptions. When the underlying goal is to predict an actual response, Hekman's two-step model is preferred. If the goal is to predict the value of the dependent variable that would be observed in the absence of selection, however, Heckman's selection model is more appropriate.

4.3.2   Endogeneity

The cross-country correlation suggests a possible causal relationship between the internet penetration and the volume of export. Access to the Internet and the volume of export might be determined simultaneously. Several recent studies have suggested that trade stimulates internet use. Economists suggest that countries with greater contact with the outside world, either via trade, tourism or because of geographical location, are more likely to be developed with respect to digital technology than other countries (Onyeiwu, 2002). Internet access might also influence export behavior. If access to the Internet makes it economical for buyers and sellers to come together then, everything else being constant, exports could be higher in countries with greater internet penetration. The internet penetration can also be endogenous because of the possibility of omitted variable bias. It is well known that, in the presence of endogeneity, OLS estimation will give biased estimates as the orthogonality assumption of OLS will be violated.

71

To reduce potential endogeneity, the study adopts instrumental variable (IV) regression. A newly constructed variable on historical, technological adoption from the Cross-country Historical Adoption of Technology or CHAT data-set (Comin and Hobijn; 2009) is used as an instrument for technology adoption today (Internet penetration). Comin et al. (2010) compute indices for technology adoption prior to the era of colonization and extensive European contacts. They compute indices for technology adoption in 1000 BC, 0 AD, and 1500 AD and found that there is a positive and significant correlation between the technology adoption indices in 1500 AD and technology adoption today. This relationship was found to be robust at the sector level even after controlling for geographical and institutional factors. Also, there was a considerable degree of cross-country variation in technology adoption in 1500 AD. They note 1500 AD data to be more precise as there were a large number of sources documenting the technology adoption patterns during that period. This measure of historical, technological adoption was computed in five different sectors, namely agriculture, transportation, military, industry and communication. In our model, we include technology adoption in communication in 1500 AD as an instrument for the modern day mode of communication (Internet penetration). To satisfy the condition for a valid instrument, communication adoption in 1500AD should be correlated with the potential endogenous variable internet penetration, but should not affect the volume of agricultural and non-agricultural exports directly.

In this paper, conventional Two-stage Least Square (2SLS) and Generalized Methods of Moment (GMM) techniques are used for IV analysis.

4.4   Data

Bilateral trade flow data for agricultural and non-agricultural commodities are collected from the Commodity and Trade Database (COMTRADE) of the United Nations Statistics Division for 2003 to 2005. Agricultural goods (Food and live animals) are defined as commodities

in Category 0 at the one-digit level of the Standard International Trade Classification (SITC Revision 1). Non-agricultural goods (Machinery and transport equipment) are defined as commodities in Category 7 at the one-digit level of the Standard International Trade Classification (SITC Revision 1). Table 4.2 and 4.3 summarizes the relevant variables used in this paper.

Table 4.2: The Internet & Agricultural Exports: Summary Statistics

Variable	Mean	Std. Dev.	Obs.
$\log(\text{Export})_{ei}$	13.98	3.138	61595
$\log(\text{Internet})_e$	3.198	1.171	62726
$\log(\text{Internet})_i$	2.913	1.384	61729
$\log(\text{GDP})_e$	25.55	2.072	61752
$\log(\text{GDP})_i$	24.82	2.345	60667
$\log(\text{Distance})_{ei}$	3.691	0.392	56777
$\log(\text{Population})_e$	16.62	1.747	62292
$\log(\text{Population})_i$	16.07	1.964	61890
$\log(\text{Real Exchange Rate})_e$	4.589	0.076	39172
$\log(\text{Tariff})_{ie}$	2.097	1.294	29365
$\log(\text{Export Cost})_{ei}$	6.880	0.424	61563
$\log(\text{Import Cost})_{ie}$	7.088	0.51	58680
1500 Technology Adoption Index$_{\_e}$	0.534	0.414	47552
1500 Technology Adoption Index$_{\_i}$	0.502	0.407	41667

Summary statistics are presented together for the years 2006 to 2010.

Data for the main variable of interest comes from the World Development Indicators database available on the World Bank website. This variable determines the number of internet users per 1000 people and is used as a proxy for Internet penetration. Gross Domestic Product (GDP) is used as a measure of country size. The data for real GDP (in constant US dollars) has been taken from the World Development Indicators published by the World Bank. Population data also comes from the World Bank data-set.

73

A weighted average of applied tariff rates weighted by the values of bilateral agricultural trade is used in this paper. The tariff data were derived from the Trade Analysis and Information System (TRAINS) of the United Nations Conference on Trade and Development (UNCTAD). Real exchange rate data expressed in local currency units relative to the US dollar, comes from the World Bank. The data on 'cost to export' and 'cost to import' comes from the "Doing Business" database constructed by the World Bank. Gravity model variables such as distance, common language, common border, colonial pasts, etc that captures the variation in trade costs between country pairs are collected from the UNCTAD database.

Table 4.3: The Internet & Non-agricultural Exports: Summary Statistics

Variable	Mean	Std. Dev.	Obs.
$\log(\text{Export})_{ei}$	13.93	3.801	71824
$\log(\text{Internet})_e$	3.302	1.151	72878
$\log(\text{Internet})_i$	2.804	1.431	70743
$\log(\text{GDP})_e$	25.58	2.022	71851
$\log(\text{GDP})_i$	24.64	2.373	70089
$\log(\text{Distance})_{ei}$	3.700	0.380	64945
$\log(\text{Population})_e$	16.47	1.778	72381
$\log(\text{Population})_i$	16.01	1.999	71600
$\log(\text{Tariff})_{ie}$	1.308	1.277	49715
$\log(\text{Real Exchange Rate})_e$	4.590	0.077	46468
$\log(\text{Export Cost})_{ei}$	6.889	0.428	71047
$\log(\text{Import Cost})_{ie}$	7.121	0.530	67752
1500 Technology Adoption Index $_e$	0.578	0.413	52133
1500 Technology Adoption Index $_i$	0.471	0.403	48458

Summary statistics are presented together for the years 2006 to 2010.

The data source for the instrument is Comin et al. (2010). As previously mentioned, a number of historical information sources are used to compute an index of cross-country technology adoption in 1000 BC, 0 AD, and 1500 AD. Technology adoption in 1500 AD was found to be an accurate predictor of technology adoption today. This measure of historical

technological adoption was computed in five different sectors, namely agriculture, transportation, military, industry, and communication. In this paper, the technology adoption in communication is used as an instrument for Internet penetration. The communication index is constructed using four variables: the use of movable block printing, the use of woodblock printing, the use of books, and the use of paper and takes a value between 0 and 1. A value closer to zero implies a lower degree of technology adoption in 1500 AD and a value closer to one suggests that the degree of technology adoption was high during 1500 AD for a particular country.

4.5 Results

This section presents the estimation results of the empirical model given by equation 4.1. The regressions are based on an unbalanced panel data set for a broad set of countries during the period 2006 to 2010. While estimating, the 1% tails of log value of agricultural and non-agricultural exports across countries were trimmed. That is, all countries were pooled and the top and bottom 1% of log value of bilateral exports in each of the pools were trimmed. Column 1 and 2 in each table presents the results for agricultural commodities. The last two columns provides the results for non-agricultural products. Each column includes standard gravity model variables along with internet penetration as main explanatory variable. The model also controls for a number of variables to minimize the omitted variable bias. Region and income dummies are included in the model to rule out the possibility that these results are driven by the omission of region and income fixed factors. Also time specific fixed effects were added to the model to account for all sources of unobserved heterogeneity that are constant for a given year across all countries. To deal with this issue of heteroscedasticity, robust clustered standard errors are used. Standard errors are clustered by distance, which is unique to each country pair but is identical for both trading partners.

4.5.1 Conventional Panel Data Techniques

As a benchmark, initially the gravity model is estimated using the Ordinary Least Square (OLS) Method. Consistency of OLS requires that the error term to be uncorrelated with the explanatory variables. Therefore, Pooled Ordinary Least Square (POLS) is consistent in the Random Effect (RE) model but is inconsistent in the Fixed Effect (FE) model. In this paper, due to the presence of time-invariant factors, the RE model is more appropriate than the FE model. Thus, the estimates from the POLS model are assumed to be consistent in this study.

The results from POLS model are presented in Table 4.4. From the first two columns of Table 4.4, we can see that there is no effect of the Internet on agricultural exports. However for non-agricultural exports, the coefficient of Internet penetration in the exporting country is highly significant and takes the expected positive sign. The results suggest that a higher degree of Internet penetration in the the exporting country will increase the volume of non-agricultural exports. For example, in column 4, the coefficient of Internet penetration in the exporting country suggests that a 1% improvement in e-governance measures in the exporting country will increase the volume of non-agricultural exports by almost 0.39%. However, in all the specifications, the coefficient of the Internet penetration in the importing country remains insignificant with a negative sign for both agricultural and non-agricultural goods. The standard gravity model variables also take the expected sign, and the results are statistically significant in almost all the cases.

The results from The Pooled Feasible Generalized Least Square (PFGLS) model are presented in Table 4.5. PFGLS estimation leads to estimators of the parameters of the pooled model that are more efficient than POLS estimation in the presence of heteroscedasticity and auto-correlation. The model works well for an infinite sample. Under the assumption that any individual-level unobserved effects are uncorrelated with regressors, PFGLS is consistent. Here, the estimates from the PFGLS model are similar to the estimates from POLS model.

Table 4.4: The Internet & Bilateral Exports: Pooled OLS

Dependent variable: log(Export)$_{ei}$	(A1)	(A2)	(N1)	(N2)
log(Internet)$_e$	0.142	0.189	0.325***	0.392***
	(0.096)	(0.107)	(0.077)	(0.08)
log(Internet)$_i$	-0.054	-0.039	-0.061	-0.034
	(0.046)	(0.048)	(0.033)	(0.035)
log(GDP)$_e$	0.663***	0.646***	1.622***	1.599***
	(0.070)	(0.075)	(0.051)	(0.055)
log(GDP)$_i$	0.665***	0.659***	0.839***	0.827***
	(0.044)	(0.045)	(0.031)	(0.032)
log(Distance)$_{ei}$	-2.759***	-2.767***	-2.937***	-2.938***
	(0.115)	(0.115)	(0.101)	(0.101)
Common Colony$_{\_ei}$	0.446	0.450	0.278	0.264
	(0.525)	(0.528)	(0.277)	(0.277)
Island Economy$_{\_e}$	-0.549***	-0.561***	-0.817***	-0.836***
	(0.108)	(0.109)	(0.079)	(0.079)
Landlocked Economy$_{\_e}$	-0.865***	-0.867***	0.731***	0.727***
	(0.118)	(0.119)	(0.080)	(0.081)
Common Language$_{\_ei}$	1.008***	1.011***	1.308***	1.310***
	(0.109)	(0.109)	(0.097)	(0.097)
Common Border$_{\_ei}$	0.951***	0.951***	1.379***	1.386***
	(0.243)	(0.243)	(0.260)	(0.260)
log(Population)$_e$	-0.151*	-0.134	-0.294***	-0.273***
	(0.076)	(0.079)	(0.053)	(0.056)
log(Population)$_i$	-0.013	-0.006	0.033	0.046
	(0.045)	(0.046)	(0.031)	(0.032)
log(Real Exchange Rate)$_e$	1.766***	1.939***	0.355	0.635*
	(0.374)	(0.381)	(0.268)	(0.272)
log(Tariff)$_{ie}$	-0.107***	-0.108***	0.001	0.003
	(0.027)	(0.027)	(0.022)	(0.022)
log(Export Cost)$_{ei}$	0.382**	0.405**	-1.487***	-1.447***
	(0.120)	(0.127)	(0.084)	(0.089)
log(Import Cost)$_{ie}$	-0.580***	-0.565***	-0.441***	-0.415***
	(0.066)	(0.068)	(0.048)	(0.049)
Region Dummy	Yes	Yes	Yes	Yes
Income Dummy	Yes	Yes	Yes	Yes
Year Fixed Effect	No	Yes	No	Yes
Observations	13628	13628	21155	21155
Adjusted R^2	0.407	0.408	0.685	0.687

Heteroscedasticity robust standard errors in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Column 1 & 2 presents the results for agricultural commodities. Column 3 & 4 provides the results for non-agricultural products. Each column includes standard gravity model variables along with internet penetration as main explanatory variable. Constant not reported.

Table 4.5: The Internet & Bilateral Exports: Pooled FGLS

Dependent variable: log(Export)$_{ei}$	(A1)	(A2)	(N1)	(N2)
log(Internet)$_e$	0.139*	0.108	0.165**	0.253***
	(0.066)	(0.074)	(0.058)	(0.063)
log(Internet)$_i$	-0.070	-0.092*	-0.037	0.024
	(0.039)	(0.043)	(0.030)	(0.033)
log(GDP)$_e$	0.621***	0.592***	1.483***	1.515***
	(0.063)	(0.067)	(0.046)	(0.049)
log(GDP)$_i$	0.713***	0.705***	0.785***	0.781***
	(0.042)	(0.043)	(0.031)	(0.032)
log(Distance)$_{ei}$	-2.675***	-2.652***	-2.689***	-2.719***
	(0.133)	(0.134)	(0.104)	(0.105)
Common Colony $_{ei}$	0.517	0.540	0.178	0.121
	(0.441)	(0.436)	(0.278)	(0.277)
Island Economy $_e$	-0.283*	-0.287*	-1.021***	-1.027***
	(0.130)	(0.130)	(0.091)	(0.092)
Landlocked Economy $_e$	-0.774***	-0.810***	0.268**	0.308***
	(0.136)	(0.137)	(0.090)	(0.092)
Common Language $_{ei}$	1.032***	1.016***	1.166***	1.210***
	(0.127)	(0.127)	(0.108)	(0.109)
Common Border $_{ei}$	0.704**	0.680**	1.320***	1.373***
	(0.251)	(0.250)	(0.271)	(0.275)
log(Population)$_e$	-0.104	-0.085	-0.212***	-0.226***
	(0.067)	(0.071)	(0.047)	(0.049)
log(Population)$_i$	-0.062	-0.058	0.087**	0.099**
	(0.045)	(0.046)	(0.032)	(0.032)
log(Real Exchange Rate)$_e$	-0.161	-0.239	-1.295***	-1.141***
	(0.206)	(0.206)	(0.171)	(0.174)
log(Tariff)$_{ie}$	-0.113***	-0.114***	-0.035*	-0.034*
	(0.025)	(0.025)	(0.017)	(0.017)
log(Export Cost)$_{ei}$	0.212*	0.260*	-0.617***	-0.658***
	(0.091)	(0.101)	(0.085)	(0.099)
log(Import Cost)$_{ie}$	-0.220***	-0.232***	-0.410***	-0.367***
	(0.057)	(0.060)	(0.045)	(0.046)
Region Dummy	Yes	Yes	Yes	Yes
Income Dummy	Yes	Yes	Yes	Yes
Year Fixed Effect	No	Yes	No	Yes
Observations	8931	8931	16520	16520

Heteroscedasticity robust standard errors in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Column 1 & 2 presents the results for agricultural commodities. Column 3 & 4 provides the results for non-agricultural products. Each column includes standard gravity model variables along with internet penetration as main explanatory variable. Constant not reported.

The result presented in column 4 suggests that a 1% increase in internet penetration in the exporting country will increase the volume of non-agricultural exports by almost 0.39%. For agricultural commodities the impact of internet penetration becomes insignificant after controlling for year fixed effects. Also, the impact of importing country's Internet adoption remains insignificant for both the commodity groups. The standard gravity model variables also take the expected sign, and the results are statistically significant in almost all the cases.

4.5.2 Heckman Model Estimates

This section presents the results after correcting for sample selection bias using Heckms's procedures. Results from the first-step Heckman procedure is included in the appendix. The result shows the identification variable, the probability that two randomly drawn people from a country pair speak in the same language, to be an important determining factor for the country pairs to engage in trade. Econometrically, this provides the necessary exclusion restriction for identification of the second stage trade flow equation. Therefore the variable "Common Language" is used as an exclusion variable in the construction of the Inverse Mills Ratio for the second stage Heckman procedure.

Table 4.6 shows the second-stage results from Heckman's Two-step model. The model shows a negative relationship between Internet penetration and the volume of exports. The findings are similar for both agricultural and non-agricultural commodities.

Table 4.7 presents the results from Heckman's selection model. The results from this model suggest that, once the sample-selection bias is corrected, a higher degree of internet penetration in the exporting country will increase the volume of exports. The results are highly significant for both commodity groups. The results further suggest that the degree of internet penetration in the importing country will also positively influence agricultural and non-agricultural exports.

Table 4.6: The Internet & Bilateral Exports: Heckman's Two-step Model.
Second-step Estimates

Dependent variable: log(Export)$_{ei}$	(A1)	(A2)	(N1)	(N2)
log(Internet)$_e$	-0.444*	-0.603**	-0.108	-0.017
	(0.183)	(0.208)	(0.121)	(0.129)
log(Internet)$_i$	-0.149	-0.211	-0.227**	-0.189*
	(0.147)	(0.156)	(0.073)	(0.076)
log(GDP)$_e$	1.396***	1.499***	1.617***	1.573***
	(0.172)	(0.180)	(0.089)	(0.092)
log(GDP)$_i$	0.794***	0.837***	1.017***	0.996***
	(0.126)	(0.130)	(0.063)	(0.064)
log(Distance)$_{ei}$	-2.579***	-2.572***	-3.185***	-3.215***
	(0.399)	(0.402)	(0.179)	(0.179)
Common Colony$_{\_ei}$	2.564***	2.517***	34.76***	34.67***
	(0.424)	(0.423)	(9.003)	(8.997)
Island Economy$_{\_e}$	-1.021**	-1.023**	6.720***	6.703***
	(0.339)	(0.343)	(1.825)	(1.823)
Landlocked Economy$_{\_e}$	0.821	0.920*	1.758*	1.713*
	(0.422)	(0.424)	(0.710)	(0.711)
Common Border$_{\_ei}$	1.353**	1.349**	30.67***	30.58***
	(0.416)	(0.414)	(7.558)	(7.552)
log(Population)$_e$	-1.066***	-1.160***	-0.441***	-0.404***
	(0.188)	(0.195)	(0.097)	(0.099)
log(Population)$_i$	-0.113	-0.160	-0.181**	-0.161*
	(0.131)	(0.135)	(0.065)	(0.066)
log(Real Exchange Rate)$_e$	2.404**	2.186**	-0.377	-0.190
	(0.788)	(0.804)	(0.602)	(0.599)
log(Tariff)$_{ie}$	0.129	0.138	0.187***	0.190***
	(0.075)	(0.075)	(0.042)	(0.042)
log(Export Cost)$_{ei}$	-0.788**	-0.934**	-0.372*	-0.286
	(0.305)	(0.317)	(0.167)	(0.172)
log(Import Cost)$_{ie}$	-0.557**	-0.622**	-0.287**	-0.258**
	(0.200)	(0.205)	(0.096)	(0.096)
Inverse Mills Ratio			36.99***	36.90***
			-9.627	-9.619
Region Dummy	Yes	Yes	Yes	Yes
Income Dummy	Yes	Yes	Yes	Yes
Year Fixed Effect	No	Yes	No	Yes
Observations	1807	1807	2573	2573
Adjusted R^2	0.433	0.435	0.652	0.653

Heteroscedasticity robust standard errors in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Column 1 & 2 presents the results for agricultural commodities. Column 3 & 4 provides the results for non-agricultural products. Each column includes standard gravity model variables along with internet penetration as main explanatory variable. Constant not reported.

Table 4.7: The Internet & Bilateral Exports: Heckman's Selection Model

Dependent variable: log(Export)$_{ei}$	(A1)	(A2)	(N1)	(N2)
log(Internet)$_e$	0.338***	0.338***	1.453***	1.453***
	(0.045)	(0.045)	(0.039)	(0.039)
log(Internet)$_i$	0.495***	0.495***	0.419***	0.419***
	(0.031)	(0.031)	(0.030)	(0.030)
log(GDP)$_e$	-0.306***	-0.315***	-0.578***	-0.548***
	(0.086)	(0.093)	(0.079)	(0.083)
log(GDP)$_i$	-0.394***	-0.400***	-0.317***	-0.297***
	(0.064)	(0.064)	(0.042)	(0.043)
log(Distance)$_{ei}$	0.756***	0.761***	0.681***	0.687***
	(0.178)	(0.177)	(0.105)	(0.104)
Common Colony $_{ei}$	-0.041	-0.040	0.150	0.191
	(0.290)	(0.292)	(0.242)	(0.267)
Island Economy $_e$	-0.022	-0.023	-0.183*	-0.167*
	(0.126)	(0.126)	(0.083)	(0.084)
Landlocked Economy $_e$	-0.164	-0.171	-0.793***	-0.787***
	(0.149)	(0.151)	(0.112)	(0.112)
Common Language $_{ei}$	-0.455**	-0.458**	-0.080	-0.071
	(0.146)	(0.147)	(0.150)	(0.157)
Common Border $_{ei}$	-0.479*	-0.479*	-0.292	-0.293
	(0.221)	(0.220)	(0.168)	(0.164)
log(Population)$_e$	-0.040	-0.033	0.092	0.059
	(0.074)	(0.081)	(0.076)	(0.081)
log(Population)$_i$	0.053	0.059	-0.050	-0.071
	(0.063)	(0.064)	(0.043)	(0.044)
log(Real Exchange Rate)$_e$	-0.997*	-1.012*	-1.065***	-1.128***
	(0.405)	(0.404)	(0.305)	(0.276)
log(Tariff)$_{ie}$	0.014	0.014	0.012	0.010
	(0.037)	(0.037)	(0.023)	(0.023)
log(Export Cost)$_{ei}$	-0.001	0.013	0.729***	0.686***
	(0.119)	(0.127)	(0.102)	(0.103)
log(Import Cost)$_{ie}$	-0.068	-0.064	0.207***	0.179**
	(0.088)	(0.093)	(0.063)	(0.065)
Region Dummy	Yes	Yes	Yes	Yes
Income Dummy	Yes	Yes	Yes	Yes
Year Fixed Effect	No	Yes	No	Yes
Rho	0.718	0.719	0.893	0.898
Inverse Mills Ratio	2.002	2.006	2.884	2.903
Observations	14285	14285	22095	22095

Heteroscedasticity robust standard errors in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Column 1 & 2 presents the results for agricultural commodities. Column 3 & 4 provides the results for non-agricultural products. Each column includes standard gravity model variables along with internet penetration as main explanatory variable. Constant not reported.

For example, from column 2, we can see that a 1% increase in the degree of Internet penetration in the exporting country will increase the volume of agricultural exports by almost 0.33%. At the same time, a 1% increase in the degree of Internet penetration in the importing country will increase the volume of agricultural exports by almost 0.5%. For non-agricultural exports, a 1% increase in the degree of Internet penetration in the exporting country will increase the volume of exports by almost 1.4%. Similarly, a 1% increase in the degree of Internet penetration in the importing country will increase the volume of non-agricultural exports by almost 0.5%. Therefore, the results suggest that a higher degree of internet adoption will be more effective for non-agricultural exports than agricultural goods.

4.5.3   IV Estimates

Table 4.8 reports the results from 2SLS analysis using the 1500 communication technology as an instrument for technology adoption (Internet penetration) today. For agricultural commodities, after controlling for year fixed effects, the coefficient for internet penetration in the exporting country appears with the expected positive sign. The result is also highly significant. The coefficient of internet penetration in the importing country still remains insignificant and takes a negative sign. However, the F-statistic presented at the bottom of Table 4.9 suggests the instrument to be weak. For non-agricultural commodities, the coefficient for internet penetration in the exporting country becomes insignificant after controlling for year fixed effects. However, the coefficient of internet penetration in the importing country becomes highly significant and takes a positive sign. Furthermore, the F-statistic presented in column 4, suggests that the instrument is strong (F-statistics = 10.418 > 10) i.e. communication technology in 1500 AD is a significant predictor of technology adoption (Internet penetration) today. Table 4.9 reports the results from GMM analysis. The point estimates obtained from using GMM are very similar to the 2SLS estimates.

Table 4.8: The Internet & Bilateral Exports: IV Analysis (2SLS)

Dependent variable: log(Export)$_{ei}$	(A1)	(A2)	(N1)	(N2)
log(Internet)$_e$	22.77	16.98***	8.829*	-1.448
	(12.67)	(4.085)	(4.075)	(2.455)
log(Internet)$_i$	-7.405	-2.792	12.18***	15.10***
	(4.557)	(6.577)	(2.628)	(3.413)
log(GDP)$_e$	-12.62	-9.148***	-3.571	2.561
	(7.493)	(2.398)	(2.411)	(1.424)
log(GDP)$_i$	6.419	2.982	-8.633***	-10.68***
	(3.620)	(5.059)	(2.037)	(2.597)
log(Distance)$_{ei}$	-3.760***	-3.581***	-3.257***	-2.523***
	(0.947)	(0.507)	(0.384)	(0.342)
Common Colony$_{\_ei}$	0.548	0.758	3.163***	2.689***
	(2.449)	(2.133)	(0.842)	(0.640)
Island Economy$_{\_e}$	0.385	-0.423	0.891	-1.125***
	(1.349)	(0.415)	(0.599)	(0.317)
Landlocked Economy$_{\_e}$	-4.222*	-3.816***	-0.573	0.987
	(1.962)	(0.949)	(0.894)	(0.726)
Common Language$_{\_ei}$	1.825	1.252	-1.030	-1.242
	(1.020)	(1.128)	(0.626)	(0.696)
Common Border$_{\_ei}$	1.148	1.043	1.234*	1.045*
	(1.155)	(0.846)	(0.560)	(0.509)
log(Population)$_e$	12.96	9.474***	4.715*	-1.279
	(7.451)	(2.344)	(2.317)	(1.360)
log(Population)$_i$	-5.266	-2.092	8.538***	10.39***
	(3.309)	(4.647)	(1.828)	(2.335)
log(Real Exchange Rate)$_e$	-3.18	1.322	-7.804**	4.307**
	(5.992)	(1.364)	(2.776)	(1.312)
log(Tariff)$_{ie}$	0.324	0.041	0.071	-0.148
	(0.278)	(0.368)	(0.078)	(0.083)
log(Export Cost)$_{ei}$	5.822*	5.561***	-1.422	-1.309
	(2.477)	(1.467)	(0.806)	(0.890)
log(Import Cost)$_{ie}$	-4.430**	-1.770	4.127***	6.550***
	(1.676)	(2.920)	(1.004)	(1.580)
Region Dummy	Yes	Yes	Yes	Yes
Income Dummy	Yes	Yes	Yes	Yes
Year Fixed Effect	No	Yes	No	Yes
Observations	9074	9074	13765	13765
Wald F-statistics	6.466	3.261	9.411	10.418

Heteroscedasticity robust standard errors in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Column 1 & 2 presents the results for agricultural commodities. Column 3 & 4 provides the results for non-agricultural products. Each column includes standard gravity model variables along with internet penetration as main explanatory variable. Constant not reported.

Table 4.9: The Internet & Bilateral Exports: IV Analysis (GMM)

Dependent variable: log(Export)$_{ei}$	(A1)	(A2)	(N1)	(N2)
log(Internet)$_e$	22.77	16.98***	8.829*	-1.448
	(12.67)	(4.085)	(4.075)	(2.455)
log(Internet)$_i$	-7.405	-2.792	12.18***	15.10***
	(4.557)	(6.577)	(2.628)	(3.413)
log(GDP)$_e$	-12.62	-9.148***	-3.571	2.561
	(7.493)	(2.398)	(2.411)	(1.424)
log(GDP)$_i$	6.419	2.982	-8.633***	-10.68***
	(3.620)	(5.059)	(2.037)	(2.597)
log(Distance)$_{ei}$	-3.760***	-3.581***	-3.257***	-2.523***
	(0.947)	(0.507)	(0.384)	(0.342)
Common Colony_$_{ei}$	0.548	0.758	3.163***	2.689***
	(2.449)	(2.133)	(0.842)	(0.640)
Island Economy_$_e$	0.385	-0.423	0.891	-1.125***
	(1.349)	(0.415)	(0.599)	(0.317)
Landlocked Economy_$_e$	-4.222*	-3.816***	-0.573	0.987
	(1.962)	(0.949)	(0.894)	(0.726)
Common Language_$_{ei}$	1.825	1.252	-1.030	-1.242
	(1.020)	(1.128)	(0.626)	(0.696)
Common Border_$_{ei}$	1.148	1.043	1.234*	1.045*
	(1.155)	(0.846)	(0.560)	(0.509)
log(Population)$_e$	12.96	9.474***	4.715*	-1.279
	(7.451)	(2.344)	(2.317)	(1.360)
log(Population)$_i$	-5.266	-2.092	8.538***	10.39***
	(3.309)	(4.647)	(1.828)	(2.335)
log(Real Exchange Rate)$_e$	-3.18	1.322	-7.804**	4.307**
	(5.992)	(1.364)	(2.776)	(1.312)
log(Tariff)$_{ie}$	0.324	0.0412	0.0711	-0.148
	(0.278)	(0.368)	(0.078)	(0.083)
log(Export Cost)$_{ei}$	5.822*	5.561***	-1.422	-1.309
	(2.477)	(1.467)	(0.806)	(0.890)
log(Import Cost)$_{ie}$	-4.430**	-1.770	4.127***	6.550***
	(1.676)	(2.920)	(1.004)	(1.580)
Region Dummy	Yes	Yes	Yes	Yes
Income Dummy	Yes	Yes	Yes	Yes
Year Fixed Effect	No	Yes	No	Yes
Observations	9074	9074	13765	13765
Wald F-statistics	6.466	3.261	9.411	10.418

Heteroscedasticity robust standard errors in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Column 1 & 2 presents the results for agricultural commodities. Column 3 & 4 provides the results for non-agricultural products. Each column includes standard gravity model variables along with internet penetration as main explanatory variable. Constant not reported.

4.6   Conclusion

The purpose of this paper was to quantify the potential effect of Internet adoption on export performance. In this study, an augmented gravity model was used and different estimation techniques were combined to empirically investigate the effects of the Internet on the volume of trade. Separate analyses were done on trade related to agricultural commodities and non-agricultural goods. The sample-selection bias present in the trade data was corrected using Heckman's procedures. Instrumental Variable analysis was also done to reduce endogeneity. According to the findings of the study, the trade promoting role of the Internet was more prominent for non-agricultural commodities. The study found weak evidence of a trade-stimulating effect of the Internet on agricultural exports. If we compare these results with the findings from Chapter 2, we can conclude that the effect of the Internet as a medium of communication is very limited. However, if the Internet is used as a platform to improve e-governance, it shows more potential in improving the terms of trade.

For trade and institutional reforms, this study gives quite important results. The Internet helps integrate the global economy by allowing the cross-border flow of ideas, knowledge, expertise, and innovations. It provides a relatively cost-effective method for communications for buyers and sellers residing in different parts of the world. However, according to the findings of this study, if the Internet is only used as a medium of communication, the trade benefits from Internet access is relatively modest both for agricultural and non-agricultural commodities. This is true because the reduction in communication cost is a comparatively smaller portion of the total trade cost, especially for agricultural trade. At the same time, most of the developing countries suffer from a lack of infrastructure that can boost production and improve terms of trade. The situation is even more serious in the agricultural sector than the manufacturing and service sectors. Regarding access to Internet infrastructure such as servers, networks, and computers there is also a huge disparity between developed and developing nations. Moreover, in developing nations a larger proportion of the population

lacks the skills necessary to use the Internet. To eliminate this alleged "digital divide" massive investment in physical and human capital should be central to the economic growth policies of the government. Furthermore, if used as a platform to reach global markets and to overcome some of the domestic impediments related to poor infrastructure and inefficient customs procedures, the Internet has the potential to produce substantial gains from trade. Therefore, building Internet infrastructure and adopting information and communication technology (ICT) for trimming down unnecessary trade impediments, should also be the priority for the policymakers.

One limitation of this study was the lack of cross-country data on one of the most important determinants of Internet penetration: the "cost of using the Internet". Better availability of this type of data would improve future analyses on this topic.

Chapter 5. Summary and Conclusion

Trade facilitation is defined as a measure that makes trade across the border easier. It is a tool that simplifies customs procedures, eliminates administrative delays, increases transparency, and improves security by incorporating new technologies in trade (Zaki, 2015). This *"journal-article style"* dissertation evaluates the effect of different aspects of trade facilitation that can considerably influence the transit time between the origin and the destination. In doing so, this study adopts the gravity model technique that has been an elemental tool for determining the size and impact of tariff and non-tariff barriers to trade. Three topics related to trade facilitation are addressed here in this dissertation.

In the second chapter of this dissertation, the relationship between e-governance and agricultural exports are examined. This is the first cross-country study in trade literature that examines the effect of e-governance on bilateral agricultural trade. The paper also proposes a novel instrument to deal with the issue of endogeneity. The results suggest that the quality of e-governance has a positive and significant impact on the volume of agricultural exports. The effect is much more significant for the quality of e-governance in the exporting country than in the importing country. The results are robust to a variety of estimation techniques.

The third chapter quantifies the effect of corruption on bilateral agricultural exports. This is the first cross-country study that establishes a relationship between agricultural commodities and the level of corruption prevailing in a country. The study found a trade-taxing extortion effect of corruption which suggests that the higher level of corruption will reduce the volume of agricultural exports. The study found evidence of a trade enhancing evasion effect. A trade-enhancing evasion effect suggests that corruption can boost trade when the amount of the tariff rises above a certain threshold level. The effects were much more prominent for the degree of corruption in the exporting country than for the importing

country. The empirical estimates are robust to different model specification and the use of various corruption indices.

The fourth chapter of the dissertation examines the role of the Internet on international trade. In this paper, separate analyses were conducted to assess the impact of Internet penetration on non-agricultural commodities. The paper also proposed a novel instrument to correct for the problem of endogeneity. The study found weak evidence of a trade-stimulating effect of the Internet on agricultural exports. However, the results were comparatively more significant for non-agricultural commodities.

Overall this dissertation lends support to the existing literature that suggests trade facilitation can simplify and harmonize trade procedures and help in reducing the transaction costs associated with the enforcement, regulation and administration of trade policies. The main findings of this dissertation show that e-governance and corruption can significantly affect the volume of exports. However, the study found the direct effect of the Internet as a medium of communication to be limited. From a policy point of view, these findings are quite important. Firstly, unlike tariff reductions that result in the loss of tariff revenues, eliminating non-tariff barriers are rewarding to both trading partners. Secondly, embracing new technologies, such as the Internet and Information & Communication Technology (ICT), to provide e-services to the citizen can enhance trade. These technologies help in improving the quality of service by reducing human error and increasing convenience. Using technology increases the efficiency of the system and also saves time and costs. At the same time, adopting technology to provide service reduces the probability of direct interaction between the traders and the customs officials, thereby reducing the incidence of bribery and discriminatory treatments. Reduction in the incidence of bribery implies a lower degree of corruption in the economy and, therefore, an increase in the volume of trade. However, the results also suggested that for countries that are highly protected, corruption can be trade enhancing. For those countries, along with the elimination of non-tariff barriers, the most effective policy to stimulate trade is to reduce the level of tariffs. Otherwise, the attempts to

reduce corruption might have an adverse effect on trade. The limitations of this dissertation are related to data availability. For example, the corruption indices used in this paper give a perception about the general level of corruption in the economy. A better predictor of the effect of corruption on bilateral trade would have been cross-country data on bribery at the border, which was unavailable. Similarly, cross-country data on one of the most important determinants of Internet penetration, the "cost of using the Internet", was unavailable. Future research aims to test the effect of these trade facilitation measures on the commodities at a more disaggregated level. This will help to further test for the difference in the responsiveness of commodities due to differences in quality and degree of perishability.

References

1. Ades, Alberto and Rafael Di Tella. 1999. "Rents, competition, and corruption". *American Economic Review*, 982–993.

2. Aidt, Toke S. 2003. "Economic analysis of corruption: a survey". *The Economic Journal* 113.491, F632–F652.

3. Anderson, James E and Douglas Marcouiller. 2002. "Insecurity and the pattern of trade: an empirical investigation". *Review of Economics and statistics* 84.2, 342–352.

4. Anderson, James E and Eric Van Wincoop. 2003. "Gravity with Gravitas". *American economic review* 93.1, 170–192.

5. — . 2004. *Trade costs*. Tech. rep. National Bureau of Economic Research.

6. Bardhan, Pranab. 1997. "Corruption and development: a review of issues". *Journal of economic literature*, 1320–1346.

7. Business, Doing and Dothan By Design. 2012. "Doing Business". *The World Bank. 2012a. http://www. doingbusiness. org/aboutâĂŤus*.

8. Cameron, A Colin and Pravin K Trivedi. 2005. *Microeconometrics: methods and applications*. Cambridge university press.

9. Clarke, George RG. 2008. "Has the internet increased exports for firms from low and middle-income countries?" *Information Economics and Policy* 20.1, 16–37.

10. Clarke, George RG and Scott J Wallsten. 2006. "Has the internet increased trade? Developed and developing country evidence". *Economic Inquiry* 44.3, 465–484.

11. Comin, Diego, William Easterly, and Erick Gong. 2006. *Was the Wealth of Nations determined in 1000 BC?* Tech. rep. National Bureau of Economic Research.

12. Comin, Diego A and Bart Hobijn. 2009. *The CHAT dataset*. Tech. rep. National Bureau of Economic Research.

13. Dutt, Pushan. 2009. "Trade protection and bureaucratic corruption: an empirical investigation". *Canadian Journal of Economics/Revue canadienne d'économique* 42.1, 155–183.

14. Dutt, Pushan and Daniel Traça. 2009. *Corruption and its impact on trade: Extortion or evasion?*

15. Fink, Carsten, Aaditya Mattoo, and Ileana Cristina Neagu. 2005. "Assessing the impact of communication costs on international trade". *Journal of International Economics* 67.2, 428–445.

16. Francois, Joseph and Miriam Manchin. 2013. "Institutions, infrastructure, and trade". *World Development* 46, 165–175.

17. Freund, Caroline L and Diana Weinhold. 2004. "The effect of the Internet on international trade". *Journal of international economics* 62.1, 171–189.

18. Gómez-Herrera, Estrella. 2013. "Comparing alternative methods to estimate gravity models of bilateral trade". *Empirical Economics* 44.3, 1087–1111.

19. Grainger, Andrew. 2011. "Trade facilitation: a conceptual review". *Journal of World Trade* 45.1, 39–62.

20. Greene, William H. 2000. "Econometric Analysis (International Edition)".

21. Gupta, Sanjeev, Hamid Davoodi, and Rosa Alonso-Terme. 2002. "Does corruption affect income inequality and poverty?" *Economics of governance* 3.1, 23–45.

22. Heckman, James J. 1979. "Sample selection bias as a specification error". *Econometrica: Journal of the econometric society*, 153–161.

23. Helpman, Elhanan, Marc Melitz, and Yona Rubinstein. 2006. "Trading partners and trading volumes". *document interne, Harvard University.*

24. Hummels, David and Georg Schaur. 2012. *Time as a trade barrier.* Tech. rep. National Bureau of Economic Research.

25. Iwanow, Tomasz and Colin Kirkpatrick. 2007. "Trade facilitation, regulatory quality and export performance". *Journal of International Development* 19.6, 735–753.

26. Jha, Chandan Kumar and Sudipta Sarangi. 2014. "Social Media, Internet and Corruption". *Internet and Corruption (March 2014).*

27. Jong, Eelke de and Christian Bogmans. 2011. "Does corruption discourage international trade?" *European Journal of Political Economy* 27.2, 385–398.

28. Kaufmann, Daniel, Aart Kraay, and Massimo Mastruzzi. 2005. "Governance matters IV: governance indicators for 1996-2004". *Policy Research Working Paper* 3630.

29. —   . 2010. "The worldwide governance indicators: a summary of methodology, data and analytical issues". *World Bank Policy Research Working Paper* 5430.

30. Khalil, Mohsen, Philippe Dongier, Christine Zhen-Wei Qiang, et al. 2009. *2009 Information and communications for development: extending reach and increasing impact.* World Bank.

31. Krueger, Anne O. 1993. "Virtuous and vicious circles in economic development". *The American Economic Review*, 351–355.

32. La Porta, Rafael, Florencio Lopez-de Silanes, Andrei Shleifer, and Robert W Vishny. 1998. "Law and Finance". *Journal of Political Economy* 106.6, 1113–1155.

33. Lambsdorff, Johann G. 2004. "How corruption affects economic development". *Global Corruption Report*, 310–212.

34. Lambsdorff, Johann Graf. 1998. "An empirical investigation of bribery in international trade". *The European Journal of development research* 10.1, 40–59.

35. — . 1999. "Corruption in empirical research: A review". *Transparency International, processed* 6.

36. — . 2003a. "How corruption affects persistent capital flows". *Economics of Governance* 4.3, 229–243.

37. — . 2003b. "How corruption affects productivity". *Kyklos* 56.4, 457–474.

38. Leff, Nathaniel H. 1964. "Economic development through bureaucratic corruption". *American behavioral scientist* 8.3, 8–14.

39. Liu, Lan and Chengyan Yue. 2013. "Investigating the impacts of time delays on trade". *Food Policy* 39, 108–114.

40. Martincus, Christian Volpe, Jerónimo Carballo, and Andrés Gallo. 2011. "The impact of export promotion institutions on trade: is it the intensive or the extensive margin?" *Applied Economics Letters* 18.2, 127–132.

41. Mauro, Paolo. 1995. "Corruption and growth". *Qarterly Journal of Economics* 110.3, 681–712.

42. Meltzer, Joshua Paul. 2015. "The Internet, Cross-Border Data Flows and International Trade". *Asia & the Pacific Policy Studies* 2.1, 90–102.

43. Méon, Pierre-Guillaume and Laurent Weill. 2010. "Is corruption an efficient grease?" *World development* 38.3, 244–259.

44. Murphy, Kevin M, Andrei Shleifer, and Robert W Vishny. 1993. "Why is rent-seeking so costly to growth?" *The American Economic Review*, 409–414.

45. Murray, Michael P. 2006. "Avoiding invalid instruments and coping with weak instruments". *Journal of Economic Perspectives* 20.4, 111–132.

46. Onyeiwu, Steve. 2002. *Inter-country variations in digital technology in Africa: Evidence, determinants, and policy implications.* 2002/72. WIDER Discussion Papers//World Institute for Development Economics (UNU-WIDER).

47. Park, Mi-Hee. 2005. "Recent Development in Infrastructure and its Impact on Agricultural and Non-agricultural Trade". PhD thesis. North Dakota State University.

48. Rauch, James E and Vitor Trindade. 2003. "Information, international substitutability, and globalization". *American Economic Review*, 775–791.

49. Rodrik, Dani. 2006. "Goodbye Washington consensus, hello Washington confusion? A review of the World Bank's economic growth in the 1990s: learning from a decade of reform". *Journal of Economic literature* 44.4, 973–987.

50. Roeder, Philip G. 2001. *Ethnolinguistic fractionalization (ELF) indices, 1961 and 1985.*

51. Samuel, P. "Huntington 1968. Political Order in Changing Societies". *New Haven.*

52. Schwab, Klaus et al. 2010. "The global competitiveness report 2010-2011". In: World Economic Forum Geneva.

53. Shepotylo, Oleksandr. 2009. "Gravity with zeros: estimating trade potential of CIS countries". *Available at SSRN 1347997.*

54. Shleifer, Andrei and Robert W Vishny. 1993. "Corruption". *Quarterly Journal of Economics* 108.03, 599–617.

55. Staples, Brian Rankin. 2002. "Trade facilitation: improving the invisible infrastructure". *Hoekman, B., Matto, A. and English Ph.(Eds.) Development, Trade and the WTO: A Handbook, Washington, DC: The World Bank.*

56. Sullivan, Michael J. 1991. *Measuring global values: The ranking of 162 countries.* Greenwood Press New York.

57. Tang, Linghui. 2006. "Communication costs and trade of differentiated goods". *Review of International Economics* 14.1, 54–68.

58. Timmis, Jonathan et al. 2012. *The Internet and International Trade in Goods.* Tech. rep.

59. Tinbergen, Jan. 1962. "Shaping the world economy; suggestions for an international economic policy".

60. Treisman, Daniel. 2000. "The causes of corruption: a cross-national study". *Journal of Public Economics* 76.3, 399–457.

61. — . 2007. "What have we learned about the causes of corruption from ten years of cross-national empirical research?" *Annual Review of Polititical Science* 10, 211–244.

62. Unwin, PTH. 2009. *ICT4D: Information and communication technology for development.* Cambridge University Press.

63. Wallsten, Scott. 2005. "Regulation and internet use in developing countries". *Economic Development and Cultural Change* 53.2, 501–523.

64. Wei, Shang-Jin. 2000. "How taxing is corruption on international investors?" *Review of economics and statistics* 82.1, 1–11.

65. Wheatley, W Parker and Terry L Roe. 2005. "The effects of the Internet on US bilateral trade in agricultural and horticultural commodities". In: *presentation at the American Agricultural Economics Association Annual Meeting, Providence, RI*. Citeseer.

66. Wilson, John S, Catherine L Mann, and Tsunehiro Otsuki. 2003. "Trade facilitation and economic development: A new approach to quantifying the impact". *The World Bank Economic Review* 17.3, 367–389.

67. — . 2005. "Assessing the benefits of trade facilitation: A global perspective". *The World Economy* 28.6, 841–871.

68. World Bank. 2001. "World development report 2002: building institutions for markets".

69. Zaki, Chahir. 2013. "Trade facilitation and corruption: a CGE model of Egypt". *The Journal of North African Studies* 18.1, 70–111.

70. — . 2015. "How Does Trade Facilitation Affect International Trade&quest". *European Journal of Development Research* 27.1, 156–185.

Appendix

E-governance

Table A.1 lists the value of E-government Readiness Index for each country during 2003 to 2005.

Table A.1: World E-government Readiness Index.

Country/Territory	World Bank Country Code	E-gov Index 2003	E-gov Index 2004	E-gov Index 2005
Afghanistan	AFG	0.12	0.13	0.15
Albania	ALB	0.31	0.34	0.37
Algeria	DZA	0.37	0.32	0.32
Andorra	AND	0.17	0.16	0.18
Angola	AGO	0.19	0.20	0.18
Antigua and Barbuda	ATG	0.36	0.37	0.40
Argentina	ARG	0.58	0.59	0.60
Armenia	ARM	0.38	0.39	0.36
Australia	AUS	0.83	0.84	0.87
Austria	AUT	0.68	0.75	0.76
Azerbaijan	AZE	0.36	0.39	0.38
Bahamas	BHS	0.43	0.46	0.47
Bahrain	BHR	0.51	0.53	0.53
Bangladesh	BGD	0.17	0.18	0.18
Barbados	BRB	0.41	0.46	0.49
Belarus	BLR	0.40	0.49	0.53
Belgium	BEL	0.67	0.75	0.74
Belize	BLZ	0.42	0.42	0.38
Benin	BEN	0.24	0.22	0.23
Continued on next page				

Country/Territory	World Bank Country Code	E-gov Index 2003	E-gov Index 2004	E-gov Index 2005
Bhutan	BTN	0.16	0.16	0.29
Bolivia	BOL	0.41	0.39	0.40
Bosnia and Herzegovina	BIH	0.31	0.38	0.40
Botswana	BWA	0.35	0.38	0.40
Brazil	BRA	0.53	0.57	0.60
Brunei Darussalam	BRN	0.46	0.46	0.45
Bulgaria	BGR	0.55	0.54	0.56
Burkina Faso	BFA	0.14	0.18	0.13
Burundi	BDI	0.18	0.16	0.16
Cambodia	KHM	0.26	0.29	0.30
Cameroon	CMR	0.27	0.26	0.25
Canada	CAN	0.81	0.84	0.84
Cape Verde	CPV	0.32	0.34	0.33
Chad	TCD	-	0.14	0.14
Chile	CHL	0.67	0.68	0.70
China	CHN	0.42	0.44	0.51
Colombia	COL	0.44	0.53	0.52
Comoros	COM	0.18	0.18	0.20
Congo	COG	0.27	0.30	0.29
Costa Rica	CRI	0.43	0.42	0.46
CÃŢte d'Ivoire	CIV	-	0.17	0.18
Croatia	HRV	0.53	0.52	0.55
Cuba	CUB	0.37	0.35	0.37
Cyprus	CYP	0.47	0.52	0.59
Czech Republic	CZE	0.54	0.62	0.64
Denmark	DNK	0.82	0.90	0.91
Djibouti	DJI	0.18	0.20	0.24
Dominica	DMA	-	0.37	0.33
Dominican Republic	DOM	0.44	0.41	0.41
Ecuador	ECU	0.38	0.39	0.40

Country/Territory	World Bank Country Code	E-gov Index 2003	E-gov Index 2004	E-gov Index 2005
Egypt	EGY	0.24	0.27	0.38
El Salvador	SLV	0.41	0.40	0.42
Eritrea	ERI	-	-	0.18
Estonia	EST	0.70	0.70	0.73
Ethiopia	ETH	0.13	0.14	0.14
Fiji	FJI	0.43	0.39	0.41
Finland	FIN	0.76	0.82	0.82
France	FRA	0.69	0.67	0.69
Gabon	GAB	0.28	0.30	0.29
Gambia	GMB	0.17	0.17	0.17
Georgia	GEO	0.35	0.38	0.40
Germany	DEU	0.76	0.79	0.81
Ghana	GHA	0.24	0.24	0.29
Greece	GRC	0.54	0.56	0.59
Grenada	GRD	0.35	0.36	0.39
Guatemala	GTM	0.33	0.34	0.38
Guinea	GIN	0.13	0.14	0.14
Guyana	GUY	0.42	0.42	0.40
Honduras	HND	0.28	0.33	0.33
Hungary	HUN	0.52	0.59	0.65
Iceland	ISL	0.70	0.77	0.78
India	IND	0.37	0.39	0.40
Indonesia	IDN	0.42	0.39	0.38
Iran	IRN	0.33	0.33	0.38
Iraq	IRQ	-	0.36	0.33
Ireland	IRL	0.70	0.71	0.73
Israel	ISR	0.66	0.68	0.69
Italy	ITA	0.69	0.66	0.68
Jamaica	JAM	0.43	0.48	0.51
Japan	JPN	0.69	0.73	0.78

Country/Territory	World Bank Country Code	E-gov Index 2003	E-gov Index 2004	E-gov Index 2005
Jordan	JOR	0.43	0.43	0.46
Kazakhstan	KAZ	0.39	0.43	0.48
Kenya	KEN	0.30	0.30	0.33
Kuwait	KWT	0.37	0.36	0.44
Kyrgyzstan	KGZ	0.33	0.45	0.44
Lao	LAO	0.19	0.23	0.24
Latvia	LVA	0.51	0.55	0.61
Lebanon	LBN	0.42	0.42	0.46
Lesotho	LSO	0.35	0.33	0.34
Liechtenstein	LIE	0.18	0.19	0.18
Lithuania	LTU	0.56	0.54	0.58
Luxembourg	LUX	0.66	0.66	0.65
Macedonia	MKD	0.36	0.37	0.46
Madagascar	MDG	0.23	0.22	0.26
Malawi	MWI	0.23	0.27	0.28
Malaysia	MYS	0.52	0.54	0.57
Maldives	MDV	0.41	0.41	0.43
Mali	MLI	0.14	0.10	0.09
Malta	MLT	0.64	0.69	0.70
Marshall Islands	MHL	0.04	0.04	0.04
Mauritania	MRT	0.16	0.17	0.17
Mauritius	MUS	0.47	0.51	0.53
Mexico	MEX	0.59	0.60	0.61
Micronesia	FSM	0.53	0.05	0.05
Moldova	MDA	0.36	0.34	0.35
Monaco	MCO	0.19	0.20	0.24
Mongolia	MNG	0.34	0.42	0.40
Morocco	MAR	0.27	0.26	0.28
Mozambique	MOZ	0.17	0.20	0.24
Myanmar	MMR	0.28	0.30	0.30

Country/Territory	World Bank Country Code	E-gov Index 2003	E-gov Index 2004	E-gov Index 2005
Namibia	NAM	0.34	0.33	0.34
Nauru	NRU	0.29	0.04	0.04
Nepal	NPL	0.27	0.28	0.30
Netherlands	NLD	0.75	0.80	0.80
New Zealand	NZL	0.72	0.78	0.80
Nicaragua	NIC	0.32	0.32	0.34
Niger	NER	0.06	0.06	0.07
Nigeria	NGA	0.23	0.25	0.28
Norway	NOR	0.78	0.82	0.82
Oman	OMN	0.36	0.29	0.34
Pakistan	PAK	0.25	0.30	0.28
Palau	PLW	0.01	0.04	0.06
Panama	PAN	0.43	0.49	0.48
Papua New Guinea	PNG	0.25	0.24	0.25
Paraguay	PRY	0.41	0.34	0.36
Peru	PER	0.46	0.50	0.51
Philippines	PHL	0.57	0.53	0.57
Poland	POL	0.58	0.60	0.59
Portugal	PRT	0.65	0.60	0.61
Qatar	QAT	0.41	0.40	0.49
Republic of Korea	REU	0.74	0.86	0.87
Romania	ROM	0.48	0.55	0.57
Russia	RUS	0.44	0.50	0.53
Rwanda	RWA	0.24	0.25	0.25
Saint Kitts and Nevis	KNA	0.43	0.42	0.45
Saint Lucia	LCA	0.44	0.46	0.45
Saint Vincent and the Grenadines	VCT	0.36	0.32	0.40
Samoa	WSM	0.30	0.38	0.40
San Marino	SMR	0.28	0.29	0.31
Sao Tome and Principe	STP	0.27	0.28	0.28

Country/Territory	World Bank Country Code	E-gov Index 2003	E-gov Index 2004	E-gov Index 2005
Saudi Arabia	SAU	0.34	0.39	0.41
Senegal	SEN	0.20	0.23	0.22
Serbia and Montenegro	SRB	0.37	0.39	0.20
Seychelles	SYC	0.42	0.43	0.49
Sierra Leone	SLE	0.13	0.17	0.16
Singapore	SGP	0.75	0.83	0.85
Slovakia	SVK	0.53	0.56	0.59
Slovenia	SVN	0.63	0.65	0.68
Solomon Islands	SLB	0.28	0.27	0.27
Somalia	SOM	0.05	-	-
South Africa	ZAF	0.52	0.49	0.51
Spain	ESP	0.60	0.58	0.58
Sri Lanka	LKA	0.39	0.37	0.40
Sudan	SDN	0.21	0.23	0.24
Suriname	SUR		0.35	0.34
Swaziland	SWZ	0.30	0.36	0.36
Sweden	SWE	0.84	0.87	0.90
Switzerland	CHE	0.76	0.75	0.75
Syrian Arab Republic	SYR	0.26	0.26	0.29
Tajikistan	TJK	-	-	0.33
Tanzania	TZA	0.25	0.28	0.30
Thailand	THA	0.45	0.55	0.55
Timor-Leste	TMP	0.09	0.05	0.25
Togo	TGO	0.23	0.23	0.23
Tonga	TON	0.39	0.38	0.37
Trinidad and Tobago	TTO	0.43	0.47	0.48
Tunisia	TUN	0.33	0.32	0.33
Turkey	TUR	0.51	0.49	0.50
Turkmenistan	TKM	0.34	0.34	
Tuvalu	TUV	-	-	0.04

Country/Territory	World Bank Country Code	E-gov Index 2003	E-gov Index 2004	E-gov Index 2005
Uganda	UGA	0.30	0.33	0.31
Ukraine	UKR	0.46	0.53	0.55
United Arab Emirates	ARE	0.54	0.47	0.57
United Kingdom	GBR	0.81	0.89	0.88
United States	USA	0.93	0.91	0.91
Uruguay	URY	0.51	0.55	0.54
Uzbekistan	UZB	-	0.40	0.41
Vanuatu	VUT	0.14	0.16	0.17
Venezuela	VEN	0.36	0.49	0.52
Viet Nam	VNM	0.36	0.34	0.36
Yemen	YEM	0.19	0.19	0.21
Zambia	ZMB	0.28	-	-
Zimbabwe	ZWE	0.30	0.28	0.33

The E-government Readiness Index takes a value between 0 to 1

Higher values of the index implies better quality of e-governance

Table A.2 shows the result from the first-step of Heckman's two-step method. Table A.3 presents the estimation from random effect model.

Table A.2: E-governance & Agricultural Exports: Heckman's Two Step Model. First-step Estimates; Identification Variable: Common Language

	Island Economy	Landlocked Economy	Common Border	Common Colony	Constant
Coefficient	0.243***	0.036	1.003***	1.242***	-1.319***
Standard Error	0.026	0.034	0.046	0.072	0.013

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A.3: E-governance & Agricultural Exports: Random Effect Model

Dependent variable: $\log(\text{Export})_{ei}$	(1)	(2)	(3)	(4)
$\log(\text{E-governance})_e$	0.043	0.676**	1.659***	1.788***
	(0.028)	(0.232)	(0.464)	(0.456)
$\log(\text{E-governance})_i$	-0.001	-0.014	-0.215	-0.161
	(0.019)	(0.025)	(0.308)	(0.307)
$\log(\text{GDP})_e$	0.686***	0.142	-0.047	0.101
	(0.018)	(0.087)	(0.138)	(0.161)
$\log(\text{GDP})_i$	0.668***	0.763***	0.808***	0.838***
	(0.012)	(0.030)	(0.076)	(0.078)
$\log(\text{Distance})_{ei}$	-2.605***	-2.735***	-2.566***	-2.527***
	(0.079)	(0.127)	(0.164)	(0.166)
Common Colony $_{ei}$	1.437***	1.150***	0.529	0.509
	(0.220)	(0.280)	(0.421)	(0.416)
Island Economy $_e$	-0.053	-0.658***	-0.506**	-0.530**
	(0.076)	(0.130)	(0.183)	(0.185)
Landlocked Economy $_e$	-0.822***	-0.676***	-0.990***	-1.062***
	(0.088)	(0.143)	(0.184)	(0.185)
Common Language $_{ei}$	0.737***	1.080***	1.562***	1.580***
	(0.086)	(0.135)	(0.172)	(0.173)
Common Border $_{ei}$	1.465***	0.987***	0.415	0.448
	(0.162)	(0.262)	(0.388)	(0.394)
$\log(\text{Population})_e$		0.467***	0.504**	0.34
		(0.088)	(0.153)	(0.178)
$\log(\text{Population})_i$		-0.0924**	-0.062	-0.0936
		(0.033)	(0.078)	(0.080)
$\log(\text{Real Exchange Rate})_e$		0.808**	-0.368	-0.528
		(0.261)	(0.417)	(0.423)
$\log(\text{Tariff})_{ie}$		-0.018	-0.014	-0.009
		(0.020)	(0.030)	(0.030)
$\log(\text{Regulatory Quality})_e$			0.252**	0.197*
			(0.082)	(0.085)
$\log(\text{Regulatory Quality})_i$			0.137***	0.124***
			(0.037)	(0.037)
Region Dummy	Yes	Yes	Yes	Yes
Income Dummy	Yes	Yes	Yes	Yes
Year Fixed Effect	No	No	No	Yes
Observations	21869	6437	2598	2598

Heteroscedasticity robust standard errors in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The first column includes standard gravity model variables along with e-governance as main explanatory variable. It also includes region and income dummies are included. Column 2, controls for the effect of population, real exchange rate, and tariff structure. Column 3, includes the quality of regulation in each country. The last column controls for time specific fixed effects. Constant not reported.

Corruption

5.0.1 Control of Corruption Index and Corruption Perception Index

In this paper Control of Corruption (CCI) index is used as a main explanatory variable. As mentioned in World Governance Indicators (WGI) reports - "Control of corruption captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as 'capture' of the state by elites and private interests." This corruption indicator is a composite index combining up to 22 different assessments and surveys from sources like the Country Policy and Institutional Assessments of the World Bank, the Asian Development Bank and the African Development Bank, the Afrobarometer Survey, the World Bank's Business Environment and Enterprise Performance Survey etc. While constructing Control of Corruption Index (CCI), a diverse group of people is surveyed, and their perception regarding corruption in the country is recorded. CCI includes assessment of a country's performance provided by business people and also assessments provided by a group of country/risk/expert analysts. Each of the surveys receives a different weight, depending on its estimated precision and country coverage. The larger weights are given to sources that have similar findings.

Some of the questions asked by data sources (surveys and expert opinions) that form a part of the CCI are as follows: "Is corruption in government widespread?" " How many elected leaders (parliamentarians) do you think are involved in corruption?" "How many judges and magistrates do you think are involved in corruption?" "How many government officials do you think are involved in corruption?" "How many border/tax officials do you think are involved in corruption?" "How common is for firms to have to pay irregular additional payments to get things done?" "How often do firms make extra payments in connection with taxes, customs, and judiciary?" "How problematic is corruption for the growth of your business?" "To what extent does corruption exist in a way that detracts from the business environment

for foreign companies?"

For sensitivity analysis, the Corruption Perception Index (CPI) is used as a proxy for corruption. CPI is a composite index created using data from different surveys conducted by a number of reputed institutions like African Development Bank, World Bank, World Economic Forum, Freedom House, The Economist Intelligence Unit, etc. CPI ranks different countries and territories based on how corrupt a country's public sector is perceived to be. To ensure accuracy and robustness of the index, CPI ranks only those countries that are covered by a minimum of three different data sources. While compiling CPI, each data sources has been normalized to the same mean and standard deviation i.e. all the data sources are given equal weight while calculating CPI for each country. While conducting the surveys, respondents were asked a few questions and were asked to assign a number in a given range to each of their answers indicating the extent to which he or she agrees to the statement or the question.

Some of the questions reflected in the 2010 CPI scores are following: "To what extent are there legal or political penalties for officeholders who abuse their positions?" "To what extent can the government successfully contain corruption?" "Are there clear procedures and accountability governing the allocation and use of public funds?" "Are public funds misappropriated by ministers/public officials for private or party political purposes; are there special funds for which there is no accountability; are there general abuses of public resources?" "Is there a professional civil service or are large numbers of officials directly appointed by the government?" "Is there an independent body auditing the management of the public finances?" "Is there an independent judiciary with the power to try ministers/public officials for abuses?" "Is there a tradition of a payment of bribes to secure contracts and gain favors?" "Is the country's economy free of excessive state involvement?" "Is the government free from excessive bureaucratic regulations, registration requirements, and other controls that increase opportunities for corruption?" "Are there significant limitations on the participation of government officials in economic life?" "Does the government advertise jobs

and contracts?" "Do whistle-blowers, anti-corruption activists, investigators, and journalists enjoy legal protections that make them feel secure about reporting cases of bribery and corruption?" "Are allegations of corruption given wide and extensive airing in the media?" "In your country, how common is it for firms to make undocumented extra payments or bribes connected with the following: a) Imports and exports? b) Public utilities (e.g. telephone or electricity)? c) Annual tax payments? d) Awarding of public contracts and licenses? e) Obtaining favorable judicial decisions?"

The correlation coefficient between CPI and CCI is almost closer to 0.97 for the sample of countries used in this paper. This high correlation between these two indices is not surprising because of the fact that there are several common data sources in the computation of the two corruption indices. For example, data sources like African Development Bank, Asian Development, Bertelsmann Foundation, Freedom House, Economist Intelligence Unit, Global Insight, Political & Economic Risk Consultancy, World Economic Forum Global Competitiveness Report, and World Bank are common for both the indices.

Table A.4 represents the value of CCI and CPI in 2010 for all the countries.

Table A.4: World Corruption Index, 2010.

Country/Territory	World Bank Country Code	Control of Corruption Index	Corruption Perception Index
Afghanistan	AFG	-1.90	1.40
Albania	ALB	-0.44	3.30
Algeria	DZA	-0.75	2.90
American Samoa	ASM	1.16	-
Andora	ADO	1.23	-
Angola	AGO	-1.26	1.90
Anguilla	AIA	1.42	-
Antigua and Barbuda	ATG	0.99	-
Argentina	ARG	-0.62	2.90
			Continued on next page

Country	World Bank Country Code	Control of Corruption Index	Corruption Perception Index
Armenia	ARM	-0.47	2.60
Aruba	ABW	1.42	-
Australia	AUS	1.76	8.70
Austria	AUT	1.81	7.90
Azerbaijan	AZE	-0.85	2.40
Bahamas	BHS	0.69	-
Bahrain	BHR	0.48	4.90
Bangladesh	BGD	-0.79	2.40
Barbados	BRB	1.04	7.80
Belarus	BLR	-1.04	2.50
Belgium	BEL	1.37	7.10
Belize	BLZ	-0.36	-
Benin	BEN	-0.70	2.80
Bermuda	BMU	1.16	-
Bhutan	BTN	0.12	5.70
Bolivia	BOL	-1.05	2.80
Bosnia and Herzegovina	BIH	-0.37	3.20
Botswana	BWA	0.67	5.80
Brazil	BRA	0.00	3.70
Brunei	BRN	0.79	5.50
Bulgaria	BGR	-0.10	3.60
Burkina Faso	BFA	-0.18	3.10
Burundi	BDI	-1.19	1.80
Cambodia	KHM	-1.09	2.10
Cameroon	CMR	-1.05	2.20
Canada	CAN	1.81	8.90
Cape Verde	CPV	0.42	5.10
Cayman Islands	CYM	0.89	-
Central African Republic	CAF	-1.29	2.10
Chad	TCD	-1.48	1.70

Country	World Bank Country Code	Control of Corruption Index	Corruption Perception Index
Chile	CHL	1.32	7.20
China	CHN	-0.33	3.50
Colombia	COL	-0.35	3.50
Comoros	COM	-1.06	2.10
Cook Islands	COK	-0.89	-
Costa Rica	CRI	0.49	5.30
Cote d'Ivoire	CIV	-1.24	2.20
Croatia	HRV	0.17	4.10
Cuba	CUB	-0.66	3.70
Cyprus	CYP	1.20	6.30
Czech Republic	CZE	0.93	4.60
Denmark	DNK	1.90	9.30
Democratic Republic of Congo	ZAR	-1.61	2.00
Djibouti	DJI	-0.71	3.20
Dominica	DMA	0.69	5.20
Dominican Republic	DOM	-0.80	3.00
Ecuador	ECU	-1.21	2.50
Egypt	EGY	-0.12	3.10
El Salvador	SLV	-0.87	3.60
Equatorial Guinea	GNQ	-1.27	1.90
Eritrea	ERI	-1.29	2.60
Estonia	EST	1.13	6.50
Ethiopia	ETH	-0.75	2.70
Fiji	FJI	-0.85	-
Finland	FIN	1.98	9.20
France	FRA	1.51	6.80
French Guina	GUF	1.17	-
Gabon	GAB	-0.51	2.80
Gambia	GMB	-0.51	3.20
Georgia	GEO	-0.21	3.80

Country	World Bank Country Code	Control of Corruption Index	Corruption Perception Index
Germany	DEU	1.62	7.90
Ghana	GHA	-0.06	4.10
Greece	GRC	0.61	3.50
Greenland	GRL	1.72	
Grenada	GRD	0.11	
Guam	GUM	1.16	-
Guatemala	GTM	-1.00	3.20
Guinea	GIN	-1.50	2.00
Guinea-Bissau	GNB	-1.35	2.10
Guyana	GUY	-0.48	2.70
Haiti	HTI	-1.39	2.20
Honduras	HND	-0.89	2.40
Hong Kong	HKG	1.54	-
Hungary	HUN	0.75	4.70
Iceland	ISL	1.70	8.50
India	IND	-0.04	3.30
Indonesia	IDN	-0.64	2.80
Iran	IRN	-0.98	2.20
Iraq	IRQ	-1.62	1.50
Ireland	IRL	1.77	8.00
Israel	ISR	0.90	6.10
Italy	ITA	0.38	3.90
Jamaica	JAM	-0.50	3.30
Japan	JPN	1.33	7.80
Jordan	JOR	0.20	4.70
Kazakhstan	KAZ	-0.61	2.90
Kenya	KEN	-0.99	2.10
Kiribati	KIR	0.07	3.20
North Korea	PRK	-1.30	-
South Korea	KOR	0.99	-

Country	World Bank Country Code	Control of Corruption Index	Corruption Perception Index
Kosovo	KSV	-0.64	-
Kuwait	KWT	0.60	4.50
Kyrgyzstan	KGZ	-1.28	2.00
Laos	LAO	-0.92	2.10
Latvia	LVA	0.78	4.30
Lebanon	LBN	-0.69	2.50
Lesotho	LSO	-0.30	3.50
Liberia	LBR	-1.01	3.30
Libya	LBY	-0.94	2.20
Liechtenstein	LIE	1.62	-
Lithuania	LTU	0.75	5.00
Luxembourg	LUX	1.83	8.50
Macao	MAC	0.70	-
Macedonia	MKD	-0.29	4.10
Madagascar	MDG	-0.85	2.60
Malawi	MWI	-0.14	3.40
Malaysia	MYS	0.53	4.40
Maldives	MDV	-0.33	2.30
Mali	MLI	-0.44	2.70
Malta	MLT	1.44	5.60
Marshall Island	MHL	-0.27	-
Martiniue	MTQ	0.89	-
Mauritania	MRT	-0.87	2.30
Mauritius	MUS	0.86	5.40
Mexico	MEX	-0.58	3.10
Micronesia	FSM	-0.09	-
Moldova	MDA	-0.39	2.90
Monaco	MCO	0.90	-
Mongolia	MNG	-0.39	2.70
Montenegro	MNE	0.00	3.70

Country	World Bank Country Code	Control of Corruption Index	Corruption Perception Index
Morocco	MAR	-0.16	3.40
Mozambique	MOZ	-0.47	2.70
Myanmar	MMR	-1.51	1.40
Namibia	NAM	0.19	4.40
Nauru	NRU	0.42	
Nepal	NPL	-1.01	2.20
Netherlands	NLD	1.81	8.80
Netherlands Antilles	ANT	0.89	-
New Zealand	NZL	1.87	9.30
Nicaragua	NIC	-0.84	2.50
Niger	NER	-0.52	2.60
Nigeria	NGA	-1.17	2.40
Niue	NIU	-0.72	-
Norway	NOR	1.92	8.60
Oman	OMN	0.64	5.30
Pakistan	PAK	-0.74	2.30
Palau	PLW	0.74	-
Panama	PAN	-0.10	3.60
Papua New Guinea	PNG	-0.95	2.10
Paraguay	PRY	-0.91	2.20
Peru	PER	-0.60	3.50
Philippines	PHL	-0.58	2.40
Poland	POL	0.66	5.30
Portugal	PRT	1.04	6.00
Puerto Rico	PRI	0.77	5.80
Qatar	QAT	0.95	7.70
Reunion	REU	0.89	
Republic of Congo	COG	-1.18	-
Romania	ROM	0.04	3.70
Russia	RUS	-0.77	2.10

Country	World Bank Country Code	Control of Corruption Index	Corruption Perception Index
Rwanda	RWA	-0.30	4.00
Samoa	WSM	0.65	4.10
San Marino	SMR	0.90	-
Sao Tome and Principe	STP	-0.72	3.00
Saudi Arabia	SAU	0.26	4.70
Senegal	SEN	-0.40	2.90
Serbia	SRB	-0.40	3.50
Seychelles	SYC	0.02	4.80
Sierra Leone	SLE	-0.96	2.40
Singapore	SGP	1.68	9.30
Slovakia	SVK	0.53	4.30
Slovenia	SVN	0.98	6.40
Solomon Islands	SLB	-0.70	2.80
Somalia	SOM	-2.45	1.10
South Africa	ZAF	0.11	5.40
South Korea	SSD	-4.50	-
Spain	ESP	1.16	6.10
Sri Lanka	LKA	-0.08	3.20
Saint Kitts and Nevis	KNA	0.71	
Saint Lucia	LCA	0.82	-
Sudan	SDN	-1.30	1.60
Suriname	SUR	-0.10	-
Swaziland	SWZ	-0.49	3.20
Sweden	SWE	1.96	9.20
Switzerland	CHE	1.77	8.70
Syria	SYR	-0.50	2.50
Taiwan	TWN	1.02	5.80
Tajikistan	TJK	-1.18	2.10
Tanzania	TZA	-0.49	2.70
Thailand	THA	-0.20	3.50

Country	World Bank Country Code	Control of Corruption Index	Corruption Perception Index
Timor-Leste	TMP	-1.22	2.50
Togo	TGO	-0.91	2.40
Tonga	TON	0.08	3.00
Trinidad & Tobago	TTO	-0.22	3.60
Tunisia	TUN	0.12	4.30
Turkey	TUR	0.12	4.40
Turkmenistan	TKM	-1.45	1.60
Tuvulu	TUV	1.02	-
Uganda	UGA	-0.39	2.50
Ukraine	UKR	-0.81	2.40
United Arab Emirates	ARE	0.37	6.30
United Kingdom	GBR	1.76	7.60
USA	USA	1.63	7.10
Uruguay	URY	0.70	6.90
Uzbekistan	UZB	-1.37	1.60
Vanuatu	VUT	0.24	3.60
Venezuela	VEN	-1.64	2.00
Vietnam	VNM	-0.53	2.70
US Virgin Islands	VIR	0.89	-
West Bank and Gaza	WBG	-0.21	-
Yemen	YEM	-1.07	2.20
Zambia	ZMB	-0.50	3.00
Zimbabwe	ZWE	-1.81	2.40

The CCI takes values in the range of -2.5 to 2.5, and CPI takes values in the range of 0 to 10. Higher values of both the indices imply lower corruption. The CCI covers more countries than CPI and hence missing values for the CPI.

Figure A.1 shows the level of corruption around the world in 2009 as measured by CPI.
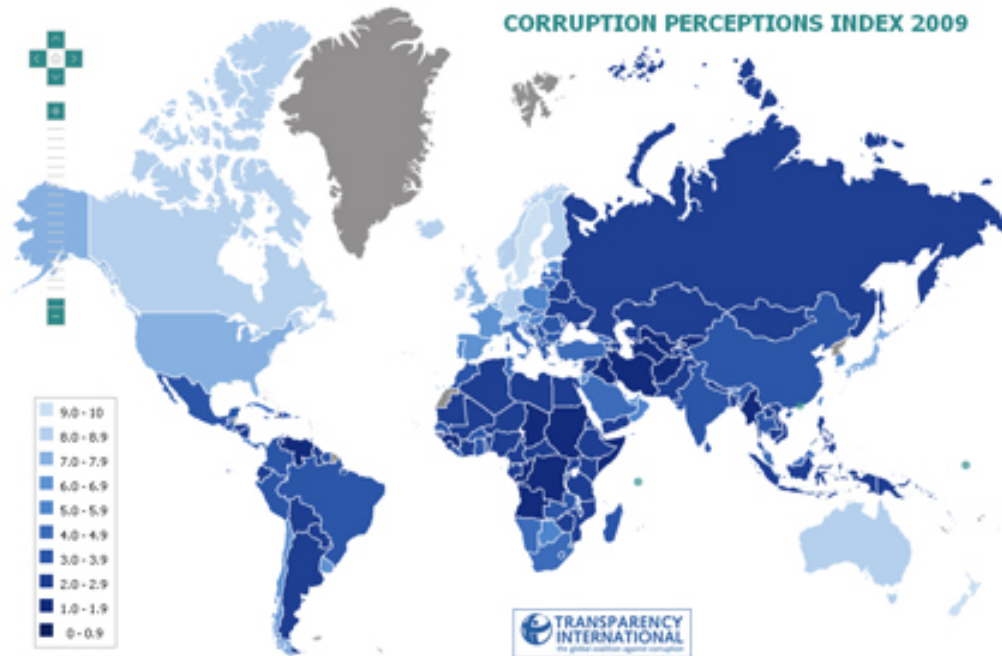

Figure A.1: Corruption Perception Index, 2009

Table A.5 presents the result from the first-step of Heckman's two-step model. Table A.6 and A.7 presents the results from random effect model using CCI and CPI respectively.

Table A.5: Corruption & Agricultural Exports: Heckman's Two Step Model.
First-step Estimates; Identification Variable: Common Language

	Island Economy	Landlocked Economy	Common Border	Common Colony	Constant
Coefficient	0.228***	0.0002	1.032***	1.279***	-1.331***
Standard Error	0.019	0.025	0.035	0.055	-0.009

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A.6: Corruption (CCI) & Agricultural Exports: Random Effect Model

Dependent variable: log(Export)$_{ei}$	(1)	(2)	(3)	(4)
CorruptionCCI$_{\_e}$	0.540***	0.352***	0.376***	0.436***
	(0.039)	(0.059)	(0.071)	(0.075)
CorruptionCCI$_{\_i}$	0.058	0.009	-0.058	-0.0271
	(0.030)	(0.048)	(0.056)	(0.057)
log(GDP)$_e$	0.577***	0.591***	0.589***	0.445***
	(0.036)	(0.073)	(0.072)	(0.086)
log(GDP)$_i$	0.700***	0.715***	0.716***	0.683***
	(0.020)	(0.029)	(0.029)	(0.031)
log(Distance)$_{ei}$	-2.860***	-2.880***	-2.870***	-2.878***
	(0.079)	(0.117)	(0.117)	(0.117)
Island Economy$_{\_e}$	-0.169*	-0.418***	-0.419***	-0.406***
	(0.075)	(0.105)	(0.104)	(0.104)
Landlocked Economy$_{\_e}$	-0.973***	-0.838***	-0.838***	-0.802***
	(0.086)	(0.135)	(0.134)	(0.135)
Common Language$_{\_ei}$	0.759***	0.919***	0.920***	0.915***
	(0.085)	(0.114)	(0.114)	(0.114)
Common Border$_{\_ei}$	1.443***	1.152***	1.147***	1.125***
	(0.159)	(0.272)	(0.273)	(0.271)
Common Colony$_{\_ei}$	1.455***	0.485	0.482	0.518
	(0.202)	(0.447)	(0.450)	(0.441)
log(Population)$_e$	0.242***	0.058	0.059	0.206*
	(0.042)	(0.081)	(0.081)	(0.095)
log(Population)$_i$	-0.004	-0.032	-0.031	-0.002
	(0.024)	(0.034)	(0.034)	(0.035)
log(Tariff)$_{ie}$		-0.132***	-0.128***	-0.129***
		(0.021)	(0.026)	(0.026)
log(Real Exchange Rate)$_e$		-0.289	-0.286	-0.233
		(0.212)	(0.212)	(0.214)
log(Tariff)$_{ie}$ × CorruptionCCI$_{\_e}$			-0.012	-0.011
			(0.018)	(0.018)
log(Tariff)$_{ie}$ × CorruptionCCI$_{\_i}$			0.041*	0.041*
			(0.018)	(0.019)
Region Dummy	Yes	Yes	Yes	Yes
Income Dummy	Yes	Yes	Yes	Yes
Year Fixed Effect	No	No	No	Yes
Observations	41171	14373	14373	14373

Heteroscedasticity robust standard errors in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The first column includes standard gravity model variables along with CCI as the main explanatory variable. It also includes region and income dummies. Column 2, controls for the effect of population, real exchange rate, and tariff structure. Column 3 includes the interaction terms between tariff structure and the level of corruption. The last column controls for time specific fixed effects. Constant not reported.

Table A.7: Corruption (CPI) & Agricultural Exports: Random Effect Model

Dependent variable: log(Export)$_{ei}$	(1)	(2)	(3)	(4)
CorruptionCPI$_{\_e}$	0.071***	0.062**	0.059	0.069*
	(0.016)	(0.024)	(0.032)	(0.033)
CorruptionCPI$_{\_i}$	0.0280**	0.0121	-0.0305	-0.0234
	(0.011)	(90.017)	(0.024)	(0.024)
log(GDP)$_e$	0.612***	0.600***	0.590***	0.499***
	(0.038)	(0.075)	(0.075)	(0.090)
log(GDP)$_i$	0.701***	0.709***	0.714***	0.693***
	(0.019)	(0.028)	(0.028)	(0.029)
log(Distance)$_{ei}$	-2.765***	-2.791***	-2.775***	-2.775***
	(0.084)	(0.123)	(0.124)	(0.123)
Island Economy$_{\_e}$	-0.205**	-0.469***	-0.468***	-0.462***
	(0.077)	(0.108)	(0.108)	(0.108)
Landlocked Economy$_{\_e}$	-0.904***	-0.813***	-0.816***	-0.798***
	(0.092)	(0.142)	(0.142)	(0.142)
Common Language$_{\_ei}$	0.728***	0.914***	0.919***	0.915***
	(0.089)	(0.118)	(0.118)	(0.118)
Common Border$_{\_ei}$	1.512***	1.170***	1.173***	1.161***
	(0.167)	(0.283)	(0.283)	(0.282)
Common Colony$_{\_ei}$	1.457***	0.575	0.569	0.596
	(0.207)	(0.480)	(0.480)	(0.476)
log(Population)$_e$	0.152***	0.028	0.037	0.127
	(0.044)	(0.083)	(0.083)	(0.097)
log(Population)$_i$	-0.018	-0.048	-0.052	-0.036
	(0.023)	(0.034)	(0.034)	(0.034)
log(Tariff)$_{ie}$		-0.132***	-0.239***	-0.241***
		(0.021)	(0.069)	(0.069)
log(Real Exchange Rate)$_e$		-0.290	-0.287	-0.270
		(0.223)	(0.223)	(0.225)
log(Tariff)$_{ie}$ × CorruptionCPI$_{\_e}$			0.002	0.002
			(0.008)	(0.008)
log(Tariff)$_{ie}$ × CorruptionCPI$_{\_i}$			0.022*	0.022*
			(0.009)	(0.009)
Region Dummy	Yes	Yes	Yes	Yes
Income Dummy	Yes	Yes	Yes	Yes
Year Fixed Effect	No	No	No	Yes
Observations	37892	13469	13469	13469

Heteroscedasticity robust standard errors in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The first column includes standard gravity model variables along with CPI as the main explanatory variable. It also includes region and income dummies. Column 2, controls for the effect of population, real exchange rate, and tariff structure. Column 3 includes the interaction terms between tariff structure and the level of corruption. The last column controls for time specific fixed effects. Constant not reported.

Internet

Figure A.2 shows the degree of internet adoption in the world in 2013.
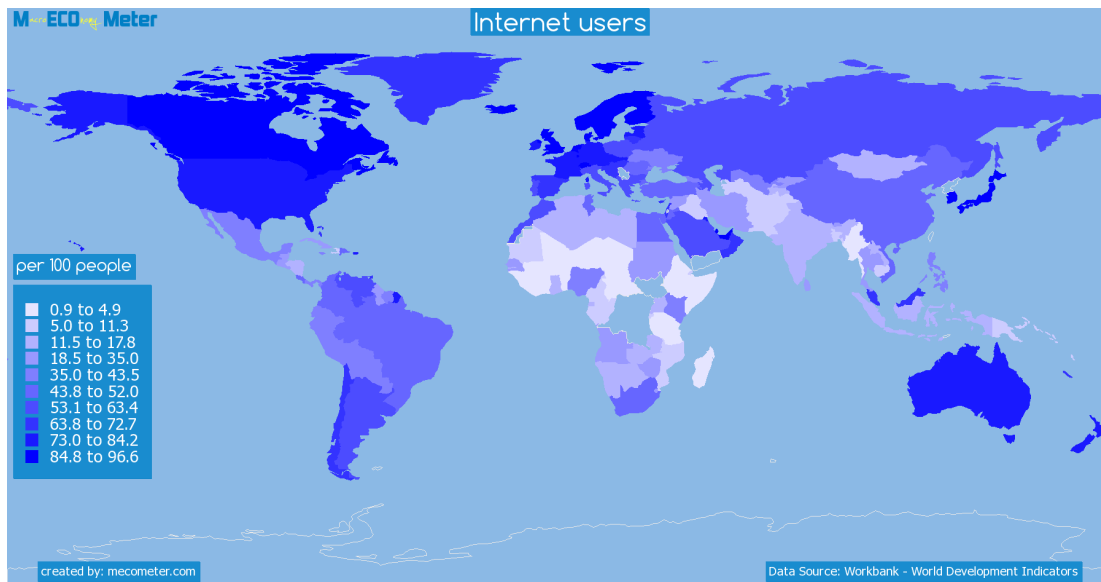

Figure A.2: Internet Users, 2013

Table A.8 shows the result from the first-step of Heckman's two-step model. Table A.9 presents the results from random effect model.

Table A.8: The Internet & Bilateral Exports: Heckman's Two Step Model.
First-step Estimates; Identification Variable: Common Language

	Island Economy	Landlocked Economy	Common Border	Common Colony	Constant
Coefficient	0.231***	0.091	1.016***	1.250***	-1.332***
Standard Error	0.018	0.022	0.035	0.056	-0.009

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A.9: The Internet & Bilateral Exports: Random Effect Model

Dependent variable: log(Export)$_{ei}$	(A1)	(A2)	(N1)	(N2)
log(Internet)$_e$	0.209***	0.195**	0.120*	0.260***
	(0.061)	(0.067)	(0.052)	(0.056)
log(Internet)$_i$	0.019	0.009	-0.065*	0.045
	(0.033)	(0.036)	(0.026)	(0.029)
log(GDP)$_e$	0.650***	0.654***	1.562***	1.555***
	(0.054)	(0.058)	(0.042)	(0.044)
log(GDP)$_i$	0.642***	0.646***	0.758***	0.726***
	(0.037))	(0.038)	(0.028)	(0.029)
log(Distance)$_{ei}$	-2.846***	-2.848***	-2.992***	-3.010***
	(0.123)	(0.123)	(0.104)	(0.105)
Common Colony_$_{ei}$	0.62	0.626	0.523	0.431
	(0.481)	(0.481)	(0.292)	(0.290)
Island Economy_$_e$	-0.374***	-0.372***	-1.104***	-1.133***
	(0.112)	(0.112)	(0.079)	(0.079)
Landlocked Economy_$_e$	-0.781***	-0.780***	0.350***	0.348***
	(0.126)	(0.129)	(0.083)	(0.087)
Common Language_$_{ei}$	0.931***	0.930***	1.232***	1.255***
	(0.119)	(0.119)	(0.098)	(0.099)
Common Border_$_{ei}$	1.121***	1.117***	1.412***	1.440***
	(0.281)	(0.281)	(0.245)	(0.248)
log(Population)$_e$	-0.069	-0.070	-0.314***	-0.298***
	(0.060)	(0.063)	(0.044)	(0.046)
log(Population)$_i$	0.013	0.009	0.068*	0.113***
	(0.039)	(0.039)	(0.028)	(0.029)
log(Real Exchange Rate)$_e$	-0.463*	-0.487*	-1.405***	-1.251***
	(0.191)	(0.193)	(0.155)	(0.157)
log(Tariff)$_{ie}$	-0.129***	-0.129***	-0.054***	-0.052***
	(0.021)	(0.021)	(0.015)	(0.015)
log(Export Cost)$_{ei}$	0.065	0.061	-0.668***	-0.595***
	0.092)	(0.106)	(0.068)	(0.075)
log(Import Cost)$_{ie}$	-0.364***	-0.378***	-0.374***	-0.290***
	(0.049)	(0.052)	(0.043)	(0.043)
Region Dummy	Yes	Yes	Yes	Yes
Income Dummy	Yes	Yes	Yes	Yes
Year Fixed Effect	No	Yes	No	Yes
Observations	13628	13628	21155	21155

Heteroscedasticity robust standard errors in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Column 1 & 2 presents the results for agricultural commodities. Column 3 & 4 provides the results for non-agricultural products. Each column includes standard gravity model variables along with internet penetration as main explanatory variable. Constant not reported.

Vita

Trina Biswas was born and raised in West Bengal, India. She attended Department of Economics, Jadavpur University, India and earned a Bachelor of Arts degree with honors in Economics in 2007. In 2009, she completed her masters degree in Economics also at Jadavpur University. She joined Department of Economics at Louisiana State University in 2010 and received Master of Science in Economics in 2012. In the same year, she was admitted to the doctoral program in the Department of Agricultural Economics and Agribusiness at Louisiana State University. Currently, she is a candidate for the degree of Doctor of Philosophy and is expected to graduate in the Fall of 2015.