The Effect of the Internet on Bilateral Trade

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Abstract

Using a gravity model framework, this paper examines the relationship between bilateral trade and the degree of internet adoption in an economy. This study distinguishes between agricultural and non-agricultural commodities to analyze the effect of the internet on commodities with different quality and degree of perishability. The article uses five-year panel data from 2006 to 2010 and corrects for the sample-selection bias. It also uses an instrumental variable approach for addressing endogeneity concerns and proposes a novel instrument. The study provides evidence that adopting the internet can be beneficial for non-agricultural exports. The study further shows that the effect of the internet on agricultural trade is limited.

JEL classification codes: F10; F13; F14
Keywords: Internet; Agricultural Exports; Non-agricultural Exports; Gravity Model

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. It helps expanding the market by reducing fixed costs (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 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 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. Including both agricultural and non-agricultural commodities in the analysis helps to test for the difference in the responsiveness of goods due to differences in quality and degree of perishability. 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 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.

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

Table 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.

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 Internet is more capable of enhancing trade in the non-agricultural sector. Whereas, the effect of the Internet as a medium of communication on agricultural exports is limited. 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 escape 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. Based on the above-mentioned facts, this paper hypothesizes the following:

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

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 is 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.

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 and most celebrated 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:

$$Y_{ei} = G\frac{(M_e M_i)}{D_{ei}} \tag{1}$$

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:

$$\begin{aligned}\log(Export)_{eit} = \alpha &+ \beta_1 \log(Internet)_{et} + \beta_2 \log(Internet)_{it} + \gamma_1 \log(GDP)_{et} \\ &+ \gamma_2 \log(GDP)_{it} + \gamma_3 \log(Population)_{et} + \gamma_4 \log(Population)_{it} \\ &+ \gamma_5 \log(Distance)_{ei} + \gamma_6 Landlocked_e + \gamma_7 Language_{ei} + \gamma_8 Colony_{ei} \\ &+ \gamma_9 Border_{ei} + \gamma_{10} Island_e + \gamma_{11} Income_e + \gamma_{12} Region_e \\ &+ \gamma_{13} \log(ExchangeRate)_{et} + \gamma_{14} \log(Tariff)_{iet} + \gamma_{15} \log(Export_C)_{eit} \\ &+ \gamma_{16} \log(Import_C)_{iet} + \delta_{ei} + \epsilon_{eit} \qquad (2)\end{aligned}$$

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. $Internet_{et}$ 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 estimated using the benchmark Ordinary Least Square (OLS) method. Estimating traditional gravity model using OLS can produce biased results due to following reasons. First, estimation results can be biased due to omitted variables. Omitted variable bias can also give rise to endogeneity. Second, as there are countries that do not trade with each other, using the original gravity equation gives rise to sample-selection bias. To alleviate potential endogeneity present in the data, instrumental variable analysis is conducted. Sample selection bias is corrected using Heckman's two-step model. The following sections review sample-selection bias and the issue of endogeneity in details.

3.1 *Sample-selection Bias*

As mentioned previously, estimating traditional gravity model using OLS can produce biased results due to missing trade values. In trade data, missing values are common as zero trade flows may result from a country's decision not to trade with another economy. The missing trade value gives rise to sample-selection bias 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.

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: 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).

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.

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. Using a number of historical information sources 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 even after controlling for factors like geography and institutional quality. 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 this paper, technology adoption in communication in 1500 AD is used as an instrument for the modern day mode of communication (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.

To satisfy the condition for a valid instrument, communication adoption in 1500 AD 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, Generalized Methods of Moment (GMM) techniques is used for IV analysis.

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 2 and 3 summarizes the relevant variables used in this paper.

Table 2: The Internet & Agricultural Exports: Summary Statistics

Variable	Mean	Std. Dev.	Obs.
log(Export)$_{ei}$	13.98	3.138	61595
log(Internet)$_e$	3.198	1.171	62726
log(Internet)$_i$	2.913	1.384	61729
log(GDP)$_e$	25.55	2.072	61752
log(GDP)$_i$	24.82	2.345	60667
log(Distance)$_{ei}$	3.691	0.392	56777
log(Population)$_e$	16.62	1.747	62292
log(Population)$_i$	16.07	1.964	61890
log(Real Exchange Rate)$_e$	4.589	0.076	39172
log(Tariff)$_{ie}$	2.097	1.294	29365
log(Export Cost)$_{ei}$	6.880	0.424	61563
log(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.

Table 3: The Internet & Non-agricultural Exports: Summary Statistics

Variable	Mean	Std. Dev.	Obs.
log(Export)$_{ei}$	13.93	3.801	71824
log(Internet)$_e$	3.302	1.151	72878
log(Internet)$_i$	2.804	1.431	70743
log(GDP)$_e$	25.58	2.022	71851
log(GDP)$_i$	24.64	2.373	70089
log(Distance)$_{ei}$	3.700	0.380	64945
log(Population)$_e$	16.47	1.778	72381
log(Population)$_i$	16.01	1.999	71600
log(Tariff)$_{ie}$	1.308	1.277	49715
log(Real Exchange Rate)$_e$	4.590	0.077	46468
log(Export Cost)$_{ei}$	6.889	0.428	71047
log(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.

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 comes fro CEPII. The data for technology adoption in communication in 1500 AD that is used as an instrument for the modern day mode of communication (Internet penetration) comes from Comin et al. (2010).

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.

5.1 *OLS estimates*

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. From the first two columns of Table 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.

5.2 *Heckman Method Estimates*

Results of the first-step Heckman procedure are presented in Table 5. 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

Table 4: The Internet & Bilateral Exports: Pooled OLS

Dependent variable: $\log(\text{Export})_{ei}$	(A1)	(A2)	(N1)	(N2)
$\log(\text{Internet})_e$	0.142	0.189	0.325***	0.392***
	(0.096)	(0.107)	(0.077)	(0.08)
$\log(\text{Internet})_i$	-0.054	-0.039	-0.061	-0.034
	(0.046)	(0.048)	(0.033)	(0.035)
$\log(\text{GDP})_e$	0.663***	0.646***	1.622***	1.599***
	(0.070)	(0.075)	(0.051)	(0.055)
$\log(\text{GDP})_i$	0.665***	0.659***	0.839***	0.827***
	(0.044)	(0.045)	(0.031)	(0.032)
$\log(\text{Distance})_{ei}$	-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)
$\log(\text{Population})_e$	-0.151*	-0.134	-0.294***	-0.273***
	(0.076)	(0.079)	(0.053)	(0.056)
$\log(\text{Population})_i$	-0.013	-0.006	0.033	0.046
	(0.045)	(0.046)	(0.031)	(0.032)
$\log(\text{Real Exchange Rate})_e$	1.766***	1.939***	0.355	0.635*
	(0.374)	(0.381)	(0.268)	(0.272)
$\log(\text{Tariff})_{ie}$	-0.107***	-0.108***	0.001	0.003
	(0.027)	(0.027)	(0.022)	(0.022)
$\log(\text{Export Cost})_{ei}$	0.382**	0.405**	-1.487***	-1.447***
	(0.120)	(0.127)	(0.084)	(0.089)
$\log(\text{Import Cost})_{ie}$	-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.

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 5: 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 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.

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.

Table 6: The Internet & Bilateral Exports: Heckman's Two-step Model. Second-step Estimates

Dependent variable: $\log(\text{Export})_{ei}$	(A1)	(A2)	(N1)	(N2)
$\log(\text{Internet})_e$	-0.444*	-0.603**	-0.108	-0.017
	(0.183)	(0.208)	(0.121)	(0.129)
$\log(\text{Internet})_i$	-0.149	-0.211	-0.227**	-0.189*
	(0.147)	(0.156)	(0.073)	(0.076)
$\log(\text{GDP})_e$	1.396***	1.499***	1.617***	1.573***
	(0.172)	(0.180)	(0.089)	(0.092)
$\log(\text{GDP})_i$	0.794***	0.837***	1.017***	0.996***
	(0.126)	(0.130)	(0.063)	(0.064)
$\log(\text{Distance})_{ei}$	-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)
$\log(\text{Population})_e$	-1.066***	-1.160***	-0.441***	-0.404***
	(0.188)	(0.195)	(0.097)	(0.099)
$\log(\text{Population})_i$	-0.113	-0.160	-0.181**	-0.161*
	(0.131)	(0.135)	(0.065)	(0.066)
$\log(\text{Real Exchange Rate})_e$	2.404**	2.186**	-0.377	-0.190
	(0.788)	(0.804)	(0.602)	(0.599)
$\log(\text{Tariff})_{ie}$	0.129	0.138	0.187***	0.190***
	(0.075)	(0.075)	(0.042)	(0.042)
$\log(\text{Export Cost})_{ei}$	-0.788**	-0.934**	-0.372*	-0.286
	(0.305)	(0.317)	(0.167)	(0.172)
$\log(\text{Import Cost})_{ie}$	-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.

5.3 *IV Estimates*

Table 7 reports the results from GMM 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 7 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.

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 impact of the Internet on the volume of trade. Separate analyses were done on trade related to agricultural commodities and non-agricultural goods to test for the difference in the responsiveness of goods due to differences in quality and degree of perishability. The sample-selection bias present in the trade data was corrected using Heckman's two-step method. Instrumental Variable analysis was also done to correct for endogeneity. According to the findings of the study, the trade-promoting role

Table 7: 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.

of the Internet was more prominent for non-agricultural commodities. However, the study found weak evidence of a trade-stimulating effect of the Internet on agricultural exports.

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 are 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 severe in the agricultural sector than the manufacturing and service sectors. Regarding access to Internet infrastructures such as servers, networks, and computers there is also an enormous disparity between developed and developing nations. Beyond differences with respect to infrastructure, an additional disparity involves government restrictions placed on internet usage. Potential for trade through a well-developed internet infrastructure can be inhibited by government controls. 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 facilitate 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.

Notes

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

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