THE ROLE OF TRADE FACILITATION INDICATORS AND GENETICALLY ENGINEERED RESTRICTIVE INDEX ON U.S. STATE EXPORTS AND EFFICIENCY

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Title

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ABSTRACT

Trade Facilitation Indicators have become important mechanisms of monitoring the ease of trade. Another issue of rising concern is the pervasive debate on genetically engineered organisms and the development of Genetically Engineered (GE) Restrictive Index to evaluate its implications on trade. With regards to these, the objective of the United States Trade Representative is to eliminate implicit trade barriers. Hence, this study examines the impact of TFIs on U.S. agricultural export and its efficiency. From the results, a 1% increase in destination's Genetically Engineered Restrictive Index leads to a US$ 9,426.82 and US$ 74,268.04 decline in corn and soybean exports while wheat experiences a US$ 26,204.05 increase. The 'I-State' paradox was also revealed from the efficiency rankings. This research recommends that GE labelling policies should be synchronized to match the requirements of the destination countries. Furthermore, information on GE foods must be transparent and disseminated to change destinations' negative perception.

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I wish to first and foremost thank the Almighty God who is the Author and Finisher of my faith for his abundant Mercies and Grace throughout my life.

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DEDICATION

My most painful experience in life was losing my mother while I was away from her, striving to make her happy in the future. I hope this work will bring you a smile wherever you are. I dedicate this work to my beloved **late mother, Nancy Nana Yaa Darko,** dear patient wife Margaret Akuli and son, Jeffrey Addey.

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CHAPTER ONE. INTRODUCTION

"What gets measured gets managed. What gets managed has a higher probability of success, or of taking corrective actions to avoid negative consequences". Anonymous

So, let us measure the effect of our trade partners' trade facilitation indicators and genetically engineered restrictive index on US State level exports and its efficiency.

1.1. Do We Have Any Problem?

The limitations imposed by cost on trade flows have drawn the attention of many international economists to trade facilitation indicators (Chen and Novy, 2011; Hornok and Koren, 2015). To understand and reduce the impact of trade costs, several variables have emerged as proxies. Since Samuelson's (1954) concept of iceberg cost theory[1], the several proxies that have been used have included tariffs and non-tariffs, exchange rates, product standards etc. Anderson and Wincoop (2004), opined that the sources of trade costs and barriers to trade are so varied that understanding the resistance factors to trade is slightly challenging. However, the need to understand trade resistance factors and formulate policies to reduce trade costs and barriers led to the development of Trade Facilitation Indicators (TFI) by the Organization of Economic Co-operation and Development (OECD). This study examines the impact of United States trade partners' TFIs on its state level agricultural export potential and trade efficiency.

According to the OECD (2014)[2] report, the United States of America (USA) trade facilitation performance was significantly higher than the OECD average in terms of information availability, involvement of trade community, advance rulings, appeal procedures, automation, border agency co-operation (internal and external), governance and impartiality. The improvement

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[1]This theory relates transport costs as an inverse proportion of trade

[2] http://www.oecd.org/unitedstates/united-states-oecd-trade-facilitation-indicators-april-2014.pdf

in trade facilitation procedures can benefit all countries both as exporters and importers. Despite the high performance of the USA in most areas of trade facilitation, the country's exporters have lamented on trade restrictions due to unimproved trade facilitation indices of partner countries, particularly the European Union (U.S. ITC, 2014; Fefer and Jones, 2017). According to the 2016 National Trade Estimates Report[3], most countries have very closed economies to the extent that U.S businesses and workers face significant obstacles when they trade abroad.

There have been several efforts by the WTO to help countries integrate into the global economy through the improvement of TFIs: about US$1.9 billion has been disbursed since 2005 (OECD, 2015). According to this report, OECD countries stand to obtain the least cost reduction potentials from the full implementation of the WTO Trade Facilitation agreements. Furthermore, there is ample literature to reflect the fact that other countries outside the OECD countries have merited more from the improvement of TFIs than the OECD cohort (Hoekman and Shepherd, 2015). Several studies have revealed that unimproved dimensions of countries' TFI have led to costs associated with trade (Francois and Manchin, 2007; Djankov et al., 2010). Anderson and Wincoop (2004) revealed that border restrictions accounted for 44% of the costs associated with trade while the ad valorem equivalent for total trade cost was estimated to be 170%. Subsequently, Arvis et al., (2013), estimated the ad valorem equivalent of border restrictions for developing countries to be 219%. It is apparent that the extent of improvement of a country's TFIs can have a significant impact on its trade. This impact can be assessed from three perspectives;

1. Effect on a nation's exports due to the improvement of its TFI.
2. Effect on a nation's exports due to the improvement of its partners' TFI.
3. Impact of improving TFIs on overall trade flows.

[3] This report is available on https://ustr.gov/sites/default/files/2016-NTE-Report-FINAL.pdf

1.2. Overview of United States (U.S.) Economy and International Trade Restrictions

The economy of the USA is the largest in the world. The gross domestic product (GDP) of the nation was estimated at $18.57 trillion in 2017 with an unemployment rate of 6.20%. Even though the real annual income of the USA in 2014 had been 6.5% less than the year before the global economic crunch of 2007, a real annual household income of $53,657 proves to be higher than in the 1960s when real annual income was $35,379 (DeNavas-Walt and Proctor, 2015). The agrarian sector has been key to the development of the US economy. Over time, the contribution of agriculture to nation's GDP has dwindled despite the adoption of innovative technologies and increasing efficiency in production leading to excess output.

Apart from revenue gained from value added products of agriculture, international trade has become an alternative avenue to market agricultural commodities. International trade involves the exchange of goods, services and capital across the borders or territories of a country. Primarily, international trade consists of exports and imports. Exports are the total quantity or value of goods or services that are sold from a country of origin to another country or destination of different territorial boundary. Import also involves the sale of goods or services into a country from a source of different territorial boundary.

The most problematic factors when exporting commodities are tariffs and non-tariff barriers such as burdensome port clearance procedures, corruption at the borders, delays and high costs of both domestic and international transportation, domestic standards and technical requirements, thefts and poor destination infrastructure. However, the decline in the number of tariff barriers and tariff percentage has led to some countries resorting to these inexhaustible list of non-tariff barriers. These tend to serve as costs which reduce the potential of exports. Hence, despite the traditional tariff barriers and transportation costs encountered during trade, these factors that lead to inefficiency of trade procedures have emerged as important (WTO, 2015).

The limitations of US trade have been well-documented. For instance, the "Report on Sanitary and Phytosanitary Measures" published by the Office of the US Trade Representative (USTR) in 2012 emphasized that non-tariff trade barriers remain one of the major hindrances toward the potential maximization of US agricultural exports. Among several others, the current one of international importance is the Genetically Engineered Organism restrictions among countries. According to the report, the consequences of these restrictions are not only limited to US farmers, ranchers, manufacturers, workers, and their families, but also deprive world consumers of access to high-quality American food and agricultural goods.

In addition, a World Trade Report (2012) show the contribution of non-tariff barriers to overall trade restrictiveness as significant and, in some cases, are far more restrictive than tariff barriers. In this regard, the current objective of the United States Trade Representative is to reduce or eliminate various non-tariff barriers and other trade restrictions to increase the Union's trade potential. In the USTR's quest to identify and combat unwarranted restrictions, the essence of understanding the trade facilitation indicators of trade partners have become crucial. This is because, majority of these restrictions are embedded in the trade facilitation indices. Typically, these measures which serve to restrict US agricultural export growth are implemented without time for compliance, do not conform to international standards and rely on questionable methods of enforcing standards (Shaffer, 2012). Several TFIs have been developed in recent times. Examples of these are World Economic Forum's Enabling Trade Index, World Bank's Logistic Performance Index and UNCTAD Liner Shipping Connectivity Index.

1.3. What Makes this Important for the U.S. States?

The individual states of the United States are autonomous to a large extent in terms of trade. The impacts of decisions and activities on individual states within the country have long been studied and discussed on diverse platforms. For instance, the US Trade Deficit Review Commission (USTDRC), in 2001 revealed that about 760,000 US jobs were lost due to the U.S-China trade deficit between 1992 and 2000. The same report also revealed that the impact of this deficit varied among states. During this period, California, which was the most severed accounted for 14% of all production shifts to China, followed by North Carolina with 11% and Texas at 10%.

Furthermore, voting by Congressmen on the US relationships with other nations is affected by the benefits their respective states obtain from such countries. Cooper (2014) stated that an FTA may create trade for one sector of the US economy but divert trade away from others and therefore a member of Congress is placed in the position of weighing the effects on his/her constituency versus the overall impact on the United States and other trading partners. He further elaborated that because the conditions of FTAs can differ radically from one to the other, the evaluation will likely differ in each case. Another factor stated in his report is that members would also consider both the immediate static effects and the long-term dynamic effects of FTAs. Epstein (2014) also identified that there was a strong positive correlation between factor endowments at the state-level and the Underwood Tariff voting in 1913. The historical pattern of voting by US Congressmen as implied from several Congressional Research Service Reports suggest that, the states do not benefit equally from the trade characteristics of the United States' trade partners.[4]

[4] In one of such Congressional Service reports, Fergusson (2015) indicates that in addition to trade negotiations becoming more complex in recent times, Congress has also insisted on tighter oversight and consultation requirements. Cooper (2014) also asserts that FTA agreements are made with the concurrence of Congress and have varying impacts in the US.

Bernardo (2017) analysed and proved that the impact of a trade war with Mexico will vary across the individual states in the USA. This analysis had arisen from President Donald Trump's proposal of a 20% tax on Mexico after an executive order issued to erect a border wall. Because the US states have different trade partners, it can be inferred that the effects of trade facilitation indicators would affect the export potential and trade efficiency levels of the different US states. Malcom (2017), analyzed the impact of local exports on congressional voting for FTAs. His results showed that House and Senate members are more likely to vote in favor of trade agreements when their states have higher exports to the country that is the subject of the agreement.

Finally, sister-city relationships or cooperation among cities within nations have become prominent in recent times. These international interactions among cities have increased in number and strengthened in commitment since the end of the World War II (Gilbert et al. 1996; Tjandradewi and Chahl, 2001; UN-HABITAT & UTO/FMCU, 2002; Tjandradewi et al. 2006). Despite the numerous benefits of this interactions, very little impact of it has been seen in the agricultural sector. But as stated in the WTO report (2015), donor countries such as the United States would be expected to increase aid for trade facilitation. According to the OECD, donor commitments had risen to US$ 670 million in 2013, representing about eightfold of the commitments in 2005. Hence, understanding the impact of the trade facilitation indicators on the efficiency of state level trade can help channel a direction for sister-city relationships and aid to specific countries that can boost state level trade efficiency.

1.4. U.S. Corn, Soybean and Wheat: A Diagrammatic Perspective

The three prominent agricultural commodities in US export markets are corn, soybean and wheat. In 2017, the USDA Foreign Agricultural Services data shows that 45% representing US$ 21.58 billion of country's bulk total agricultural exports was soybean followed by corn with an export value of US$ 9.11 billion or 19%. A pie chart of the bulk total agricultural commodities relative to each other is shown in Figure 1.1.

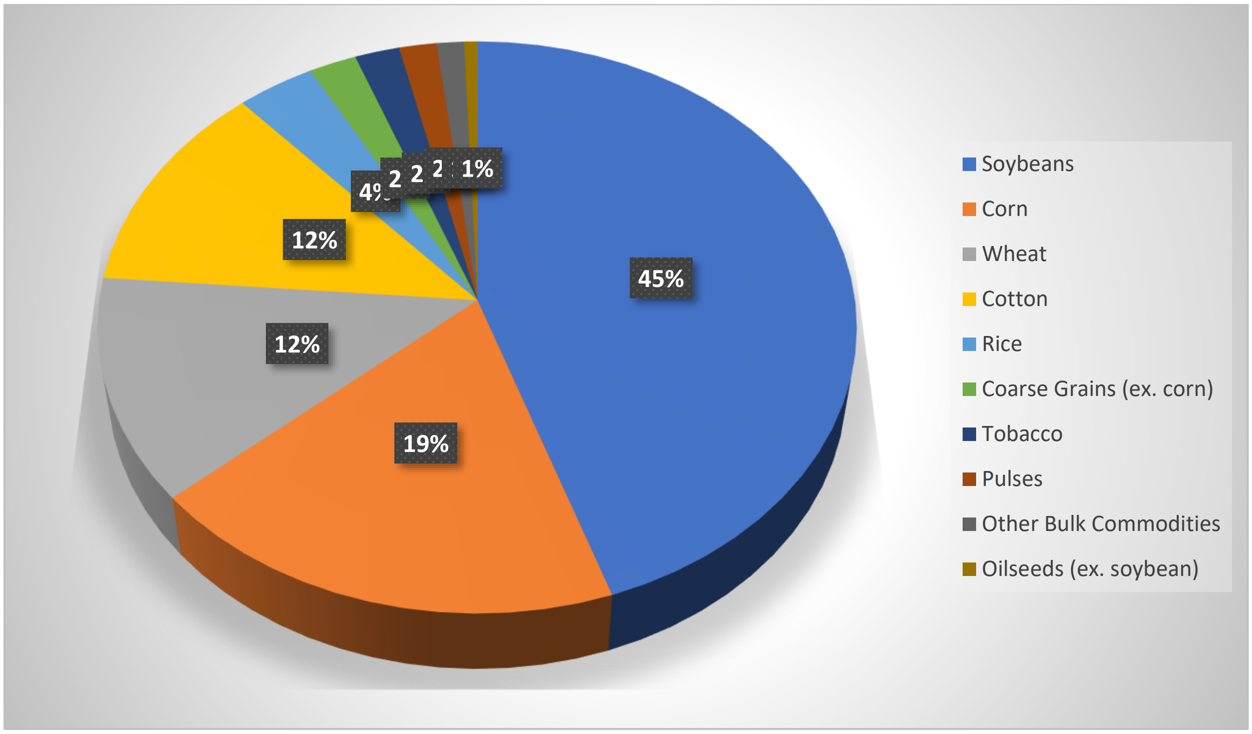

Figure 1.1: Percentage of U.S. Bulk Agricultural Export Commodities by Crop
Source: Foreign Agricultural Services, Official USDA Estimates 2017.

On the international market, the U.S. is among the leading producers of these three commodities. Figure 1.2, 1.3 and 1.4 briefly present a global overview of the production of these three commodities in 2016. From Figure 1.2, the U.S. produced about 0.384 billion metric tons of corn in 2016, followed by China with 0.219 billion metric tons.

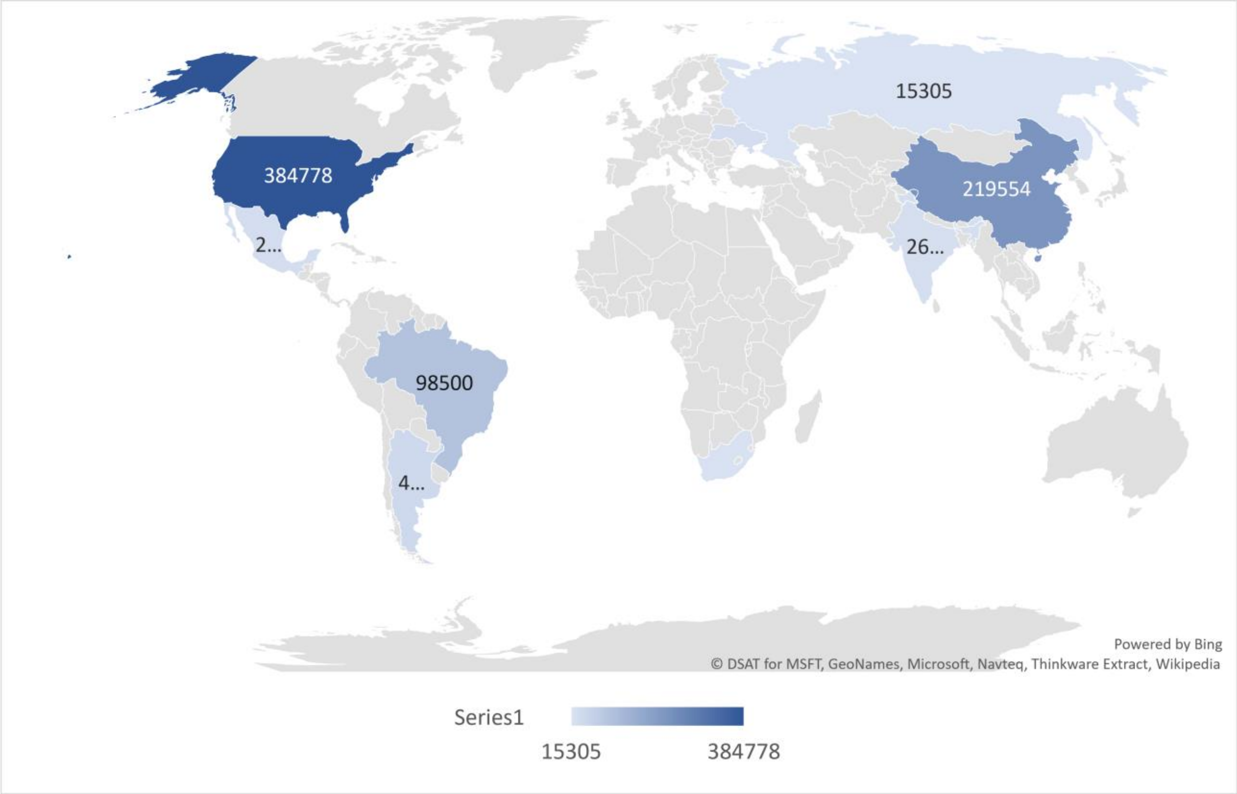

Figure 1.2: Major Producers of Corn Around the Globe
Source: Foreign Agricultural Service, Official USDA Estimates, 2017

The United States leads in soybean production. The FAS (2017) production estimates show that the U.S. produced 117,208,000 metric tons of soybean in 2016, followed by Brazil with 114,000,000 metric tons. For wheat, the world leader was China with 128,850,000 metrics and Russia with a production of 72,529,000 metric tons in 2016. The U.S. was the third major producer with 62,859,000 metric tons.

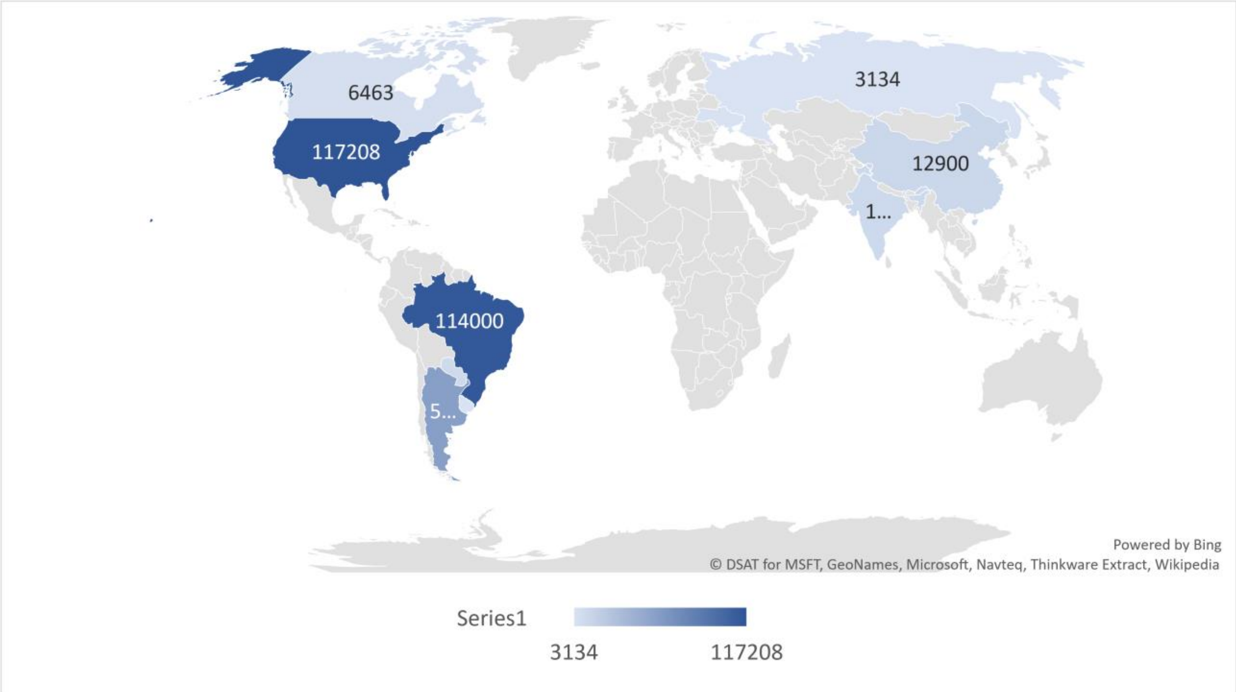

Figure 1.3: Major Producers of Soybean Around the Globe
Source: Foreign Agricultural Service, Official USDA Estimates, 2017

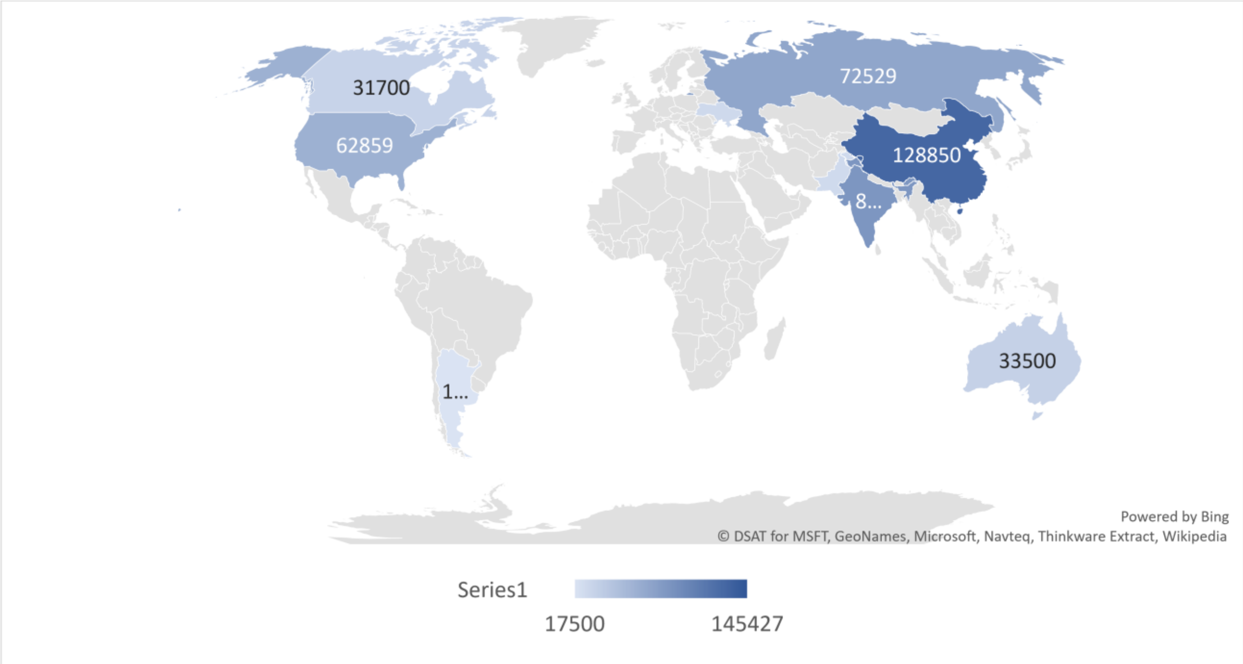

Figure 1.4: Major Producers of Wheat Around the Globe
Source: Foreign Agricultural Service, Official USDA Estimates, 2017

Even though the US performs well in the exports of these commodities, the exports of these three commodities has seen several fluctuations from 1970. Figure 1.5 reveals the export trend of these three commodities over the period. The importance of this trend is the implication of maximum potential exports not being reached in certain years compared to others. To reach export potentials for these commodities, the barriers to trade must be eliminated if possible or reduced. With the advent of trade facilitation agreements as a WTO priority for trade liberalization, the trade partners of the US will be required to play an important role in facilitating the trade of these produce. The major trade partners for the US are China, Mexico, Canada, Japan. Figure 1.6, 1.7 and 1.8 show the major export destinations for U.S. corn, soybean and wheat respectively.

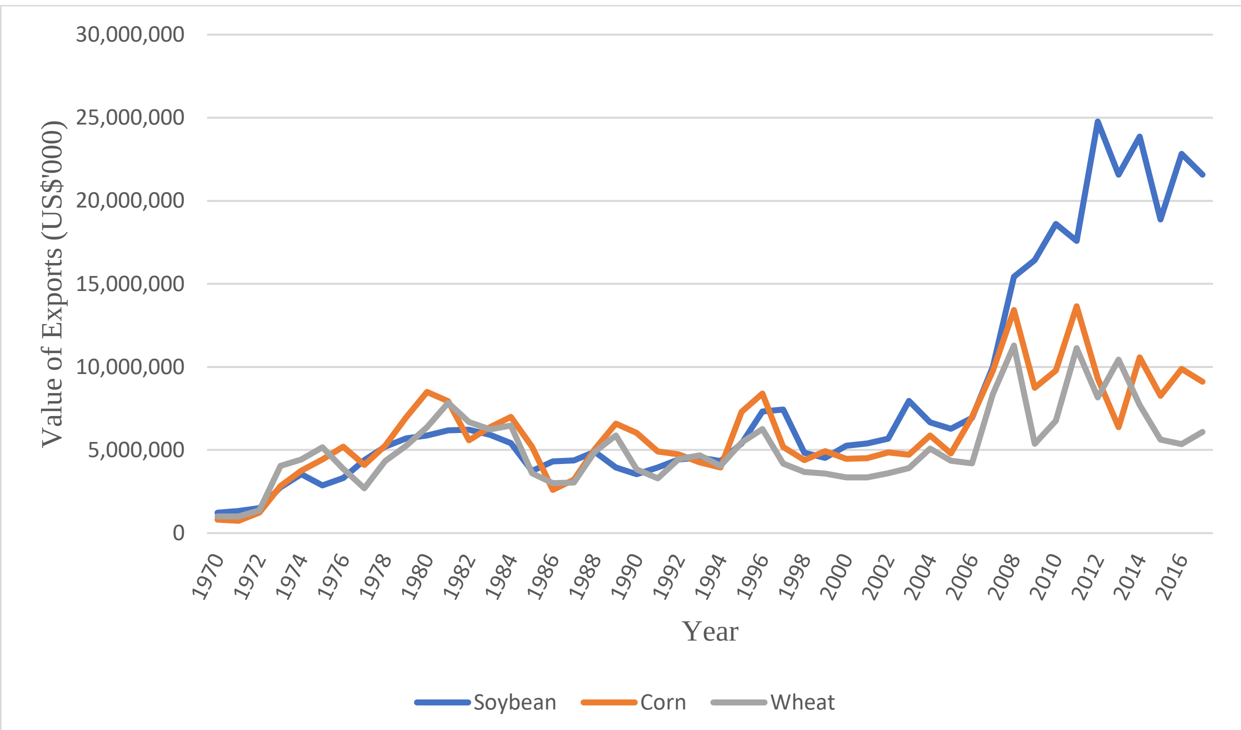

Figure 1.5: Trend of U.S. Corn, Soybean and Wheat Export
Source: USDA Foreign Agricultural Service (2017)

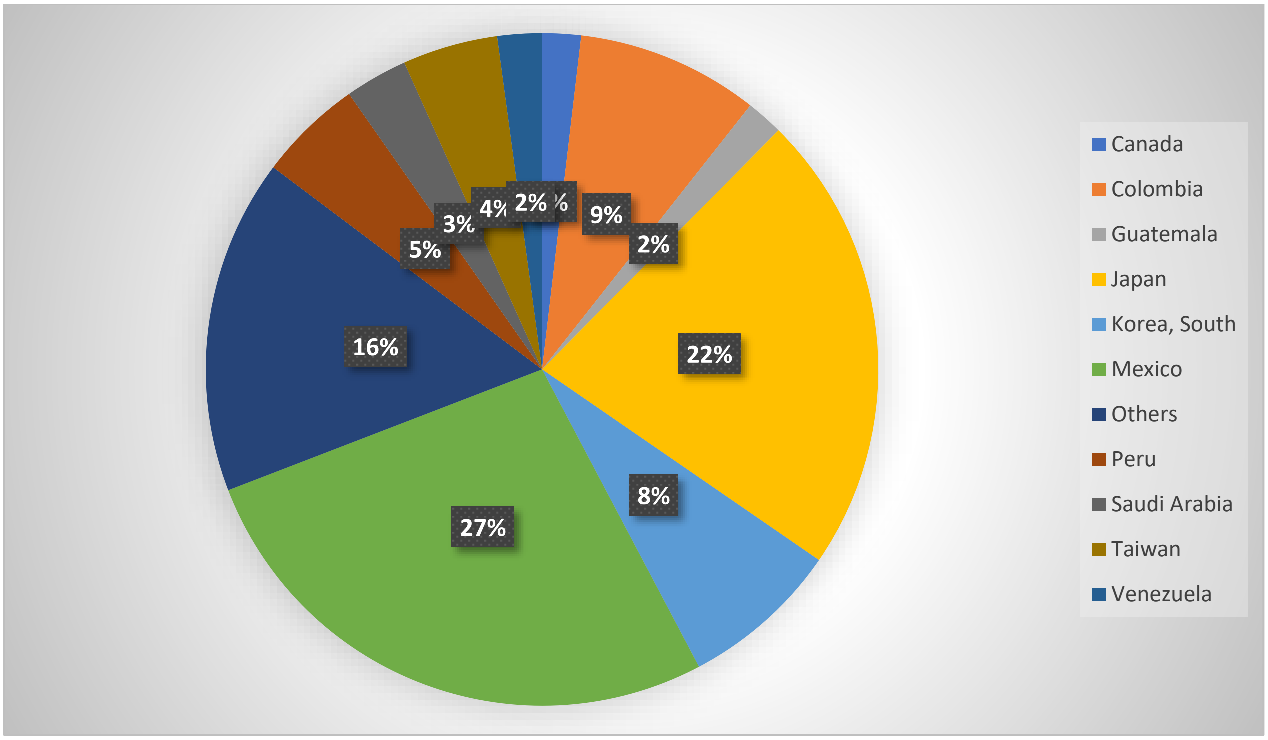

Figure 1.6: Top Export Destinations of U.S. Corn

Source: USDA Foreign Agricultural Service (2017 Trade Estimates)

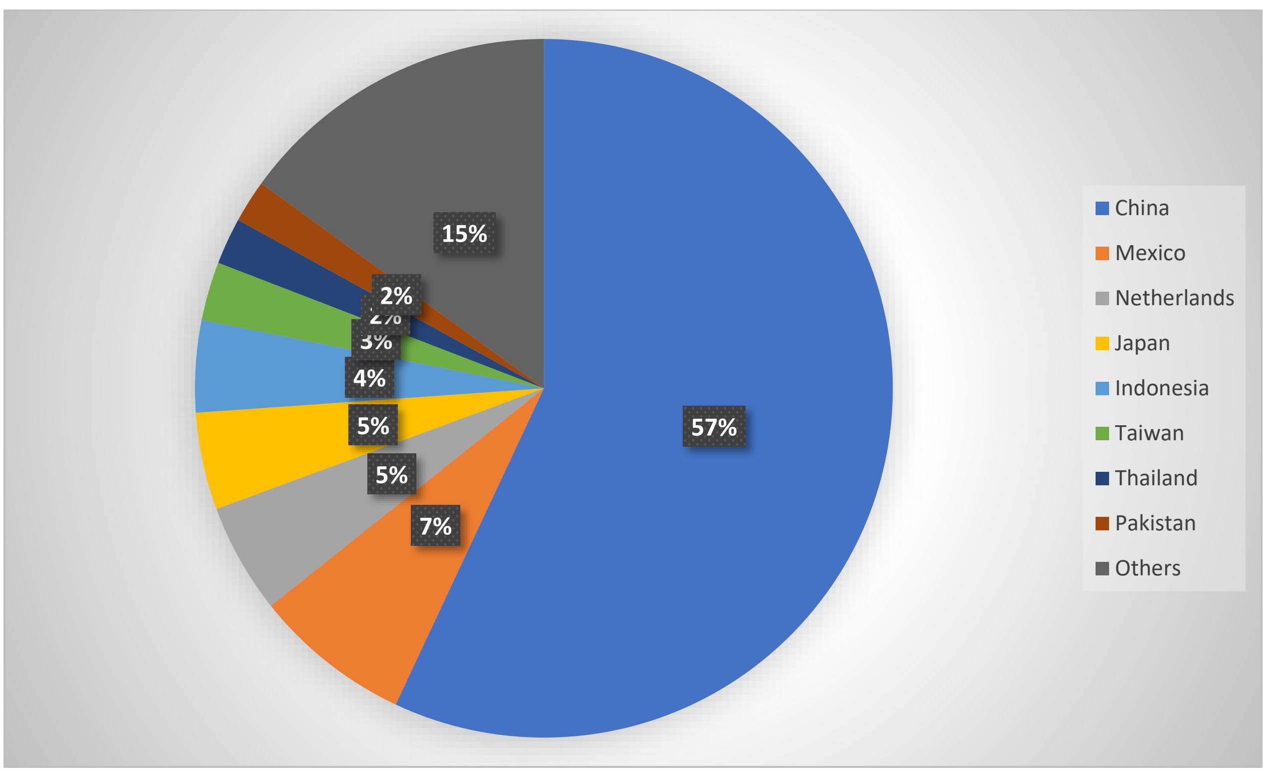

Figure 1.7: Top Export Destinations of U.S. Soybean

Source: USDA Foreign Agricultural Service (2017 Trade Estimates)

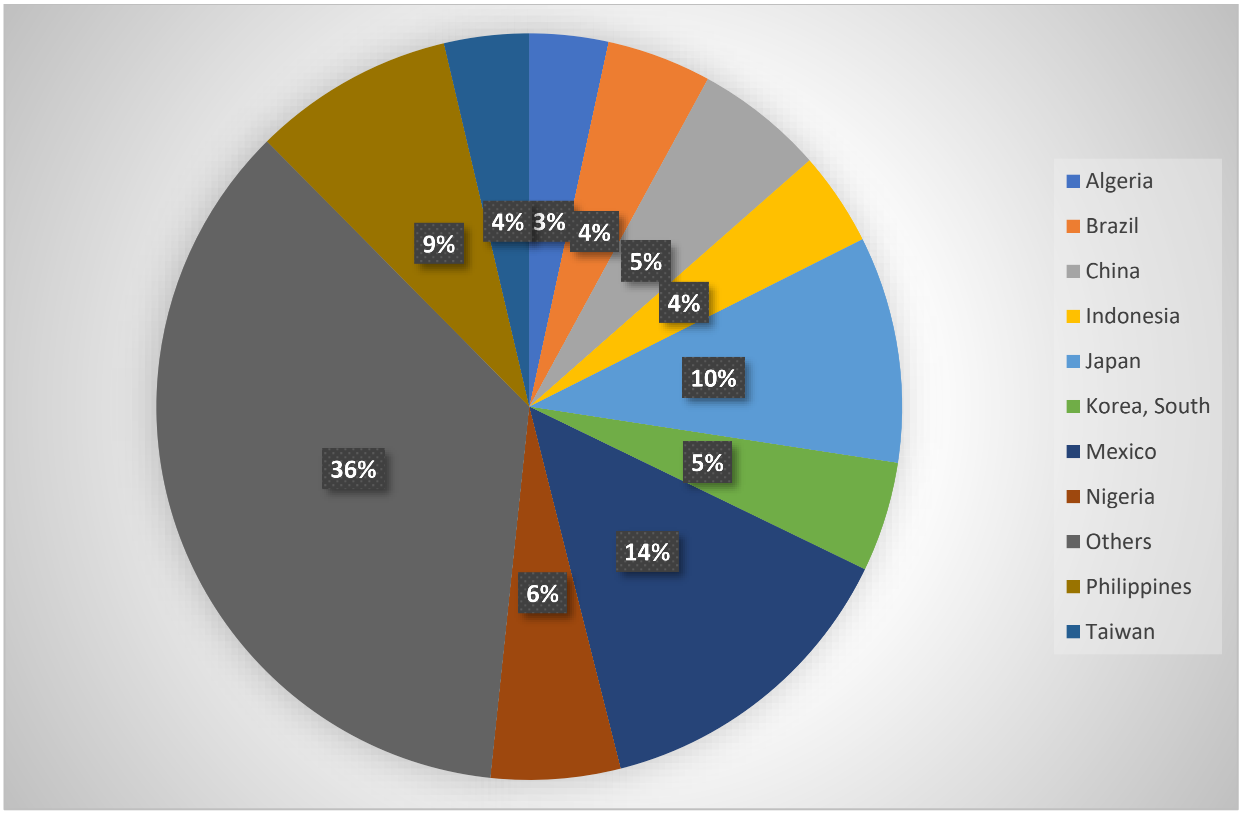

Figure 1.8: Top Export Destinations of U.S. Wheat
Source: USDA Foreign Agricultural Service (2017 Trade Estimates)

Based on the 2017 U.S Export estimates by the USDA Foreign Agricultural Service, the total export for corn, soybean and wheat by the country were US$9,143,348.00, US$21,683,809.00, US$6,312,693.00 respectively. The major destinations for corn in that year were Mexico, Japan, South Korea and Colombia with 27%, 22%, 9% and 8% respectively. About 57% of U.S. soybean exports in that year were sent to China. Mexico had 7% while the Netherlands and Japan had 5% each. From Figure 1.8, 14% of total U.S. wheat exports were sent to Mexico. This was followed by Japan with 10% and the Philippines with 9%. Nigeria had 6% while China and South Korea had 5% each.

1.5. Research Objectives

The main goal is to examine the role of trade facilitation indicators and genetically engineered restrictive index on US State exports and its efficiency. To achieve this goal, the two specific objectives of this thesis are;

i. To estimate the effects of destination or importing countries TFIs and GERI on state level export.

ii. To determine the impact of destination TFI and GERI on export efficiency.

The TFIs considered were drawn from two main sources (i) Four Enabling Trade Indices (ETI) developed by the World Economic Forum, and (ii) Genetically Engineered Restrictive Index (GERI) of the product destination constructed by author following the method introduced by Vigani and Olper (2015). Building on earlier methodology, rigorous econometric estimation techniques and necessary tests are performed to guarantee the reliability of the estimates obtained and consequently, the inferences and policy recommendations drawn.

1.6. Rationale of Study

The importance of trade facilitation was first discussed as a WTO agenda at the Singapore Ministerial Meeting in 1996 (Iwanow and Kirkpatrick, 2009). The "Bali Package" was quorum-agreed and signed in December 2013 at the 9th WTO Ministerial Conference. This package was a trade agreement that consisted of four major areas; Trade Facilitation Agreements, Food Security, Cotton Trading Issues and Production Subsidies, and Development and Least Developing Countries issues. Under the trade facilitation agreement, members were mandated to develop specific areas within their countries that hinder trade, particularly in the case of developing nations. Members are required to implement strategies to develop these deficient areas and improve trade openness. To achieve this, countries with deficiencies may dwell upon either monetary requirements or expertise from advanced countries.

As known, the US has been the refuge for most countries since the end of World War II. For instance, in 2014, the US donated about US$ 32 billion in the form of foreign aid. Based on this leadership role, identifying the impact of their partner's TFI on state level efficiency is essential because it will help determine key areas which both strengthens and limits trade with their partners. Based on this information, aids given to countries can be prioritised depending on which areas hinder the individual states exports potentials to them. Furthermore, areas for mobilisation of technical assistance and capacity building can be prioritised based on the outcome of this study. The measurement of trade restrictiveness over that years have been quite difficult and hence most studies use simple indicators that are not well grounded in trade theory (Rodriguez and Rodrik, 2001; Nicita et al., 2009). The current study presents a comprehensive set of indicators that measure trade facilitation, and consequently reveal the extent of trade restrictiveness.

The contribution of this paper can be summarized in these five major points. First, to the best of our knowledge, this is the first study to quantitatively analyse the impact of commodity destination's trade facilitation indicators on the US state level exports. Secondly, the potential of exports for each state in the Union is measured using a fusion of the stochastic frontier model and the traditional gravity model of trade measurements. Hence the export efficiency of these states is compared given the trade facilitation indicators of their trade partners. Thirdly, the impacts of GERI on the exports of crops that are genetically engineered and those that are not genetically engineered are compared. Penultimately, this is the first study to quantify the impact of the recently constructed genetically engineered restrictive index[5] of the US states' trade partners on their export

[5] In this paper, the Genetically Engineered Restrictive Index was constructed by the authors for 217 countries worldwide following the method introduced by Vigani and Olper (2015)

efficiency. Finally, policy makers have increased dependence on the ex-post estimates of the partial effects of trade partner characteristics and trade agreements to make decisions on international relations and choices. Hence, conducting this pioneer study at the state level will help provide policy makers with alternative considerations on TFI related decisions.

This paper is organized into six chapters. In chapter 2, the relevant literature is reviewed. This section discusses the impact of trade costs on trade flows followed by TFI. The two TFIs employed in this study, Enabling Trade Indices (ETI) and Genetically Engineered Restrictive Index (GERI) are highlighted. The link between TFIs and trade costs is also discussed in this section. Measures of productivity and efficiency are highlighted in this section. Empirical studies on TFIs and trade costs are finally discussed. In chapter 3, we present the data used for this study in addition to the sources. Chapter 4 presents the conceptual framework, theoretical foundations and model specification. We present the results and discussions in the penultimate chapter while the final chapter discusses the policy implications of our results and suggestions in section 6.

CHAPTER TWO. LITERATURE REVIEW

2.1. Introduction

This section reviews relevant literature to this research. A historical overview of the impact of trade costs on trade flows in classical trade models is first discussed. This is followed by a description of trade facilitation indicators, enabling trade index and the genetically engineered restrictive index. It also highlights empirical studies and econometric estimation techniques regarding this study.

2.2. The Impact of Trade Costs on Trade Flows in Classical Trade Models

Ironically, the Ricardian model which was among the first to explain international trade assumed a model without trade costs. Subsequently, the greatest plague of international trade has been cost of trade. Hence, the importance of trade costs on trade flows has been widely studied. The emergence of the "border puzzle" by McCallum (1995)[6] who drew conclusions based on inadequate econometric estimation techniques made the need to understand trade costs more important. Deardorff (2004) explained that the presence of trade costs prevents a proper description of the usual measures of comparative advantage[7]. His basic assumption was that a producer exports a good for which its own relative cost of production is low compared to the rest of the world. Prior to this research, Obstfeld and Rogoff (2000) opined that the 'unobserved costs' of trade could be possible culprits that account for the several puzzles of missing trade. The first attempt to address this issue has been attributed to Anderson and Wincoop (2003), henceforth AW. Despite AW (2003) "successfully" reducing McCallum's biased estimate from 2200% to 44%,

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[6] John T. McCallum told the world that trade among provinces in Canada was 2,200% more than trade between states in US and provinces in Canada. However, Anderson and Wincoop showed that his estimation did not have a theoretical foundation due to omitted variables leading to biased estimates.

[7] Comparative advantage among countries are usually conducted based on autarky prices or country's costs.

their study drew a lot of criticisms.[8] Among other reasons, it was argued that the log linearized OLS estimation of trade data employed in AW (2003) also leads to biased estimates in the presence of heteroscedasticity (Silva and Tenreyro, 2006; Westerlund and Wilhelmsson, 2007; Khan and Kalirajan, 2011).

Given the vast range of variables that affect trade, it is difficult to measure the real costs that account for trade between partners. Hence researchers normally base their analysis on the set of factors they desire to understand and explain. Khan and Kalirajan (2011) grouped all trade costs into four; 1) 'natural' transport cost, 2) 'behind the border' cost, 3) implicit 'beyond the border' cost and 4) explicit 'beyond the border' costs. The effects of 'natural' transport and 'behind the border' costs have practically been agreed upon in international economics literature. In that we know, agree and understand that "behind the border" cost is under the control of the home country while the effects of natural transport cost are embedded in technological improvements and energy efficiency in the transportation sector. The explicit 'beyond the border' cost[9] has been mitigated to a large extent by the WTO. Hence, the obvious culprit in the trade resistance issue is the implicit 'beyond the border' cost. Perhaps, these 'unobserved costs'[10] could be proxied from the trade facilitation indicators of a product destination. In subsequent sections, we discuss the components of the trade facilitation indicators and the extent to which they can boost or resist trade.

2.3. Trade Facilitation Indicators (TFI)

Trade facilitation is defined by the WTO as the simplification and harmonisation of international trade procedures. It dwells on four pillars which are transparency, simplification,

[8] Maybe it wasn't successfully after all.
[9] Explicit 'beyond border' costs are tariffs and other physical barriers to trade imposed by the destination country while implicit 'beyond border' costs are the hidden costs or barriers that are embedded in procedures such as border documentation, phytosanitary requirements and other seemingly unintended regulations and features of trade partners.
[10] As used by Obstfeld and Rogoff (2000)

harmonisation and standardization. The OECD (2002) found that trade transaction costs accounted for 15% of traded goods value globally. Trade facilitation aims to reduce all costs associated with trade including those derived from enforcement, regulation and administration of trade policies but excluding production costs (Anderson and Wincoop, 2004; Iwanow and Kirkpatrick, 2009; World Trade Report 2015). Moise et al., (2011) estimated that the measures which simplify trade procedures are likely to reduce trade cost by 5.4 %. OECD (2015)[11] estimated that the potential cost reduction in the full implementation of TFA will lead to 16.5% in cost reduction for low income countries, 17.4% for lower-middle income countries, 14.6% for upper-middle income countries and 11.8% for OECD countries.

Despite the existence of a wide range of trade facilitation indicators, the set developed by OECD in 2013 has been widely employed in research. This involves a full spectrum of the trade regulatory and customs procedures agreed upon at the WTO's Trade facilitation meeting in 2013, Indonesia. The 12 indicators developed are; publication and availability of information; opportunity to comment, information before entry into force and consultation; advance rulings; appeal or review procedures; other measures to enhance impartiality; non-discrimination and transparency; discipline on fees and charges imposed or on in connection with importation and exportation; release and clearance of goods; border agency cooperation; movements of goods under customs control intended for import; formalities connected with importation, exportation and transit; freedom of transit; and customs cooperation.

Since its introduction, these indicators have been updated every two years. Its recent version in 2017 has a total of 163 countries. The OECD Trade and Agricultural Directorate[12] views

[11] http://www.oecd.org/trade/WTO-TF-Implementation-Policy-Brief_EN_2015_06.pdf

[12] For further details, the interested reader should see the OECD report from the "Future Research Agenda for Trade Facilitation and Inclusive Growth Beijing" held on the 12 September 2013. The full report can be found on https://artnet.unescap.org/tid/projects/tfig-evdokia.pdf

the expected impact of these indicators in two dimensions; first its impact on trade cost and secondly, its impact on trade volumes or flows. And this corresponds to the objective of an exporter to either maximize exports subject to a given cost (level of trade resistance) or minimize cost (level of trade resistance) subject to a given level of exports. In the absence of trade quotas however, the exporting country places little or no priority to the second objective. Likewise, this paper focuses on the first objective of an exporting country within this context. TFIs are so diverse that various studies mostly focus on specific ones of interest (Sa Porto et al., 2015). However, this study employs a set that encompass a wide area related to the TFI of a country. These two TFIs are the ETIs and the GERI.

2.3.1. Enabling Trade Indices (ETI)

These indices form part of the TFIs constructed by the OECD. They were constructed by the World Economic Forum[13] and the Global Alliance for Trade Facilitation as a measure of a country's trade openness. Being biennially released, five editions have been constructed since its inception in 2008. The index consists of four broad areas which are indicators of the ease of trade; border administration; market access; infrastructure; and operating environment. A brief description of the components of these sub-indices can be found in Table 2.1. These four areas were constructed from various sub-pillars that are based on the framework of the WTO TFA.

[13] A comprehensive report of the Global Enabling Trade 2016 Report can be found on the World Economic Forum website http://www3.weforum.org/docs/WEF_GETR_2016_report.pdf . This is a joint publication of the World Economic Forum and the Global Alliance for Trade Facilitation. The current study presents only portions of this report and other sources that sufficiently explains its objective.

Table 2.1: List of Variables Used for Constructing Enabling Trade Indices

Sub Index	Pillar	Variables Considered
Market Access	Domestic Market Access	Effective Trade Weighted Average applied by country Share of goods imported duty free Complexity of tariff regime measure through tariff variance Prevalence of tariff peaks and specific peaks Number of distinct tariffs
	Foreign Market Access	Average tariffs faced by country Margin of preference in destination markets negotiated through bilateral or regional trade agreements
Border Administration	Efficiency and Transparency of border administration	Range, quality and comprehensiveness of customs and services of related agencies Average time, costs and number of documents required for export or import process Predictability and transparency of border processes Prevention of corruption
Infrastructure	Availability and quality of transport infrastructure	Measures road transport, air transport, railroad and seaport infrastructure. Air connectivity Sea-line connectivity
	Availability and quality of transport services	Presence and competences of ship and logistics companies Ease, cost and timeliness of shipments Postal efficiency
	Availability and use of ICT	Use of mobile and telephone services Quality of internet access Number of available business for transactions
Operating Environment	Operating Environment	Level of protection of property rights, the quality and impartiality of its public institutions Efficiency in enforcing contracts Availability of finance Openness to foreign participation in terms of foreign investments and labour Level of personal security measured by the incidence of crime and terrorism.

Source: Summary of Construct from World Economic Forum[14]

2.3.2. Genetically Engineered Restrictive Index (GERI)

Based on the WTO regulations, countries can implement policies within the "Agreements on the Application of Sanitary and Phytosanitary Measures" framework (SPS Agreements). This deals with the application of food safety, animal and plant health regulations. The agreement gives countries the full mandate of ensuring that food is safe for their consumers and prevent the spread

[14] Full details on the indicators used and the methodology used for these variables can found on http://reports.weforum.org/global-enabling-trade-report-2016/the-enabling-trade-index-2016-framework/

of diseases or pests among plants and animals. In general, these measures were deemed to restrict trade to some extent. Hence, the WTO has urged governments to establish measures consistent with international standards.

However, the emergence of genetically engineered foods (GE foods) in 1994 sparked persistent disagreements among countries and scientists. As at now, there is no conclusive consensus on the health hazards of GE foods. Countries that favour GE foods include the United States, Brazil, Argentina, India, Canada, China, Paraguay, Australia, Uruguay and South Africa. On the contrary, all or majority of the European Union do not support GE foods. In recent past, countries that have banned GE (either imports or domestic production) include but not limited to Peru, Russia, Switzerland, Egypt, Japan, France and Ireland. That notwithstanding, those that have not banned GE foods place tight restrictions on their imports, particularly among the European countries such as Germany and Italy. This animosity towards GE foods among certain countries place some extent of restriction on the trade of those who cultivate it (FAO, 2014). Meanwhile, GE varieties of corn and soybean constitute the major grain exports of the U.S. The USDA ERS[15] indicated that GE corn covered about 89% of domestic corn produced in the country. This high proportion implies that the impact of GE restrictions and bans by trade partners is expected on state level exports in the US. Figure 2.1 shows the percentages of GE corn and soybean produced in the US from 2000 to 2017.

Another important export crop in the US is wheat. However, the USDA ERS indicated that there is no commercial production of wheat in the United States[16].

[15] A report on the trends in GE adoption and cultivation can be found on the USDA ERS web page through this link https://www.ers.usda.gov/data-products/adoption-of-genetically-engineered-crops-in-the-us/recent-trends-in-ge-adoption.aspx

[16]Further reading on non-commercial production of GE wheat in US can be found on https://www.ers.usda.gov/topics/crops/wheat/background.aspx

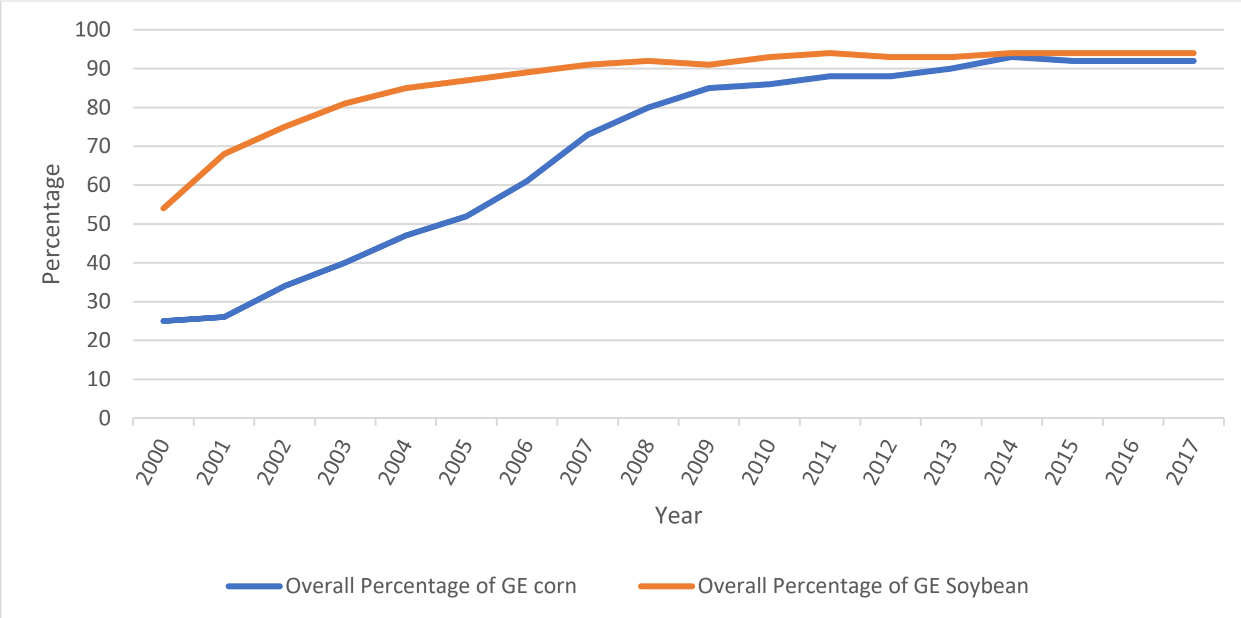

Figure 2.1: Percentage Production of GE Corn and Soybean in U.S.
Source: USDA Economic Research Service (2018 Estimates)

2.4. Link Between Trade Facilitation Indicators and Trade Costs

The preamble in preceding sections of this chapter suggests that there is a firm relationship between improving TFIs and reduction in trade costs. Hence, we hypothesize in this study that an improvement in any of these indicators can reduce trade cost and consequently improve the trade flows (i.e. exports to that destination). Of course, there has been several testaments of literature to support this. However, the noble focus of this literature is the effect of the improvement of the destination's TFI on the origin's import to the destination. In that regard, we present a testable hypothesis that there is a link between the export of commodities from US states and the trade facilitation characteristics of its partners. Wherein, if the destination's characteristics are improved, the quantum of trade from the states to these countries will also improve. In summary, these TFIs are viewed as cost reduction tools that must be improved to increase exports.

2.5. Efficiency Measures

The concern about performance has led to a wide extent of literature on productivity and efficiency analysis. This may be attributed to increasing demand at minimum costs. Despite the frequently exchanged use of these two terms, productivity and efficiency are different concepts. Productivity is a measure of the ratio of the aggregate output to the aggregate input used in a production process. This is a non-compared performance measure. Efficiency on the other hand is a relative performance measure. It is defined as the maximum amount of output that can be acquired from a given level of input or minimum amount of inputs that can be used to obtain a set level of output. A major difference in these two concepts is comparability of production. The essence of competition among firms has led to a wide range of focus on efficiency analysis.

Efficiency analysis has been historically attributed to Farrell (1957), whose seminal paper introduced the concept of technical and allocative efficiency. Since then, it has been expanded and generalized by Charnes et al., (1978) and Banker et al., (1984) among others. There has been a huge advancement of related literature such that, a single study such as this may not be able to discuss them all. However, key concepts related to this study will be discussed.

Efficiency measures have normally been obtained through either parametric (Stochastic Frontier Analysis) or non-parametric (Data Envelopment Analysis) methods. Despite several debates on which of these is the best, each is wholesome for specific purposes. According to Shaik et al., (2017), DEA for instance is advantageous in the sense that, it does not impose an ‘a prior’ functional form, can handle multiple inputs and multiple outputs, and further compute the efficiency in the absence of price data. Hence non-parametric techniques envelopes the observations based on the frontier. The frontier is measured by the maximum distance between the output and inputs. Coelli et al., (2005) defined the random errors and the characteristic deviations from the frontier as the inefficiency. The parametric method (Stochastic Frontier) decomposes the errors into the white noise and the inefficiency term. (Aigner et al., 1977; Battese and Coelli, 1995) This is an advantage of the SFA. In this study, emphasis is laid on the SFA efficiency measure to establish the export efficiency levels among the states.

2.6. Empirical Studies

International economics remain one of the most exploited research areas in the field of economics. This could be linked to the fact that individual, businesses, countries and regions are mindful that their successes are not only dependent on what goes on around them within their own countries and regions but also on others. Despite trade activities predating the sixteenth century, the foundations of the free market laid by Adams Smith in the eighteenth became the springboard for later trade studies. It further proliferated after Tinbergen's gravity model application.

According to Chan et al., (2014), three major areas have been considered over the years under trade studies. The first group have focused on the economic theory underlying the gravity model while the second and third have dealt with the empirical specification and econometric issues respectively. However, a well specified trade gravity model would often end up dealing with all three areas. In that regard, this section briefly delves into empirical studies on the impact of trade costs on exports and other factors limiting export potentials of exporter countries. In addition, studies on challenges encountered in the use of the panel data for trade data analysis and prescribed remedies will be discussed in this section.

2.6.1. Trade Efficiency Studies

Few studies have been conducted on the determinants of trade efficiency. Kalirajan (1999) examined the difference between actual and potential trade based on trade between Australia and its trading partners in the Indian Ocean Rim. His study emphasized on the fact that, the error term of a gravity model is accounted for by a wide majority of factors such that the gravity model with fixed coefficients will be inappropriate in estimating it. In effect, he introduced the stochastic varying-coefficient gravity equation to measure the difference in trade. The benefits of this introduced methodology were not clearly distinguished from the existing methods. Kalirajan (2007) used the stochastic frontier productions to examine country-specific resistance to bilateral trade flows between countries. His focus was on the effect of regional cooperation on export potential. He found that regional cooperation had led to about 15% increase in Australia's trade potential. The variables considered in his study were the GDP, populations, distance and regional cooperation dummy.

Another influential study on trade efficiency was by Ravishankar and Stack (2014). Their study used a panel data of 17 origin and 10 destination countries spanning from 1994 to 2007. It was revealed based on the SFA results that trade efficiency was determined by exporter GDP, distance, GDP per capita difference, whether the destination is landlocked or not and the accession into EU-2004 and EU-2007. Doan and Xing (2018) studied the efficiency levels of Vietnam's exports with its major trading partners using a stochastic frontier gravity model. Using a panel data from 1995 to 2013 comprising of 28 of Vietnam's trading partners, the authors focused on the impact of free trade agreements and rules of origin. Other variables included in their model were the traditional variables of the gravity model. Their results revealed that ASEAN membership contributed to the country's trade efficiency while rules of origin and non-membership of EU and NAFTA had a negative impact.

2.6.2. Studies on Trade Costs and Trade Facilitation Indicators

Wilson et al., (2003) analysed the relationship among trade facilitation, trade flows and GDP per capita in the Asia-Pacific region for the goods sector. The country specific port efficiency, customs environment, electronic-business usage and regulatory environments were used as the indicators. Their major findings were that port efficiency has a positive impact on trade. Regulatory barriers were found to decrease trade. The policy recommendations drawn from their paper was that improvements in customs and greater electronic business use could be used as tools for trade expansion. In addition, their model predicted that an improvement in the four areas could boost intra-APEC trade by US$ 254 billion which represented about 21% of their trade.

Iwanow and Kirkpatrick (2007) investigated the impact of the implementation of trade facilitation, quality regulation and infrastructure indicators on export performance. Their study indicated that a 10% increment in trade facilitation would yield a 5% increase in export. Also, a 10%, increment in the regulatory environment and quality of infrastructure provision were found to yield about 11% and 8% respectively. They concluded that trade facilitation alone is unlikely to result in a significant improvement in export performance. Later in 2009, these authors again show that liberalizing trade is not enough to achieve high export performance.

Helble et al., (2009) examined impact of transparency in the Asia Pacific. Their study employed four main variables; structure of trade policy, logistics, supply chain development and policy implementation, customs and border procedures, and importer and exporter transparency index. They concluded that improving trade-related transparency in APEC could hold significant benefits by raising intra-APEC trade by approximately US$148 billion or 7.5 per cent of baseline trade in the region. Shepherd and Wilson (2009) accessed the importance of trade facilitation indicators on trade flows in Southeast Asia. Their analysis was conducted for 6 sections in this region; Food, Industrial Supplies, Fuels, Capital goods, Transport Equipment and Consumer goods. They found that trade flows in Southeast Asia are sensitive to transport infrastructure and information and communications technology. Hence, they concluded that the region could make significant economic gains from trade facilitation reform.

Portugal-Perez and Wilson (2012), trade facilitation measures were grouped into ‘soft’ infrastructure, which is related to intangible measures such as transparency, customs management, the business environment, and other institutional aspects that are intangible; and ‘hard’ infrastructure which also includes all the tangible measures, examples being roads, ports, highways, telecommunication and other infrastructure. Based on a panel data for 101 countries spanning 3 years, they found that trade facilitation in general increases export performance. Specifically, physical infrastructure and regulatory reforms to improve the business environment had positive impacts. A key component of their study was the inclusion of models involving interaction terms. Based on this, they found that the marginal effects of infrastructure improvements on exports declined with increase in per capita income. Exports were found to increase with information and communications technology for relatively richer countries.

Beverelli et al., (2015) examined the effect of trade facilitation on export diversification using extensive margins. This assessment was conducted both on the world bank regional and income classification levels. They measured this variable in two dimensions; exports of new products and exports to new destinations. Their results concluded that trade facilitation had a positive impact on extensive margins of trade. The employed measure of trade facilitation were the market access index and the average trade facilitation index developed by the World Economic Forum. Their analysis was a cross-sectional one due to the availability of a single period data for the TFI. Sa Porto et al., (2015) analysed the impacts of selected trade facilitation measures on international trade flows for 72 countries over a two-year period (2011 and 2012) within the gravity model framework. They employed four estimation techniques; pooled cross-section model, fixed effects model, random effects model and the Poisson maximum likelihood estimator. Their study employed the Authorized Economic Operator (AEO) TFI measure. ion arrangement between pairs of countries in the sample. Their results revealed that the presence of an authorized economic operator program and the existence of a single-window program will improve countries' trade performance. However, the existence of a mutual recognition arrangement will not necessarily improve countries' trade performance.

In summary, the literature on trade facilitation indicators indicate that the improvement in TFI will lead to trade expansion of the origin. A handful of the studies have had contrary results. Yet still, it is important to elaborate on the fact that these are the effects of the improvement of a country's TFI improvements on its trade expansion. Practically, none discussed the effect of the improvement of a country's trade partners' TFI on its exports to it.

2.6.3. Studies on GE Restrictions and Agricultural Product Standards

The impact of trade barriers on agricultural exports and trade potential has been widely studied. The effect of product standards on developing agricultural exports to the EU was studied by Shepherd and Wilson (2013) using the gravity model. The study employed a panel data from 1995 to 2003. They revealed that voluntary product standards in EU food and agriculture markets can have significant trade effects. EU standards were found to be trade-inhibiting for goods that are raw or lightly processed. On the other hand, internationally harmonized EU standards have much weaker trade effects and for a few cases, were found to be trade-promoting. The concluded that EU standards may negatively affect developed countries more than developing countries in the agricultural sector.

Cemal (2014) studied the effect of low-level presence (LLP) and adventitious presence (AP) of GE Organisms on international trade flows for maize. On a broad perspective, they concluded that GE regulations had a restrictive effect on trade on maize trade flow. However, the LLP threshold had an ambiguous effect on trade flows of maize. From their study, many countries reported that they have a GE regulation but did not have a declared LLP threshold. The EU applies a technical solution for feed and few other countries adopt the EU regulations. They recommended that GE crop producing countries, either research or commercialized production, should take all the necessary measures in the stages of production, harvesting, transportation, storage, and marketing to eliminate low level of presence in conventional crops.

Also, Ferro et al., (2015) studied effect of product standards on agricultural exports using 61 importing countries and 66 different products. Their study introduced and employed a measure of standards restrictive index to access this impact. Using the gravity model, they found that more restrictive standards were associated with a lower probability of observing trade. However, they found after controlling for sample selection and proportion of exporting firms in a gravity model that the effect of standards on trade intensity in most cases is indistinguishable from zero. Their results also indicated that exports from developing countries are constrained by stricter standards.

2.6.4. Studies on U.S. State Level Export Performance

At the state level in US, the determinants of the performance of manufacturing exports was first studied by Coughlin and Fabel (1987). Their study employed a pooled data from 1963 to 1980 for all the fifty US states within the Heckscher-Ohlin-Vanek model. It was found that physical capital and human capital were statistically significant in determining the performance of manufacturing exports. Overtime, the importance of physical capital declined while that of human capital increased. However, their study is not the same to the current study because, trade factors were not considered in their model. Yet still, their research is the closest to what the current study desires to achieve in terms of state level export efficiency.

2.7. What We Can't Escape: Expected Estimation Problems and Possible Solutions

This section presents the possible problems to empirical estimations and their suggested solutions from literature. To be able to draw meaning conclusions and inferences from the OLS[17] regression estimates, the Gauss-Markov's[18] assumptions must be met. The valuation of these ideal conditions may lead to diverse issues such biasedness, inefficiency and inconsistency. Specifically, failure to formulate the least square estimation parameters in a linear form will lead to wrong estimates. If the expected value of the error term is not zero as expected, i.e. $\sum \varepsilon_i \neq 0$, a biased intercept will be obtained. A violation of the constant variance assumption $V(\varepsilon_i) = E(\varepsilon_i^2) = \sigma_\varepsilon^2$ will lead to biased standard errors even though it does not cause biased estimates. Despite this, obtaining biased standard errors can lead to Type II errors[19] which may lead to inconsistent inferences. However, Fox (1997) indicated that heteroskedasticity is only worth correcting when the problem is severe. When assumption of no correlation between the error terms, $[Cov(\varepsilon_i, \varepsilon_j) = E(\varepsilon_i \, \varepsilon_j) = 0, i \neq j]$ is violated, large standard errors are obtained. This problem may occur as spatial correlation in panel and cross-section or as serial correlation for panel and time series.

In general, some of these assumptions are relevant for gravity model estimation and trade data analysis. Hence, the related ones and other essential issues are discussed further in this section. The focal issues in this section are zero trade problem, missing data, reverse causality, unobserved heterogeneity and cross-sectional dependence. Possible remedies from literature are considered

[17] The OLS estimation method been the commonly used estimation technique for gravity model estimations. Alternative estimation techniques have been discussed in recent years due to its flouting of the Gauss-Markov's assumptions.
[18] The Gauss-Markov's assumption states that if a linear regression model has a zero-expected value for its errors which are uncorrelated in addition to having a minimum variance, then the Ordinary Least Squares Estimator yields the Best Linear Unbiased Estimator (BLUE).
[19] Type II Error implies the failure to reject the null hypothesis at a given level of significance when it is uncharacteristic of the true population. Biased standard errors lead to this condition because the hypothesis is formulated based on the standard errors.

and the techniques with the optimal estimates are discussed. Optimality in this case desires unbiased and consistent estimates.

2.7.1. Endogeneity

A major issue associated with the empirical estimation of panel gravity models is endogeneity. For instance, despite the basic model implying that GDP or income leads to increased trade, a clear-cut relationship on the directionality between these two components have not been established yet. In the specific case of this study, improvements in TFI is assumed to lead to increased exports. However, the nature in which these variables were constructed may also lead to a counterintuitive argument that improvements in TFI is because of increased level of trade. Thirdly, we agree with AW (2004) that the determinants of trade are too vast to be modelled in one go, hence the possibility of omitting essential variables in our model cannot be ignored.

We tend not to dwell much upon measurement error considering its low probability of occurrence, yet we do not completely rule out its chances of occurrence. As widely known, endogeneity leads to biased estimates and inconsistent, hence must be corrected. AW (2003) suggested the use of a non-linear least squares estimation to solve this problem. AW (2003) and Feenstra (2004) also suggested the use of country fixed effects to handle endogeneity to obtain unbiased estimates.

2.7.2. Heterogeneity

Heterogeneity has been widely documented as one of the sources of biased estimates in gravity model estimations. This implies the differences among trade partners that are omitted from the model. The two groups are observed heterogeneity and unobserved heterogeneity. Glick and Rose (2002) suggested that the country(partner)-paired fixed effects are symmetric and hence recommended the symmetric fixed effects as a solution to heterogeneity. This imposes the restriction that partner-paired fixed effects are symmetric i.e. $\gamma_{ij} = \gamma_{ij}$. In summary, proponents of accounting for heterogeneity in trade models imply that there are differences between trade partners which could affect trade flows. However, if GDP is the market value of all goods and services produced in a country in a specified period, then what else could have been excluded from the model? Based on this definition of GDP, we assume that all differences between partner-pairs have been accounted for. AW (2003) suggested the importer and exporter fixed effects to control for inward and outward multilateral resistance respectively.

2.7.3. Missing Data, Zero Trade and Heteroskedasticity

Another expected problem associated with trade data is the occurrence of zero trade flows. This may be because of some trade partners not trading within a given year or certain agencies not reporting trade values below certain thresholds. Many studies ignore this missing or zero trade and estimate with log linearized model. This may lead to two consequences; it leads to non-constant variance (heteroskedasticity) or it may lead to sample selection bias if values are used as logs. There have been many solutions suggested to cater for this through empirical studies.

Two main solutions have been dominantly discussed in literature. The first group is based on Krugman (1979) New Trade Theory. This theory which was later developed into the "New" New Trade Theory by Melitz (2003) suggests that trade may not necessarily be attributed to factors such as geographical proximity as originally perceived in the gravity model. But may also be linked to firm characteristics such as economies of scale. Hence, Helpman et al., (2008) based on this theory indicated that, zero trade may be a policy decision where industries find it unprofitable to bear the fixed costs associated with trading with the destination market. They therefore suggested that this decision-making process can be modelled as the first stage of the trade estimation process. This therefore leads to the two-stage Heckman (1979) sample selection process. In stage one, all the zeros are captured to determine why trade occurs. The second stage incorporates the inverse Mills ratio to correct for the sample selection bias. This model is mostly useful for studying intensive and extensive margins in trade[20]. Other estimation techniques that employ similar concepts are the tobit model and the double hurdle model.

The second group of advocates led by Silva and Tenreyro (2006) suggested the use of the Pseudo-Poisson Maximum Likelihood (PPML) estimation technique to handle this issue. Other advantages are provision of consistent estimates in the presence of fixed effects and interpretation of coefficients of independent variables as semi-elasticities. However, Burger et al., (2009) critiqued that the standard Poisson model is not appropriate in the presence of over dispersion and excess trade zero flows. Hence, they suggested and justified the use of another family of generalized linear models (GLM), namely negative binomial and zero-inflated Poisson models (Poisson fixed-effects estimation techniques). One limitation of this approach is that the estimator only accounts for heteroskedasticity partially and hence inferences drawn must be based on the Ecker-White robust covariance matrix operator.

2.7.4. Serial Correlation

The presence of serial correlation does not lead to biased or inconsistent estimates of the static OLS estimator but makes the estimates inconsistent and invalid in dynamic models. It also leads to inefficiency of estimates in static OLS models.

2.7.5. Test of Time Series Property

Testing for stationarity of time series or panel data is very essential in regression analysis. This is primarily important because a non-stationary series is derived from persistent shocks and

[20] Intensive margins of trade involve increasing the intensive of trade with existing trade partners while extensive margins of trade involve finding or beginning new trade partnerships. Heckman et al., (2008) indicated that the first stage explains the exit and entry patterns (extensive margins) while the second stage explains the intensity of trade (intensive margins).

can lead to spurious regression results. Spurious regressions occur when the R-squared obtained is high even if the independent variables are not particularly related to the dependent variable. In the presence of non-stationarity, the standard assumptions of asymptoticity will not be met. If the asymptotic properties of a regression model are not met, the t-ratios become invalid which makes hypothesis testing liable to type I or type II errors.

Despite the idea of unit roots testing being originally suggested for time series, it has been propagated in panel data analysis over the past two decades. The basic difference between time series and panel data unit root testing is embedded in heterogeneity. Heterogeneity may result from the addition of cross-sectional units in panel data. The complexity of panel data unit root test is based on this characteristic given that, few panel data are homogeneous. However, seminal papers by Levin and Lin (1992, 1993) and Levin et al., (2002) paved way for tests based on heterogenous panels. An issue of importance in the treatment of balanced and unbalanced panel unit roots test. Most of the unit root tests require the panel to be balanced. However, the Fisher unit root test does require such a restriction. Baltagi (2005) stated that it combines information based on individual unit root tests. Proposed by Maddala and Wu (1999) and Choi (2001), the Fisher test is written as;

$$P = -2\sum_{i=1}^{N} Inp_i \ , \quad (2.1)$$

Where the p-values are combined from individual cross-sectional unit root tests in the panel data. $-2Inp_i$ has a X^2 distribution with 2 degrees of freedom and P is distributed as a X^2 distribution with 2N degrees of freedom as $T_i \to \infty$ for finite N. The Fisher test for non-stationarity as the null and tests for cointegration in the panel. According to Baltagi (2005), the two other tests besides the Fisher's inverse chi-square test statistic P are the inverse normal test $Z = \frac{1}{\sqrt{N}}\sum_{i=1}^{N} \Phi^{-1}(p_i)$, where Φ is the standard normal cumulative distribution function. Because $0 \le p_i \le 1$, $\Phi^{-1}(p_i)$ is an $N(0,1)$ random variable and as $T_i \to \infty$ for all I, $Z \Rightarrow N(0,1)$. Both the first and second tests were proposed by Choi (2001). The second is a logit test $L = \sum_{i=1}^{N} In\frac{(p_i)}{(1-p_i)}$ which assumes a logistic distribution for $In\frac{(p_i)}{(1-p_i)}$ with a mean 0 and variance $\pi^2/3$. The advantages gained from these three Fisher-type tests are similar. These are (1) The dimensionality of the cross-sections can be either finite or infinite, (2) The presence of different types of stochastic or non-stochastic components do not matter, (3) The time-series dimensions are permitted to be heterogenous for each *i*, and (4) Some groups will have unit roots while others may not due to the specification of the null hypothesis.

CHAPTER THREE. DATA AND VARIABLES CONSTRUCTION

3.1. Data Sources

The state level exports of corn, soybean and wheat were obtained from the USDA Foreign Agricultural Services database on (https://apps.fas.usda.gov/gats/default.aspx). This link provides the total states export of each crop from 2004 to 2017 at both monthly and annual levels. The time-span of this variable formed the basis for this study's period. Annual export values of the commodities were considered. Data on the state level population was obtained from the Federal Reserve of St. Louis on (https://fred.stlouisfed.org/search?st=State+population+USA). The state level GDP for both the agricultural sector and the total GDP were obtained from the Bureau of Economic Analysis on (https://bea.gov/national/index.htm#gdp). To obtain the characteristics of the trade destinations, the gravity variables data set which was constructed by the Centre d'Etudes Prospectives et d'informations Internationale[21] (CEPII) research expertise on world economy was accessed from (http://www.cepii.fr/CEPII/en/bdd_modele/bdd_modele.asp). This gravity dataset was constructed by the institute using data sources from World Bank Development indicators, Baier and Bergstrand, the WTO, Frankel (1997); and Glick and Rose (2002). The Enabling trade indices were obtained from the World Economic Forum on (http://reports.weforum.org/global-enabling-trade-report-2016/enabling-trade-rankings/). This link has the overall ETI, the four sub-indices and seven pillars. The focus of this study however remains on the four sub-indices. This variable is treated as time invariant in the model because the WEF[22] indicated that, the implementation of the TFI measures will require an average of 3 years with some needing as much as 5 years for implementation. Hence, we assume that these characteristics are developed by countries over time rather than in year. Furthermore, the period for this study is 12 years and

[21] Name kept in French as shown on their website
[22] http://www3.weforum.org/docs/GETR_2016/WEF_GETR_2016_04_Chapter_2.pdf

therefore we find it appropriate to incorporate this variable as a time invariant. Lastly, the data created by WEF is in biennial form and does not cover for consistent number of countries over the years.

The third group TFIs was constructed by the authors for 198 countries based on Vigani and Olper (2013) construction for 60 countries. Varied sources of data were employed for both constructions. The GE restrictive index was built by obtaining information for six main regulatory categories regarding it; these are the approval process; risk assessment; labelling (http://www.centerforfoodsafety.org/ge-map/); traceability; coexistence and member of international agreements. A Likert scale scoring of these categories are then used in the construction of this index. The categorical scoring ranges from 0 (first condition) to the highest condition's correspondent number. Based on their scale, the scores for each of the categories are provided in Table 3.1. The expected total sum of the scale is 20. Hence, the overall GERI index is obtained as a normalized unweighted sum obtained by each country. (Section 3.2 discusses a detail of the construction of the GERI).

The data on the trade agreements the countries have with the United States was obtained from (https://ustr.gov/trade-agreements). This website contains the various trade agreements of the United States with start dates and end dates. This information is measured as a dummy variable in the data. The trade agreements of focus are whether the destination is in a bilateral agreement with the US or not, whether the respondent is a member of NAFTA or not and whether the country is a member of CAFTA or not.

3.2. Construction of GERI

Calibration of Index: Table 3.1 shows the representative scores for the ranks for all the indicators. In computing the index, the score obtained for each indicator are summed and divided by the sum of the maximum score for each category. This sum of the maximum for each category is 20. The range of the index therefore lies between 0 and 1. Having an index of 0 implies the highest openness to GMOs by a country while 1 represents the highest extent of restrictiveness to GMOs. The components of the GERI are described in detail.

Approval Process: The approval process for the entry or cultivation of genetically modified foods remains the primary step the extent of restrictiveness of a country. Some countries have strict bans on both cultivation and imports while others have flexible approval processes and malleable extent of restrictions. Despite wide variations of approval processes among countries, there exist two extreme approval processes; the concept of substantial equivalence and the precautionary principle.

The concept of substantial equivalence implies that a new product must be the same as an existing similar product except for its modifications. This concept preceded the introduction of genetically modified foods. Hence in this case, application of this approval process for GM foods necessitates for the new GM product to have similar characteristics with existing similar products except for the added, enhanced or removed traits through genetic engineering. The United States are the main enforcers of this concept for the GM approval process. On the other end, the precautionary principle is largely employed by the EU. According to this principle, the exports of GMOs for deliberate release into the environment and consumption by the public must be notified to the importing country before the export takes place, to allow it to take an informed decision on such imports.

Bearing this in mind, the approval process score is ranged from 0 being the absence of GMO approval process and 4 representing countries that have been declared as GM free. The substantial equivalence is viewed as the less restrictive while the precautionary principle is seen as the more restrictive.

Risk Assessment: An important step to inform the decision of a country on the approval of GM is risk assessment. Hence, a positive approval will largely depend on a positive result from the risk assessment. This assessment normally focusses primarily on the effects of this GM on human health, animals and the environment. For most nations, this process is carried out by the phytosanitary inspectorate division of their customs. At times fields trials are necessary. Wherefore, the speed of approval becomes dependent on the efficiency of the risk assessment process. Following from the main literature, 0 is defined as the absence of risk analysis and 3 is defined as the countries that have been declared GM free.

Labelling: Labelling of GM organisms has led to a pervasive argument among experts over the years. The two main labelling regimes are the positive labelling and the negative labelling. Positive labelling mandates an indication of whether the food has been genetically engineered while negative labelling mandates an indication of the absence of genetic modification. Despite the complexity of this issue, what remains clear now is the existence of some form of labelling adopted in most countries. This is an attempt to help improvement on the concern of consumers right to know. However, the major complain among GM producers has been the cost of labelling. One important factor that affects the cost of labelling is the threshold level (Vigani and Olper, 2013). Hence various countries have adopted different labelling thresholds. Based on this, the categories of labelling are represented by 0 for the absence of labelling to 4 for countries that are GM-free. The implications for the scale between these two points can be found in Table 3.1.

Traceability: For GM products approved, the possibility of a negative effect after consumption cannot be eliminated. Hence, there is the need for traceability mechanisms that aids fast and prompt response for efficient withdrawal in case of such eventuality. To ensure this, appropriate record-keeping of events must be practice from the port-of-entry to the farm-level. The traceability of the destination is represented by 0 for nations that do not require traceability of import foods. 3 represents countries that are GM-free.

Coexistence Strategies: The introduction of genetically modified foods into any country presents a dimension of competition to its existing traditional and organic products. Furthermore, the characteristics of GM seeds makes it impossible to cultivate it in tandem with other forms of seed. To prevent the contamination of non-GM fields, policies must be put in place. Formulation of such policies are a bit challenging due to lobbyists behaviour of stakeholders from both GM and Non-GM advocacy groups, especially with non-GM advocates lobbying against GM-advocates. The scoring used therefore ranged from 0 for countries with no coexistence policies to 4 for countries which have been declared as GM-free.

Membership in International Agreements: The two agreements considered for this indicator are the Codex Alimentarius and the Cartagena Protocol on Biosafety. The Codex Alimentarius constitute of a set of internationally recognize standards, guidelines, codes of conducts and regulations that ensure food safety through food production policies and supply chain managements. This agreement enforces the safety assessment for GM foods.

On the other hand, the Cartagena Protocol on Biosafety is an international agreement that is part of the Convention on Biological Diversity. Its objective is to ensure the safe handling, transport and use of living modified organisms (LMOs) which have a possibility of imposing adverse effects on biological diversity. The Likert scoring for this indicator is 0 for countries that are not members of either agreements, 1 for countries that are members of 1 and 2 for countries are members of both.

Table 3.1: Likert Scores for GERI Categories[23]

Regulatory Categories	Scores
(1) Approval Process	
Absence of GMO approval procedures	0
Mandatory approval process, but not yet enforced	1
Mandatory approval process adopting the principle of substantial equivalence	2
Mandatory approval process adopting the precautionary principle	3
Countries declared 'GM-free'	4
(2) Risk Assessment	
Absence of GMO risk analysis	0
Proposed risk assessment, but not yet enforced	1
Mandatory risk assessment	2
Countries declared 'GM-free'	3
(3) Labelling	
Absence of labelling policies	0
Voluntary GMO labelling	1
Mandatory GMO label without threshold or with threshold >1%	2
Mandatory GMO label with threshold ≤ 1%	3
Countries declared 'GM-free'	4
(4) Traceability	
Absence of GMO traceability nor IP system	0
GMO traceability not yet enforced or is in place an IP system	1
Mandatory GMO traceability	2
Countries declared 'GM-free'	3
(5) Coexistence	
Absence of coexistence strategies	0
GMO coexistence policies not yet enforced	1
Partial guidelines on GMO and non-GMO coexistence	2
Exhaustive guidelines on GMO and non-GMO existence	3
Countries declared 'GM-free'	4
(6) Membership in International Agreements on Biotechnology	
No adherence to international agreements	0
Adherence to a single international agreement	1
Adherence to both international agreements	2

3.3. Data Limitations and Alternative Data Source

U.S agricultural exports are transported through rail, barge, truck, and ocean vessels. However, ocean vessels are predominant for movements to the final destinations. The USDA Agricultural Marketing Service (2013) indicated that about 146.5 million metric tons of US agricultural exports and 40.7 million metric tons of imports representing 80% and 78% of exports and imports respectively were waterborne in the 2011 fiscal year.

[23] A vivid description of the six categories can be found in Vigani and Olper 's (2013) "GMO standards, endogenous policy and the market for information".

The challenge posed by this phenomenon is that the Foreign Agricultural Service (FAS) records state level agricultural exports based on port values. AMS (2017) attributes 36% of waterborne agricultural trade to the New Orleans Port Region followed by New York/New Jersey which accounted for 6%. This port in addition to 18 other ports accounted for 52% of the waterborne agricultural trade while the rest of the posts accounted for 12%. Based on the FAS dataset, Louisiana which is the state for which this export is recorded shows high export values. Hence, states without ports are likely to reveal downward biased export efficiency particularly if they are high producers of the commodity. Ironically, many of the leading agricultural producing states in the US e.g. Iowa, Indiana, Illinois, Nebraska just to mention a few, have no ports.

To rectify the possibility of such bias, this study employs the Economic Research Service (ERS) export data which is collected based on the states total production of that crop. The limitation to this data is that it does not report the individual destinations of the commodity. Hence, to account for that in this study, we multiply this value by the share of the destination's export as a ratio of the state's total export reported by the FAS.

3.4. Descriptive Statistics of Data

A primary essential concept of trade analysis is the counts of zeros and missing trade. Table 3.2 presents the count of trade and no trade values for the three commodities. About 33% of non-zero trade occurred for corn and soybean among the states and their partners while less than 30% of trade occurred for wheat. From Table 3.3, the average export of corn over the period across the states is US$ 6,081,819 while its average domestic price is US$167.99 per metric ton. The average soybean export value over this same period is US$18,202,950.00 whiles average price is US$ 358.15 per metric tons.

Table 3.2: Proportion of Trade for Three Commodities

Model	Total Observations	No Trade (Percentage)	Trade (Percentage)
Corn	17,405	11,605(66.68%)	5,800 (33.32%)
Soybean	10,128	6,732 (66.47%)	3,396 (33.53%)
Wheat	11,700	8,359 (71.44%)	3,341 (28.56%)

Table 3.3: Descriptive Statistics of Corn Model Variables

Variable	Mean	Std. Dev.	Minimum	Maximum
Export Value	6,081,819	60,428,710	0	2,499,467,000
Global Price	190.13	63.84	98.41	298.41
Tariff difference	7.04	3.24	0.50	11.50
Exchange Rate	589.20	2564.60	0.27	29011.49
GERI	0.38	0.19	0	1
Border Admin.	4.87	0.93	1.70	6.40
Infrastructure	4.51	0.96	2.33	6.18
Market Access	4.42	0.69	2.08	5.86
Open Env’t	4.50	0.68	2.83	5.87
State GDP	437,480,800,000	431,247,300,000	2,266,400,000	2,481,348,000,000
Destination GDP	675,000,000,000	1,270,000,000,000	467,000,000	11,000,000,000,000
Domestic Price	167.99	57.11	70.45	310.94

Table 3.4: Descriptive Statistics of Soybean Model Variables

Variable	Mean	Std. Dev.	Minimum	Maximum
Export Value	18,202,950	195,559,800	0	7,085,250,000
Global Price	382.98	105.13	217.45	537.76
Tariff difference	7.09	3.01	0.5	11.50
Exchange Rate	1163.34	3814.69	0.27	29011.49
GERI	0.39	0.19	0	0.75
Border Admin	5.00	0.89	2.41	6.40
Infrastructure	4.72	0.94	2.21	6.19
Market Access	4.37	0.66	2.08	5.83
Open Env’t	4.54	0.66	2.89	5.87
State GDP	454,429,600,000	466,146,500,000	2,266,400,000	248,134,800,000
Dest’n GDP	1,040,000,000,000	1,670,000,000,000	467,000,000	11,000,000,000,000
Domestic Price	358.15	99.38	191.05	540.08

From Table 3.5, the average export value for wheat is US$ 7,025,215 with an average price of US$ 201.23 per metric ton. The descriptive statistics of the variables employed for the three crops are presented in Table 3.3 to 3.5.

Table 3.5: Descriptive Statistics of Wheat Model Variables

Variable	Mean	Std. Dev.	Minimum	Maximum
Export Value	7,025,215	37,094,230	0	874,883,000
Price of wheat	215.03	53.67	129.89	286.95
Tariff diff	6.71	3.27	0.5	11.50
Exchange rate	1005.51	3454.37	0.27	29011.49
GERI	0.34	0.18	0.05	1
Border Admin	4.63	0.99	1.699208	6.40
Infrastructure	4.26	1.02	2.209484	6.19
Market Access	4.38	0.70	2.078442	5.86
Open Env’t	4.30	0.67	2.83098	5.87
StateGDP	428,343,600,000	469,814,000,000	23,262,000,000	2,481,348,000,000
Dest’n GDP	685,000,000,000	1,310,000,000,000	467,000,000	11,000,000,000,000
Domestic P.	201.23	55.18	97.36	352.34

CHAPTER FOUR. THEORETICAL MODEL AND METHOD OF ANALYSIS

4.1. Conceptual Framework

The fundamentals of this study are built on the impact and segregation of costs postulated by Khan and Kalirajan (2011). As shown in Figure 4.1, they indicate that international trade between partners is affected by costs which may be categorised into natural transport cost, behind the border cost, implicit beyond the border cost and explicit beyond the border cost. The focus of our discussion is on implicit beyond the border costs. Hence the conceptual framework incorporates this type of costs along with the explicit beyond border costs to assess their impact on US states agricultural exports.

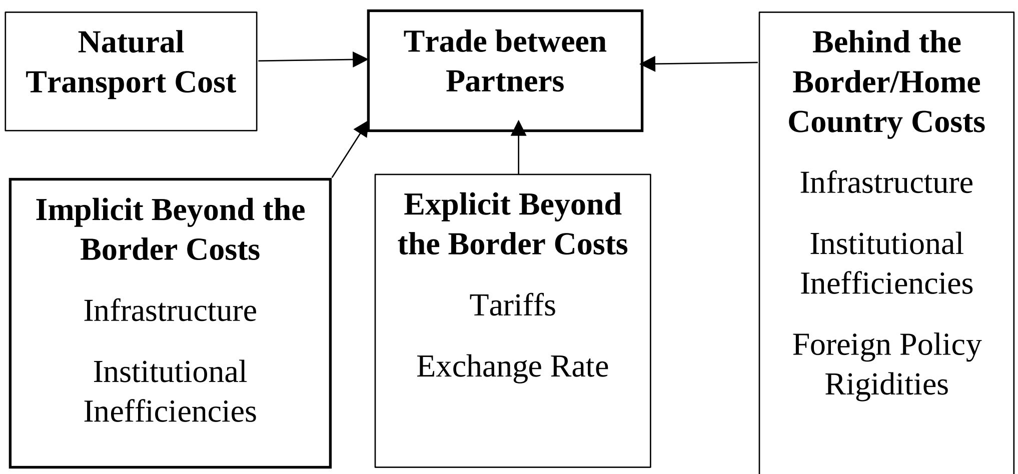

Figure 4.1: All Costs Affecting Trade Between Trade Partners
Source: Khan and Kalirajan (2011)

Based on this, it is conceptualised in Figure 4.2 that, US state agricultural exports can be influenced by implicit beyond the border costs which are measured by trade facilitation indicators and genetically engineered restrictive index of the destination country. The 'explicit beyond' the border costs which are likely to influence US state exports are exchange rate and tariff differences. Based on the existing established literature reviewed, the GDPs of the trade partners and their Free Trade agreements' status with the US are also incorporated. The final variable included is the global commodity price to domestic commodity price ratio. Following the conceptual framework, the theoretical and empirical models are established based on the two objectives of this study.

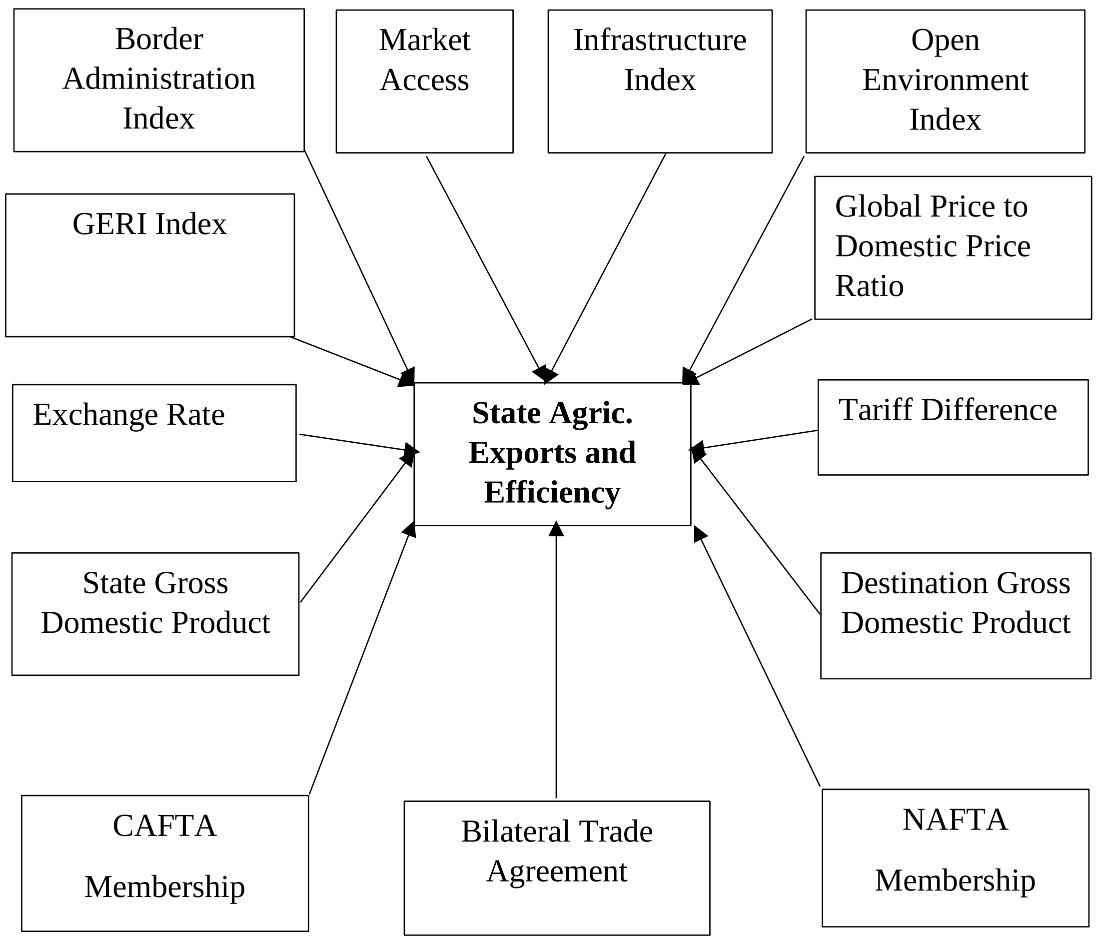

Figure 4.2: Conceptual Framework of the Determinants of U.S. State Agricultural Exports
Author's construct (2018)

4.2. Theoretical Model

4.2.1. The Gravity Model

The first objective desires to establish the impact of these trade facilitation indicators and GERI on state agricultural exports. These variables are augmented with selected gravity model variables. The fundamental framework for estimating trade relationships has been the trade gravity model pioneered by Tinbergen (1962). The concept of the gravity equation is a physics theory which was originally introduced by Isaac Newton in 1687. With reference to Anderson (2016), this framework begins with equation (4.1);

$$F_{ij} = G \frac{M_i^{\beta_1} M_j^{\beta_2}}{D_{ij}^{\beta_3}} \quad (4.1)$$

where; M_i *and* M_j are the masses of the objects i and j; and D_{ij} is the distance between the two objects. The replication and first application of this model in international trade by Tinbergen modifies the gravitational force into trade flows between two countries i and j as EX_{ij} and represents it by equation (4.2).

$$EX_{ij} = G \frac{M_i M_j}{D_{ij}^2} \quad (4.2)$$

Where;
EX_{ij} =Bilateral trade flow between country i and j
G = Gravitational Constant
M_i =Relevant Economic activity mass at origin i
M_j =Relevant Economic activity mass at origin j
D_{ij} =Trade resistance factors between country i *and* j

In general, the gravity model is functionally represented as;

$$EX_{ij} = f(M_i, M_j, D_{ij}) \quad (4.3)$$

4.2.2. Gravity Model Construction with Trade Costs

The success of the gravity model has been due to the incorporation of diverse[24] theoretical foundations and modifications over the years.[25] The Heckscher-Ohlin relative factor abundance model built upon the Ricardian model of comparative advantage has been used to explained trade as based on the factor endowments of the countries involved in trade. The first document which

[24] Alan V. Deardorff (1998) opined that; “I suspect that just about any model of trade would yield something very like the gravity equation, whose empirical success is therefore not evidence of anything but just a fact of life”

[25] Despite criticisms on its oversimplification of world trade by renowned economists such as Bertil Ohlin, this research does not delve into such area of the gravity model

gives a theoretical explanation to the gravity model has been attributed to Anderson (1979).[26] This was based on the constant elasticity of substitution (CES) and assumption of goods differentiated by origin. The abundant existing trade studies have employed these theoretical underpinnings based on their objectives. Based on our objective of assessing the impact of trade facilitation, we build a modified gravity trade model based on the Anderson and Wincoop (2003) gravity model specification. Their model decomposed trade resistance into three components; (i) bilateral trade barrier between the trade partners i and j, (ii) i's resistance to trade with all regions and (iii) j's resistance to trade with all region. They imposed the assumptions that each origin is specialized in the production of only one good with a fixed supply of each good and an identical and homothetic preferences approximated by the CES utility functions. Following their work, if the US state i exports a commodity to destination j, we assume that consumption region j will maximize

$$(\sum_i \beta_i^{(1-\sigma)/\sigma} c_{ij}^{(\sigma-1)/\sigma})^{\sigma/(\sigma-1)} \quad \text{subject to the budget constraint} \quad \sum_i p_{ij}c_{ij} = y_j \qquad (4.4)$$

In this maximization model, σ is the elasticity of substitution between all goods, β_i is a positive distribution, y_j is the nominal income of region j residents, and p_{ij} is the price of region i good for region j consumers, p_i is the exporter's supply price and c_{ij} is the net trade costs for export of commodity from origin i to destination j. If the trade cost factor between i and j is t_{ij}, then $p_{ij} = p_i t_{ij}$. Following through the comparative statics of their model yields;

$$InEX_{ij} = k + Iny_i + Iny_j + (1-\sigma)\rho Ind_{ij} + (1-\sigma)Inb_{ij} - (1-\sigma)InP_i - (1-\sigma)InP_j \qquad (4.5)$$

From equation 4.5, y_i and y_j are the incomes of i and j, d_{ij} is the geographical distance between the two trade partners. Traditionally, these resistance factors have been measured using

[26] Since then, there have been a wide range of theoretical explanations e.g. Krugman (1979, 1980), Helpman and Krugman (1985), Bergstrand (1989, 1990), Helpman and Krugman Deardorff (1998), Anderson and Wincoop (2003),

tariffs, price ratios, geographical distance, contiguity, common currency, common language, among other factors.

Prior to the empirical model estimation, the unit roots test for the time varying variables were conducted. As discussed in the literature review section, the unbalanced nature of the panel data employed leads to the use of Fisher-type units roots tests due to its advantages in such situations. The variables considered here are the export values, destination GDP, tariff difference and exchange rate. From the results (Table 4.1), it is seen that these variables have no issues with unit roots.

Table 4.1: Results of Unit Root Test

Variable	Inv. $\mathbf{Chi^2}$(P)	Inv. Normal (Z)	Inv. Logit (L)	Mod. Inv. $\mathbf{Chi^2}$(Pm)
		Corn		
FAS Export	188.88***	-10.20***	-14.47***	22.59***
ERS Export	159.31***	-8.99***	-11.68***	17.55***
Destination GDP	2242.18***	-39.69***	-92.80***	164.41***
Tariff difference	2327.96***	-45.91***	-110.38***	193.79***
Exchange Rate	2335.66***	-43.27***	-99.54***	173.72***
		Soybean		
FAS Export	882.07***	-23.31***	-42.59***	72.31***
ERS Export	1073.27***	-27.46***	-52.33***	89.21***
Destination GDP	1907.18***	-39.40***	-84.38***	146.45***
Tariff difference	1984.44***	-41.41***	-91.42***	159.37***
Exchange Rate	1752.53***	-37.60***	-78.57***	135.99***

4.2.3. Empirical Model Specification

Based on the theoretical model developed by AW (2003), four groups of variables were selected to explain US state level exports to destinations: basic gravity model variables, trade facilitation indicators, genetically engineered regulatory index and the free trade agreements relationship of destination with US. Andrews et al., (2006) consider this type of panel model as having a three-way error-components:

$$In\left(EX_{ijt}\right) = x_{it}\beta + w_{j(i,t)t}\gamma + u_i\eta + q_{j(i,t)}\rho + \alpha_i + \emptyset_{j(i,t)} + \mu_t + \epsilon_{it} \qquad (4.6)$$

States are indexed from $i = 1 \dots \dots N$. They are observed once per period $t = 1 \dots \dots T$ for each destination $j = 1 \dots \dots J$. The destination countries for each of the states may change overtime. The subscript $j(i,t)$ maps the state to destination j at time t. y_{it} is the dependent variable. x_{it} and u_i are vectors of observable $j - level$ covariates. Both state and destination countries are assumed to enter and exit the panel. This makes the data an unbalanced panel with T_i observations per state. This implies that there are $N^* = \sum_{i=1}^{N} T_i$ observations (states periods) in total. From the equation, the three error components are α_i for the state, $\emptyset_{j(i,t)}$ for the destination and μ_t for the unobserved time effects. The heterogeneity terms are assumed to be accounted for by the trade partners' GDP. Studies such as Sun and Reed (2010) and Yang and Martinez-Zarzoso (2014) estimated trade flows without the inclusion of these error components. To that effect and considering the interest of this study, equation (4.6) is reduced to a one-way error-component model given as:

$$In(EX_{ijt}) = x_{it}\beta + w_{j(i,t)t}\gamma + \epsilon_{ijt} \tag{4.7}$$

where ϵ_{ijt} captures the state, destination and time deviations. Based on this preamble, we specify the empirical model as;

$$In(EX_{ijt}) = \beta_0 + \beta_1 lnX_1 + \beta_2 lnX_2 + \beta_3 lnX_3 + \beta_4 lnX_4 + \beta_5 lnX_5 + \beta_6 lnX_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{11} X_{11} + \beta_{12} X_{12} + \beta_{13} X_{13} + \epsilon_{ijt} \tag{4.8}$$

where X_i in equation (4.8) represents both x_{it} and $w_{j(i,t)t}$ variables. Descriptions of the $X_i's$ are found in Table 4.2.

4.2.4. Stochastic Frontier Gravity Model

In the second objective, it is postulated that actual export by the state may be a limited percentage of its maximum potential export due to implicit and explicit beyond the border costs. Kalirajan (1999) defined the potential trade between countries as the maximum possible trade that can occur, given the determinants, when there is no resistance to trade between the two countries.

Rooted in this definition, we define export efficiency as the maximum export capacity when a destination's restrictive cost characteristics are minimized. In other words, the maximum trade capacity at minimum costs. Several studies have been conducted to identify the impact of trade costs on trade. In the basic gravity model, the Gauss-Markov's assumption has been maintained that the difference between actual and potential trade is purely random. However, the concept of TFIs suggests that this deviation from potential or optimal trade may be influenced by the resistance factors enforced by trade partners.

The basic idea for efficiency analysis dwells on the seminal paper by Farrell (1957). He introduced a stimulating idea which was greatly influenced by Koopmans (1951) and Debreu (1951) decomposition of the overall efficiency of a production unit into technical and allocative efficiency (Murillo-Zamorano, 2004). In his paper, he showed two ways by which a firm can be inefficient. In the first (technical inefficiency), a firm may become inefficient if they obtain output(s) that is less than the obtainable maximum output(s) from a determined set of inputs. Alternatively, allocative efficiency is the ability of a firm to use optimal proportions of inputs, given prices. A diagrammatic representation of this relationship is shown in Figure 4.3.

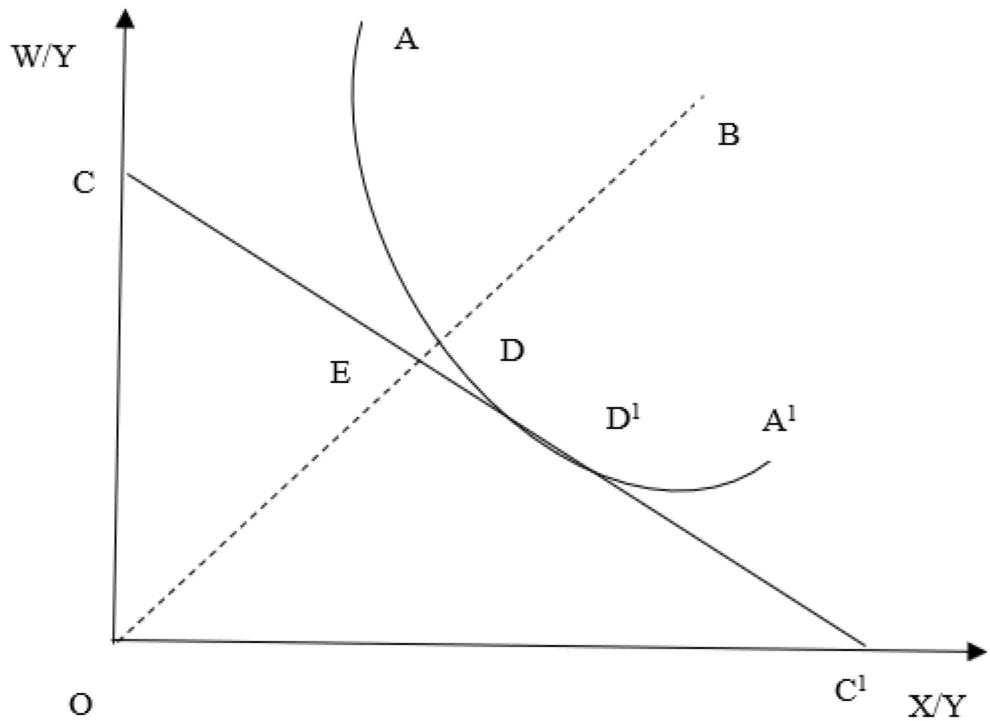

Figure 4.3: Farrell's Decomposition of Economic Efficiency

Figure 4.3 reveals a unit efficient isoquant AA^1 with a budget line CC^1. W^* and X^* are assumed to be inputs to produce output Y^*. The output at point B is given by (X^*/Y^* , W^*/Y^*). The technical efficiency is measured as OD/OB. This is a measure of the actual proportion of (W^*, X^*) that is required to produce Y^*. The total efficiency is given as 1, hence the technical inefficiency is given as 1- (OD/OB).

This concept is emulated for the stochastic frontier (SFA) production function which was introduced simultaneously yet independently by Aigner et al., (1977); Meeusen and van den Broeck (1977); and Battese and Corra, (1977). The competing models for SFA are Data Envelopment Analysis (DEA) and Free Disposal Hull (FDH), with the former being the stronger of the competitors.

The SFA model is incorporated into the gravity model to the achieve the study objective. A set of indices representing trade facilitation indicators are incorporated into the model. Therefore, in addition to the traditional gravity model distance factors, the enabling trade indices and genetical modified organisms restrictive index are included to account for the sources of export inefficiency. From the gravity model, the export function for bilateral trade from country i to j is;

$$EX_{ij} = f(M_i , M_j, D_{ij};\ \beta) \tag{4.9}$$

The Stochastic Frontier Analysis assumes that a state will export potentially less than it can due to inefficiencies. Introduction of the trade facilitation indicators (TFI_j) and $GERI_j$ of the export destination j into the model yields;

$$EX_{ij} = f(M_i , M_j, D_{ij}, TFI_j, GERI_j;\ \beta) \tag{4.10}$$

Linking equation (4.10) to the stochastic frontier production function (Aigner et al.,1977; Meeusen and van den Broeck,1977; Battese and Coelli, 1995) gives;

$$EX_{ij} = f(M_i , M_j, D_{ij}, TFI_j\ GERI_j;\ \beta\ + V_i - U_i\ ) \tag{4.11}$$

Where V_i is assumed to be $iid\ \ N(0, \sigma_v^2)$ random errors, independently distributed of the $U_i s$; U_i is the non-negative random variable associated with the technical inefficiency of export, which is independently distributed, such that U_i is obtained by truncation (at zero) of the normal distribution with, mean, $z_i\delta$ and variance, σ^2; z_i is a $1 \times m$ vector of explanatory variables associated with the technical inefficiency of exports of the states; and δ is an $m \times 1$ vector of unknown coefficients. Because trade is being measured over time, a time component t, is introduced in equation (4.11) to give;

$$EX_{ijt} = f(M_{it} , M_{jt}, D_{ijt}, TFI_j, GERI_j;\ \beta\ + V_{ijt} - U_{ijt}\ ) \tag{4.12}$$

Following Kumbhakar and Lovell (2000), the panel time invariant form is specified, where inefficiency effects are assumed to be static with respect to time. They specified a dual cost function problem which allows equation 4.12 to be empirical specified as

$$In\left(EX_{ijt}\right) = \beta_0 + \beta_1 lnX_1 + \beta_2 lnX_2 + \beta_3 lnX_3 + \beta_4 lnX_4 + \beta_5 lnX_5 + \beta_6 lnX_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{11} X_{11} + \beta_{12} X_{12} + \beta_{13} X_{13} + v_{it} - su_{it} \quad (4.13)$$

where u_{it} is the time-invariant technical inefficiency term with a truncated-normal distribution $N^{+}(\mu, \sigma^2)$, which is truncated at zero with a mean μ and variance σ^2 which is independent and identically distributed of the random error term $v_{it} \underbrace{iid} N\,(0, \sigma_v^2)$. The random error term is normally distributed with a mean of zero and a variance of σ_v^2. Specifying an xtfrontier model in Stata version 14 presents 's' as a coefficient of the inefficiency term with a negative which represents a cost function or positive for a production function. A description of the variables used for this study based on the literature reviewed and the conceptual framework is shown in Table 4.2. The measurement and 'a prior' expectations of these variables are also shown in this table.

Table 4.2: Summary of Variables and Their “A Prior” Expectations[27]

	Variable	Description	Measurement	“A Prior” Expectation
$\boldsymbol{EX_{ij}}$	Export	Value of exports from US state (FAS)	US dollar	Dependent Variable
$\boldsymbol{EX_{ij}}$	TrueEx	Value of exports from US state (ERS)	US dollar	Dependent Variable
$\boldsymbol{X_1}$	DestGDP	GDP of destination country	US dollar	+
$\boldsymbol{X_2}$	StateGDP	Gross Domestic Product of State	US dollar	+
$\boldsymbol{X_3}$	Tariffdiff	Difference in tariff	Index number	-
$\boldsymbol{X_4}$	pRatio	Global Price/Domestic Price	Ratio	-
$\boldsymbol{X_5}$	Ex	Exchange rate between US and partner	Currency per dollar	-/+
$\boldsymbol{X_6}$	GERI	Genetically Engineered Restrictive Index	0-1(highest restriction)	-
$\boldsymbol{X_7}$	Market	Index for market access	1-7(highest openness)	+
$\boldsymbol{X_8}$	Border	Index for border administration	1-7 (highest openness)	+
$\boldsymbol{X_9}$	Infrastructure	Index for transport and communication	1-7(highest openness)	+
$\boldsymbol{X_{10}}$	Business	Index for business environment	1-7 (highest openness)	+
$\boldsymbol{X_{11}}$	Bilateral	Bilateral trade agreement	Dummy (1: yes, 0 otherwise)	+
$\boldsymbol{X_{12}}$	CAFTA	Member of CAFTA	Dummy (1: yes, 0 otherwise)	+
$\boldsymbol{X_{13}}$	NAFTA	Member of NAFTA	Dummy (1: yes, 0 otherwise)	+

[27] State GDP, Destination GDP, Tariff difference, Exchange rate, price ratio and GERI are expressed as logs while he the Trade Facilitation Indices and the Trade Agreement dummies are expressed as levels.

CHAPTER FIVE. RESULTS AND DISCUSSIONS

5.1. Introduction

This chapter presents the results and discussions. The results of the unit root test are first discussed followed by the results for the factors affecting US states exports. This is divided into two, first the estimates are obtained in a traditional gravity model estimation framework. Secondly the export efficiency is obtained through a stochastic frontier gravity model.

5.2. The Role Trade Facilitation Indicators and GERI on State Exports

5.2.1. Empirical Model Build-Up Based on FAS State Export Data

The first objective of this study deals with the impact of TFIs on US state level exports. As revealed from literature, analysis of trade data presents a wide range of challenges. Hence, this section is used to briefly elaborate on the assumptions imposed to establish a robust model with practically relevant inferential discussions. The model build-up is established in four stages based on a systematic addition of the relevant group of variables to the basic gravity model. All these are considered in a fixed effects model prior to the final model establishment. The first stage considers only the traditional gravity model variables for the three commodities. In the second stage, the trade facilitation indicators are added to the base model. The third stage involves the addition of the Genetically Engineered Restrictive Index while the final stage adds the trade agreements status of the trade partners with the US. For most of the variables in these models, the “a prior” expectations were met. Each of the stages of the model-building section considers four different option models for each of the crops. The information of the model build-up stage is used to construct the final model.

In stage one (Figure 5.2), model one incorporates the GDPs and Population of the trade partners to represent the body masses described in Tinbergen’s model. The resistance factors in the equation are the geographical distance between US and the trade partners, contiguity, common currency, exchange rate, tariff differences between the US and the destination countries, the price ratio between the global price of each commodity and the state level domestic market price. Based the criticism of the gravity model to have several omitted variables, some of the remedies suggested in literature are employed. The most notable being the addition of exporter or importer effects is pursued. Hence, the exporter fixed effects are added in model two. The addition of these partner-domain fixed effects dummies to account for heterogeneity normally requires the removal of the GDP variables, as collinearity has been proposed to possibly exist between these two variables. Model three in stage one adds the importer fixed effects, excluding the exporter fixed effects and the proxies of the body masses. The final model of this stage incorporates the importer and exporter fixed effects with the exclusion of the body mass proxies.

Stage two, Table 5.3 introduces the trade facilitation indicators into the model. Similar considerations made in the first stage to account for heterogeneity are also performed for this stage. The addition of the variable representing the Genetically Engineered Restrictive Index is incorporated in Stage three shown in Table 5.4. In the final stage (Table 5.5) of the model build-up, the three Free Trade Agreements dummies introduced are whether the partner country has a bilateral trade agreement with US or not, whether it is a member of CAFTA-DR or not; and whether it is a member of NAFTA or not. All stages account for options to control for heterogeneity as conducted in stage one for all three crops.

To decide on whether to control for heterogeneity or not, using the partner-domain effects, the summary of the results obtained from the four different models in each stage for each of the crops are compared. Despite some minor differences observed, the notable discrepancies are few and far in-between the models. Hence the uncontrolled model can be used. Based on this, we adopt the framework of model one where the exporter or importer control effects are excluded.

To understand the impact of trade facilitation indicators on US state level exports, the variables employed in the final model are the GDPs, exchange rate, tariff difference and global price to state level price ratio of commodity to represent the basic gravity model variables. The other groups of variables are the four TFIs, the GERI index and the three FTAs related to the USA.

5.2.2. The Final Model Using FAS Export Data

5.2.2.1. Basic Gravity Variables

In the corn model, the use of the Hausman Specification Test for model appropriateness justified the fixed effects model. The overall model has an R-squared value of 25.8%. The GDP of the origin is 0.703 which implies that a 1% increase in the GDP of the US State will lead to a 0.703% increase in total exports of the state. Also, 1% increase in the GDP of the destination country will lead to a 0.332% increase in exports from the State. A 1% appreciation in the currency of the destination is found to increase exports from the States by 0.172%. Among the variables retained from the basic gravity model, the variables mentioned are found to be significant at 1% while the ratio of the global price to the state level price of corn is found to be insignificant.

The Hausman test indicated the random effects model to be appropriate for the soybean model. The base gravity model variables found to be significant are state GDP, destination GDP and exchange rate. The elasticities of these variables are 1.867, 0.982 and 0.16 respectively. Just as for the corn model, the price ratios are insignificant while the exchange rate does not meet the 'a prior' expectation. The wheat model also found the random effects model to be appropriate. A 1% increase of state GDP in this model increases wheat exports by 0.427%, while a 1% increase in destination GDP leads to a 0.397% increase in state export.

For corn and wheat, we find evidence of the home market effect[28] suggested by Feenstra et al., (2001). However, this was not found for soybean. The contrary result for soybean may be attributed to the increasing global demand and reliance on US soybean. According to the United Soybean Board[29](2016), the increase in world demand for US soybean can be attributed to increasing global incomes, especially in developing countries. This increase in income has led to a conventional increase in meat demand which necessitates the increased use of soybean meal as feed. It further opines that these increased incomes have led to increased desire to improve dietary needs such as protein sources, of which soybean food products remain very important. Most of the elasticities obtained are consistent with the average elasticities of gravity model from a meta-analysis by Head and Mayer (2013, pp. 34).

5.2.2.2. Trade Facilitation Indicators

The impact of the TFIs are also estimated in the fixed effects model in Figure 5.1. The TFIs found to be significant at 1% are the border administration, infrastructure and the open environment indices. The market access index is found to have no significant impact on US State corn exports. Considering the 'a prior' expectations, only the infrastructure index conforms with the expectation of a positive relationship with trade. A unit increase in the destination's infrastructure index leads to a 70.0% increase in state level corn exports. It is revealed from the model that a unit increase in the border administration index of the destination decreased the state's export by 41.3% while a unit increase in the open environment index decreased state level export by 64.9%. Economic theory postulates that trade facilitation indicators should boost trade, however Fontagne et al., (2016) found a contrary relationship for some of these TFIs. Other studies that

[28] The home market effects suggest that the GDP of the origin will have a high elasticity of exports than the elasticity of destination's GDP.
[29] https://unitedsoybean.org/article/the-outlook-on-us-soy-demand

have found certain TFIs to have a negative relationship with trade are Iwanow and Kirkpatrick (2007) and Sa Porto et al., (2015) who found trade agreements to have a negative effect on trade. Hence the counter intuitive results of this study regarding TFI is not in isolation. Furthermore, establishing this negative effect elaborates the possibility of export inefficiency among states.

5.2.2.3. Genetically Engineered Restrictive Index

The GERI is -0.305, -0.366 and 0.311 for corn, soybean and wheat respectively with significance levels of 1%, 5% and 1% respectively. This implies that a 1% increase in the GERI will lead to a 0.305% decline US states' corn export while a similar increase in this index will cause a 0.366% decrease in state level soybean been exports. On the other hand, a 1% increase in the index will lead to a 0.311% increase in the export of wheat. All these variables conform to the expected 'a prior' signs. This is because about 90% of the US corn and soybean are genetically engineered while there hasn't been any commercial cultivation of GE wheat in the Union as at 2018. In effect, countries with higher GERI are more likely to be open to US wheat than its corn and soybean.

5.2.2.4. Free Trade Agreements

The three free agreements considered in the study are whether the destination has a bilateral agreement with US or not, member of CAFTA and NAFTA membership. For the corn model, having a bilateral trade agreement with the US did not affect the exports significantly. CAFTA and NAFTA were significant at 5% and 1% respectively. A coefficient of 1.151 for CAFTA meant that, CAFTA membership increased state corn exports by 1.15% while 2.593 for NAFTA meant that been a member of this trade agreement increased state corn exports by 259.3%. Lambert and McKoy (2009) also found agricultural trade to have increased by 145% among NAFTA members from 1995 to 2004. Furthermore, CAFTA membership increased soybean exports by 95.4% at a significance level of 1%. Having a bilateral trade with the US and being a member of CAFTA increased wheat exports by 78.2% and 68.9% respectively at a 1% significance level.

Table 5.1: Final Model Selection with Fixed Effects and Random Effects Estimation

Variable	**Corn**		**Soybeans**		**Wheat**	
	Fixed Eff.	Random Eff.	Fixed Eff.	Random Eff.	Fixed Eff.	Random Eff.
LnSGDP	0.703***	0.464***	1.867***	0.702***	1.390***	0.427***
	(0.266)	(0.166)	(0.397)	(0.18)	(0.278)	(0.156)
LnDestGDP	0.332***	0.339***	0.982***	1.028***	0.361***	0.397***
	(0.032)	(0.031)	(0.056)	(0.055)	(0.041)	(0.04)
LnEx	0.172***	0.172***	0.167***	0.163***	-0.044***	-0.045***
	(0.012)	(0.012)	(0.017)	(0.017)	(0.014)	(0.014)
LnpRatio	-0.078	-0.02	0.505	0.521	-0.111	0.006
	(0.209)	(0.208)	(0.368)	(0.37)	(0.345)	(0.343)
Borderadmin	-0.413***	-0.418***	-0.600***	-0.661***	-0.378***	-0.384***
	(0.098)	(0.099)	(0.171)	(0.171)	(0.102)	(0.102)
Infrastructure	0.700***	0.691***	-0.286	-0.281	-0.302**	-0.360***
	(0.11)	(0.11)	(0.196)	(0.198)	(0.127)	(0.127)
Marketaccess	0.223***	0.227***	0.296**	0.342***	0.172**	0.179***
	(0.066)	(0.066)	(0.115)	(0.115)	(0.069)	(0.069)
Openvironment	-0.649***	-0.639***	0.320*	0.337*	-0.611***	-0.585***
	(0.112)	(0.112)	(0.174)	(0.175)	(0.137)	(0.137)
LnGERI	-0.305***	-0.312***	-0.366**	-0.417***	0.339***	0.311***
	(0.072)	(0.072)	(0.146)	(0.146)	(0.098)	(0.099)
Bilateral	0.181	0.202*	-0.237	-0.16	0.705***	0.782***
	(0.111)	(0.11)	(0.18)	(0.18)	(0.137)	(0.136)
CAFTA	1.151***	1.164***	0.373	0.458	0.604***	0.689***
	(0.127)	(0.126)	(0.307)	(0.308)	(0.144)	(0.143)
NAFTA	2.593***	2.542***	0.954***	0.881***	0.138	0.075
	(0.122)	(0.121)	(0.168)	(0.169)	(0.133)	(0.133)
Constant	-8.699***	-6.593***	-33.483***	-20.255***	-12.112***	-2.127
	(3.266)	(2.073)	(4.892)	(2.46)	(3.69)	(2.534)
Observations	5335	5335	2703	2703	3136	3136
Number of PanelID	39	39	30	30	42	42
R-squared	0.228		0.247		0.156	

5.3. Role of Trade Facilitation Indicators and GERI on Export Efficiency

The determinants of agricultural export efficiency among US states is shown in Table 5.2. The 1% significance of the sigma_u term (μ) indicates that the source of export variations can truly be attributed to inefficiencies. The sigma_v (ɳ) is negative and significant. This implies that increasing export losses or inefficiencies over the period are due to implicit constraints. Expectedly, the genetically engineered restrictive index of destination countries has a negative impact on the export efficiency of corn and soybean at elasticities of 0.309 and 0.400 respectively. The coefficient of wheat being positive signifies export benefits received from non-commercial production of genetically engineered wheat. It has a coefficient of 0.323.

The border administration index has a negative effect on the export efficiency of the three crops. A unit increase in this TFI leads to a 41.6%, 64.1% and 38.6% decrease in the export efficiency of corn, soybean and wheat respectively. The Infrastructure index positively affects the export efficiency of corn with 0.694 coefficient at 1% significance while the effect on the export efficiency of wheat is -0.339 with a significance level of 1%. The open environment index has a negative impact on the export efficiency of corn and wheat with coefficients of 0.642 and 0.587. It has a positive impact on soybean exports at significance of 5% and coefficient of 0.338. Market access positively affects the export efficiency of soybean with a coefficient of 0.324 at a 5% level of significance.

Table 5.2: Parameter Coefficients of State Export Efficiency

Variable	Corn	Soybean	Wheat
Deterministic Component of Stochastic Frontier Model			
State GDP	0.542***	1.013***	0.730***
	(0.194)	(0.27)	(0.231)
Destination GDP	0.337***	1.014***	0.386***
	(0.031)	(0.055)	(0.04)
Exchange Rate	0.172***	0.166***	-0.044***
	(0.012)	(0.017)	(0.014)
Price Ratio	-0.043	0.526	-0.024
	(0.207)	(0.367)	(0.341)
Border Administration Index	-0.416***	-0.641***	-0.386***
	(0.098)	(0.17)	(0.101)
Infrastructure Index	0.694***	-0.286	-0.339***
	(0.109)	(0.196)	(0.126)
Open Environment Index	-0.642***	0.338*	-0.587***
	(0.111)	(0.174)	(0.136)
Market Access Index	0.226***	0.324**	0.178***
	(0.066)	(0.114)	(0.068)
Genetically Engineered Restrictive Index	-0.309***	-0.400***	0.323***
	(0.072)	(0.146)	(0.098)
Bilateral Trade Agreement Dummy	0.194*	-0.18	0.756***
	(0.11)	(0.179)	(0.136)
CAFTA Membership Dummy	1.160**	0.441	0.665***
	(0.126)	(0.305)	(0.143)
NAFTA Membership Dummy	2.563***	0.919***	-0.101
	(0.121)	(0.168)	(0.132)
Constant	-1.2	-18.699***	-2.549
	(3.459)	(3.73)	(3.198)
Mean of Underlying Truncated Distribution			
Constant	6.374**	5.273***	2.897***
	(2.533)	(1.588)	(0.461)
Scale Parameters of the Random Components of e(i)			
In_sigmaU	1.958***	2.012***	1.935***
	(0.093)	(0.093)	(0.179)
In_sigmaV	-0.513**	-0.825***	-0.109
	(0.246)	(0.305)	(0.38)
Observations	5,335	2,703	3,136
No. of PanelID	39	30	42

Table 5.3 presents the efficiency of the U.S. states based on the characteristics of their trade partners. The trade efficiency of the states was estimated based on the USDA Foreign Agricultural

Service export data. The most efficient state for corn over 2004-2015 was Connecticut with an export efficiency of 89% followed by Maine, Louisiana, Massachusetts and Mississippi with 84%, 84%, 79% and 77% respectively. The least 6 efficient states over the period were California, Nebraska, Florida, Illinois, Indiana and Arizona with efficiency levels of 7%, 7%, 7%, 6%, 6% and 6% respectively.

The most efficient soybean export states were California, Washington, Connecticut, Idaho and Louisiana with 91%, 89%, 85% ,82% and 80% export efficiencies respectively. The least efficiency soybean exporters were Missouri, Minnesota, Illinois, North Carolina, Michigan and Indiana with export efficiencies of 13%, 13%,13%, 12%, 11% and 1% respectively. Finally, the most efficient wheat exporting states were Oregon, Connecticut, Louisiana, Kansas, Hawaii and with efficiencies of 91%, 91%, 84%, 82% and 76% respectively while the least were Florida, Arizona, Illinois, Nevada, Pennsylvania and California which were 33%, 33%, 32%, 24%, 22% and 21% respectively.

Table 5.3: State Export Efficiency for the Three Crops Using FAS Data

Crop	**Corn**		**Soybean**		**Wheat**	
State	Efficiency	Rank	Efficiency	Rank	Efficiency	Rank
Alabama	0.35	20	0.57	18	0.71	11
Alaska	0.70	7	0.44	20	0.63	19
Arizona	**0.06**	**51**	0.67	12	0.33	45
Arkansas	0.26	30	0.18	40	0.57	22
California	**0.07**	**46**	**0.91**	**1**	**0.21**	**49**
Colorado	0.22	34	0.80	6	0.41	42
Connecticut	**0.89**	**1**	**0.85**	**3**	**0.91**	**2**
Delaware	0.57	10	.	.	0.67	13
District of Columbia	0.49	12	0.59	14	0.72	6
Florida	**0.07**	**48**	0.23	35	0.33	44
Georgia	0.36	19	0.33	26	0.51	29
Hawaii	0.74	6	0.44	21	**0.76**	**5**
Idaho	0.20	36	**0.82**	**4**	0.51	32
Illinois	**0.06**	**49**	0.13	46	**0.32**	**46**
Indiana	**0.06**	**50**	**0.10**	**49**	0.49	35
Iowa	0.19	39	0.21	38	0.48	38
Kansas	0.40	18	0.15	42	**0.82**	**4**
Kentucky	0.30	23	0.31	28	0.66	14
Louisiana	**0.84**	**3**	**0.80**	**5**	**0.84**	**3**
Maine	**0.84**	**2**	0.74	8	0.72	7
Maryland	0.31	21	0.32	27	0.53	27
Massachusetts	**0.79**	**4**	0.74	9	0.72	8
Michigan	0.26	29	**0.11**	**48**	0.36	43
Minnesota	0.22	33	0.13	45	0.46	41
Mississippi	**0.77**	**5**	0.54	19	0.64	17
Missouri	0.20	37	0.13	44	0.56	25
Montana	0.19	38	0.71	10	0.49	34
Nebraska	**0.07**	**47**	0.29	30	0.51	31
Nevada	0.63	8	0.71	11	**0.24**	**47**
New Hampshire	0.56	11	0.67	13	0.72	9
New Jersey	0.31	22	0.19	39	0.60	21
New Mexico	0.17	41	.	.	0.56	24
New York	0.15	44	0.18	41	0.52	28
North Carolina	0.21	35	**0.12**	**47**	0.50	33
North Dakota	**0.24**	**32**	**0.23**	**36**	**0.69**	**12**
Ohio	0.08	45	0.22	37	0.51	30
Oklahoma	0.27	28	0.41	24	0.62	20
Oregon	0.27	27	0.79	7	**0.91**	**1**
Pennsylvania	0.16	43	0.26	31	**0.22**	**48**
Rhode Island	0.49	13	0.59	15	.	.
South Carolina	0.40	17	0.24	34	0.65	16

Table 5.3: State Export Efficiency for the Three Crops Using FAS Data (Continued)

Crop	**Corn**		**Soybean**		**Wheat**	
State	Efficiency	Rank	Efficiency	Rank	Efficiency	Rank
South Dakota	0.27	26	0.25	33	0.49	37
Tennessee	0.28	25	0.25	32	0.57	23
Texas	0.17	40	0.29	29	0.49	36
Utah	0.29	24	0.59	16	0.55	26
Vermont	0.63	9	0.59	17	.	.
Virginia	0.40	16	0.35	25	0.48	39
Washington	0.16	42	**0.89**	**2**	0.71	10
West Virginia	0.49	14	0.41	23	0.64	18
Wisconsin	0.25	31	0.15	43	0.66	15
Wyoming	0.48	15	0.44	22	0.48	40

Table 5.4: Quantifying Export Deficits Based on Actual and Potential Exports (FAS Data)

Crop	Corn ('000 dollars)			Soybean ('000 dollars)			Wheat ('000 dollars)		
State	Actual Exports	Potential Export	Export Deficit	Actual Export	Potential Export	Export Deficit	Actual Export	Potential Export	Export Deficit
Alabama	**1438.83**	**4118.67**	**2679.84**	**12865.115**	**22689.28**	**9824.16**	1065.452	1501.117	435.6643
Alaska	0.00	0.00	0.00	1.4166667	3.21	1.79	0	0	0
Arizona	**723.88**	**11685.66**	**10961.78**	153.66667	230.28	76.62	**3129.394**	**9593.906**	**6464.512**
Arkansas	371.33	1455.31	1083.98	**2626.35**	**14331.29**	**11704.94**	1949.875	3412.808	1462.933
California	**587.48**	**8352.99**	**7765.51**	285.50417	312.55	27.04	356.5995	1713.45	1356.851
Colorado	147.02	683.37	536.35	2.40625	3.01	0.60	439.0421	1060.941	621.8992
Connecticut	2256.69	2539.92	283.23	5288.381	6217.28	928.90	4733.098	5193.89	460.792
Delaware	5.75	10.01	4.26			0.00	119.8333	178.8297	58.99639
District of Columbia	1.50	3.09	1.59	2440.125	4114.79	1674.67	156.4583	216.9002	60.44186
Florida	116.81	1786.36	1669.55	8.3385417	36.67	28.34	7.236111	22.02821	14.7921
Georgia	165.78	464.86	299.08	**1537.2619**	**4638.40**	**3101.14**	466.3054	908.0626	441.7572
Hawaii	13.42	18.10	4.68	299.91667	678.68	378.77	3.257143	4.26121	1.004067
Idaho	53.10	261.40	208.30	30.075	36.60	6.52	718.2379	1420.308	702.0697
Illinois	**7700.74**	**119630.03**	**111929.29**	**19207.952**	**146768.88**	**127560.93**	**1323.695**	**4127.143**	**2803.449**
Indiana	**497.53**	**7768.53**	**7270.99**	**811.93056**	**8012.68**	**7200.75**	**234.5922**	**480.8449**	**246.2528**
Iowa	**6987.25**	**36963.84**	**29976.60**	**7191.2683**	**34784.40**	**27593.13**	**622.3982**	**1285.047**	**662.6486**
Kansas	**4069.66**	**10185.85**	**6116.20**	**11888.822**	**77943.80**	**66054.98**	**10915.8**	**13240.98**	**2325.177**
Kentucky	301.79	1020.01	718.22	445.05	1421.37	976.32	461.9546	699.0803	237.1257
Louisiana	**66488.99**	**79207.74**	**12718.76**	**148711.92**	**185843.44**	**37131.52**	**16089.8**	**19187.57**	**3097.768**
Maine	94.57	112.59	18.03	58.133333	78.13	19.99	75.29167	104.3778	29.08614
Maryland	58.47	187.84	129.37	332.29583	1045.36	713.06	83.52778	156.7771	73.24932
Massachusetts	1.49	1.88	0.39	17.383333	23.36	5.98	0	0	0
Michigan	1054.36	3987.21	2932.86	**3841.1699**	**36345.56**	**32504.39**	170.6556	476.8924	306.2368
Minnesota	2745.00	12444.36	9699.36	**3731.0725**	**28331.16**	**24600.09**	**1562.334**	**3426.295**	**1863.961**
Mississippi	438.48	569.56	131.08	1619.6923	3005.54	1385.85	520.4688	812.6891	292.2203
Missouri	**4085.21**	**20411.72**	**16326.51**	**5680.6296**	**42483.46**	**36802.83**	1010.858	1818.295	807.4371
Montana	183.92	959.41	775.49	35.125	49.28	14.15	848.2848	1715.532	867.2476

Table 5.4: Quantifying Export Deficits Based on Actual and Potential Exports (FAS Data) (Continued)

Crop	Corn ('000 dollars)			Soybean ('000 dollars)			Wheat ('000 dollars)		
State	Actual Exports	Potential Export	Export Deficit	Actual Export	Potential Export	Export Deficit	Actual Export	Potential Export	Export Deficit
Nebraska	**3028.08**	**45718.55**	**42690.47**	**22312.475**	**76437.48**	**54125.01**	631.1369	1247.389	616.2523
Nevada	125.21	198.42	73.21	141.5625	198.60	57.04	3.416667	14.25996	10.84329
New Hampshire		0.00	0.00	9	13.49	4.49	27.75	38.47018	10.72018
New Jersey	28.07	91.15	63.07	**1985.381**	**10248.02**	**8262.64**	696.0547	1161.572	465.5178
New Mexico	95.40	554.39	459.00	0.0	0.0	0.00	97	172.1833	75.18331
New York	**776.36**	**5020.75**	**4244.39**	**2932.4455**	**16246.49**	**13314.04**	1265.397	2427.487	1162.091
North Carolina	111.35	530.93	419.58	**3053.7308**	**26101.07**	**23047.34**	246.771	489.0769	242.3059
North Dakota	**7216.25**	**30542.85**	**23326.60**	**1396.7083**	**6202.60**	**4805.89**	**2800.97**	**4074.228**	**1273.258**
Ohio	**903.08**	**11039.93**	**10136.85**	**11650.841**	**53509.34**	**41858.50**	**295.7608**	**577.7739**	**282.0132**
Oklahoma	21.08	79.14	58.05	1318.875	3229.55	1910.68	**3366.146**	**5424.181**	**2058.035**
Oregon	**3472.01**	**13031.19**	**9559.18**	**22821.929**	**29062.79**	**6240.86**	**33126.71**	**36337.57**	**3210.868**
Pennsylvania	36.17	222.25	186.08	719.53125	2741.38	2021.85	24.58333	111.9386	87.35529
Rhode Island	20.83	42.91	22.08	126.70833	213.67	86.96	1.472222	1.91858	0.446358
South Carolina	33.28	83.19	49.91	855.66667	3629.95	2774.28	98.25424	150.481	52.22674
South Dakota	598.86	2196.51	1597.65	698.88333	2818.22	2119.34	546.1579	1123.902	577.7445
Tennessee	140.01	493.17	353.16	1815.7803	7213.58	5397.80	726.2827	1281.506	555.2232
Texas	**3743.30**	**21663.34**	**17920.05**	**9720.0758**	**32967.89**	**23247.82**	**15822.15**	**32446.45**	**16624.3**
Utah	11.23	38.17	26.95	2.2916667	3.86	1.57	5.083333	8.106239	3.022906
Vermont	56.04	88.81	32.77	251.5	424.11	172.61	303.3077	555.9679	252.6602
Virginia	1247.63	3107.06	1859.43	**8239.4695**	**23362.32**	**15122.85**	**3010.745**	**6313.072**	**3302.327**
Washington	**48084.91**	**294064.24**	**245979.33**	**133388.09**	**149568.38**	**16180.29**	**32294.6**	**45193.91**	**12899.31**
West Virginia	0.00	0.00	0.00	7.3611111	18.02	10.66	40.33333	63.09339	22.76006
Wisconsin	**664.69**	**2682.33**	**2017.64**	**2262.0083**	**15380.40**	**13118.40**	**5713.807**	**8664.511**	**2950.704**
Wyoming	9.54	19.74	10.20	1	2.26	1.26	40.70833	85.53829	44.82996

5.3.1. Value of Exports Lost by States Due to Inefficiencies

The dollar value of exports lost by the states due to export inefficiencies are measured in this section. This measure is obtained based on the state export efficiency as a percentage proportion of the actual average export by the state over the period. This is represented mathematically as;

$$EX_{gi} = \{\frac{1 * EX_{ai}}{EX_{effi}}\} - EX_{ai} \quad (5.1)$$

where EX_{gi} is the export gap for state i, EX_{ai} is the average actual export for state i over the study period and EX_{effi} is the export efficiency for state i. 1 represents the full potential of the state because the export efficiency is represented between 0 and 1.

Based on this, Table 5.4 reveals the export deficits of the states for the three crops. Illinois has deficits of US$ 111,929,290.00, US$ 127,560,930.00 and US$ 2,803,449.00 for corn, soybean and wheat respectively. The average deficits for Iowa are US$29,976,600.00, US$ 27,593,130.00 and US$ 662,648.60 for corn, soybean and wheat respectively.

In general, other states that have large corn export gaps are Washington, Nebraska, North Dakota, Missouri, Texas and Louisiana with deficits of US$ 245,979,330.00, US$ 42,690,470.00, US$23,326,600.00, US$ 16,326,510.00, US$17,920,050.00 and US$ 12,718,760.00 respectively. States that have high soybean deficits are Kansas, Nebraska, Ohio, Louisiana, Missouri Michigan and Minnesota with deficits of US$ 66,054,980.00, US$ 54,125,010.00, US$ 41,858,500.00, US$ 37,131,520.00, US$ 36,802,830.00, US$ 32,504,390.00 and US$ 24,600,090.00 respectively. High export efficiency gaps in value for wheat are found in Texas, Washington and Arizona with deficits of US$ 16,624,300.00, US$12,899,310.00 and US$6,464,512.00 respectively.

5.3.2. The 'I-States Paradox': A Representative Case of State Export Data Report Issues

For any reader conversant with the United States agricultural sector, particularly the grain sub-sector, the prominence of I-States, namely, Iowa, Indiana and Illinois cannot be overlooked. For grains like corn, Iowa's role as the leading producer has been rarely matched over a long period of time. However, the results from the export efficiency reveal Iowa to have low scores across the three crops; a paradox that must be discussed and disentangled. The 'I-State Paradox' is therefore used as a term to represent states which have a low export efficiency despite high production.

The primary reason for the 'I-State paradox' can be attributed to the methodology employed in measuring state exports. As noted by the University of California Agricultural Issues Center (2012), export estimates differ from diverse sources. For instance, the Foreign Agricultural Services estimates (which was used for the efficiency scores in Table 5.3) are based on port values of exports while other sources such as the Economic Research Service calculate the states' exports based on the state's share of the commodity's production. The use of port value makes states like Louisiana, California, Washington and Oregon report high values of exports at the detriment of inland producers along the corn belt in Iowa, Illinois, Indiana and Nebraska, Minnesota who lack ports and waterbodies for mass transport of their produce. Similar phenomenon may also be observed for soybean and wheat. Based on this premise, the state export data from ERS is employed with the objective of minimizing the effect of the 'I-State Paradox'.

5.4. Estimation Based on ERS State Export Data

To remedy the problem of the 'I-State Paradox', the Economic Research Service (ERS) data for export value is employed. To account for the state exports to the various country destinations, the proportions of trade were obtained using the FAS[30] export data.

[30] The ERS data provides the commodity's exports as the state's total export of that commodity. However, the FAS provides specific destinations of state's exports of each of the commodities.

5.4.1. Model Build-Up

Table A7 reports the basic gravity model parameter estimates for the three crops. For the corn model, the destination GDP, destination population, distance, contiguity dummy, common language dummy, exchange rate and tariff difference are significant are varying percentages. In model, two, where observed and unobserved heterogeneity are controlled for, similar variables are significant with the inclusion of exporter fixed effects. In model three, where the heterogeneity control term is the importer fixed effects, the control term is insignificant. However, similar variables in model three as in model one and two are significant. Model four controls for heterogeneity using both the exporter and importer fixed effects. The significant variables are similar to models one, two and three. In the soybean model one, all variables except the common currency, state population and price ratios are significant. For soybean models two, three and four which control for heterogeneity, none of the control terms are significant. The basic wheat gravity model one reveals the GDPs of origin and destination, the population of the destination, distance, contiguity, exchange rate and tariff difference as significant. The heterogeneity control models show all the control factors to be significant. The standard errors for both the heterogeneity-controlled and uncontrolled models are similar with only minor variations.

In Table A8, the four trade facilitation indicators are included. The border administration index is significant but has a negative coefficient. Models two, three and four also have the border administration index as the only significant trade facilitation indicator. However, this does not conform to the “a prior” expectation. In the soybean model, only the open environment index is significant among the trade facilitation indicators. It is positive and conforms to the “a prior” expectation. In the wheat models, the uncontrolled model has border administration and open environment index to be significant. Both variables do not conform to the “a prior” expectations.

The wheat models with different controls for heterogeneity has the border administration index, infrastructure index and open environment index to be significant. Only the infrastructure index conforms to the “a prior” expectation.

The genetically engineered restrictive index is included A9. This variable is significant for all the four models for each of the three crops. The coefficients are negative for the corn and soybean models while positive for the wheat models. The “a prior” expectations are met in these models. The final section of the model build-up adds three trade agreements in relation with United States. The dummies of trade agreements included are bilateral trade agreement of the destination with the USA, membership of NAFTA or CAFTA dummy. For the corn models, NAFTA is found to be significant for both the controlled and uncontrolled models. Bilateral trade agreement is also significant for the model in which heterogeneity is controlled using the importer fixed effects.

5.4.2. The Final Model Using ERS Export Data

To evaluate the importance of trade facilitation indicators and genetically engineered restrictive index on the US state level trade, the ERS data is used. The significance of this data is that it accounts for the crop production differences among the states, unlike the FAS data set that employs only port values of trade. The variables are selected for the final model are based on the inferences from the model build-up procedure. The variables selected for the final empirical model are the GDP of the origin and destination, exchange rate between the US and partner countries, tariff differences and the ratio of global prices of the commodities to their domestic prices. The four trade facilitation indicators (border administration index, infrastructure index, market access and open environment index) are also included in the final model. The genetically engineered restrictive index, bilateral trade agreement dummy, CAFTA and NAFTA membership dummies are also included in the model. The results of the fixed effects and random effects are compared using a Hausman specification test for consistency. The final model is specified in Table 5.5.

5.4.2.1. Basic Gravity Variables

5.4.2.1.1. Corn Model

For the corn model, the fixed effects model is established as the appropriate model by the Hausman test. Having established minimal differences in standard errors and coefficients between the models control for heterogeneity and those not control for heterogeneity, the model without controls is employed to account for variations in GDP. Among the variables selected from the basic gravity model, the state GDP is found to be insignificant. The destination GDP is significant at 1% with a coefficient of 0.326. A unit increase in the destination GDP leads to a 0.326% increase in state corn exports. This implies that US states tend to export more corn to countries with large economies. The exchange rate of a dollar to the destination's currency is positive and significant at 1%. A unit increase in the value of the US dollar in relation to the destination currency will lead to a 0.178% increase in corn exports. This means that the US will not benefit from a devaluation of its currency in terms of its corn export. McKenzie (1999) described the impact of exchange rate volatilities on trade flows as a basic paradox which remains unsolved at both theoretical and empirical level in international trade studies. His study explained that the direction of exchange rate depends on the measurement of volatility[31] or sectors and countries concerned. In the case of this, it may be attributed to both. Exchange rate is measured as the ratio of the US dollar to the destination's currency. First, the US dollar is vehicle currency of international trade. In addition, countries in East Asian economies, particularly China have undervalued their currencies with the objective of reducing trade surpluses regarding their trade with the United States (Qiao, 2007).

[31] Some studies measure exchange rate volatility as trade weighted averages whiles others measure it as direct exchange rate of currency to the trade vehicle currency.

Meanwhile East Asian countries such as Japan, South Korea and Taiwan (Republic of China) remain among the top ten export destinations of US corn. At the regional level, East Asia accounted for US$3,400,134,000 of US corn exports in 2017 (https://www.fas.usda.gov/data). This represents 37.3% of total US exports, (Figure 5.1). This therefore makes the impact of dollar to trade-partner exchange rate appreciation justifiably positive.

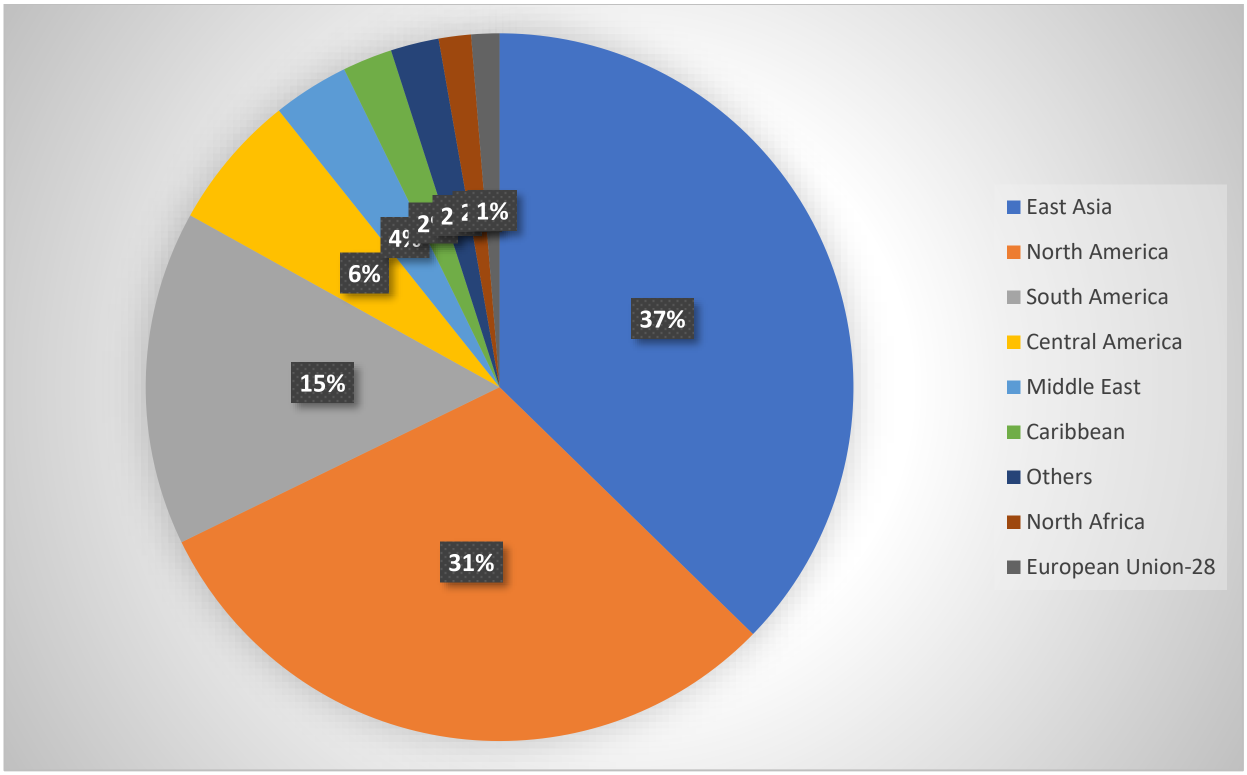

Figure 5.1: Share of U.S. Corn Exports by Region

The tariff difference between the US and the destination partner is negative and significant at 1%. A unit increase in the tariff difference leads to a 0.927% decrease in corn exports to the destination. This conforms with the 'a prior' expectation and implies that the US states export corn to countries whose tariff rates are similar the country's tariff rate. The ratio of global corn prices to state corn prices is not a significant determinant of corn export. Despite expecting this variable to have an impact on export, an important dimension of exports is revealed with its insignificance; futures trade. US corn is mainly traded on the futures market based on seasons. The futures contract months are March, May, July September and December. Hence, using annual price ratio of the world to the state as the determinant of state exports does not yield any effect as revealed in this study.

5.4.2.1.2. Soybean Model

In the soybean model, the random effects model is revealed to be appropriate. The basic gravity model variables significant for soybean are the same as those found for corn. A unit increase in the destination GDP leads to a 0.923% increase in the states' exports to the destination. This conforms to the general expectation in trade theory with regards to the effect of a destination's wealth. This model also reveals a positive effect of the dollar to destination's exchange rate on state level exports. In similar fashion as observed for the corn model, the effect of currency devaluation among East Asian countries to maintain respectable trade balances cannot be overlooked. Even in this case, this region accounts for a higher proportion of US soybean exports than observed for corn. The US FAS database indicates that 65.86% of the total US$21,582,206,000 US soybean exports were purchased by East Asia in 2017 (Figure 5.2). The tariff differences are significant and negative as expected in the soybean model. A 1% increase in the tariff difference between the US and the destination country leads to a 0.399% decrease in state export. The impact of soybean futures trade makes the ratio of global soybean prices to domestic soybean prices insignificant in determining US' states soybean exports.

Wheat remains the most important US grain export after soybean and corn. In the wheat model, the random effects model is justified to be appropriate by the Hausman specification test. Contrary to both the corn and soybean models, the state GDP is negative and significant at 5%. A 1% increase in GDP of the state leads to a 0.363% increase in the state exports. This implies that wheat exporting states with larger economies export more than those with small economies. The destination GDP is significant at 1% with a 0.363% elasticity. This also conforms with the theoretical underpinning of international trade. The tariff difference also conforms to the 'a prior' expectation of trade theory. This variable is significant at 1% and has a negative coefficient. A unit increase in the tariff difference leads to a 0.548% decrease in the state wheat exports. This implies that the state reserves the high tendency of exporting wheat to countries whose tariff rates are similar to the United States. The exchange rate of the US dollar to the destination's currency is insignificant and does not affect the export of wheat from the state.

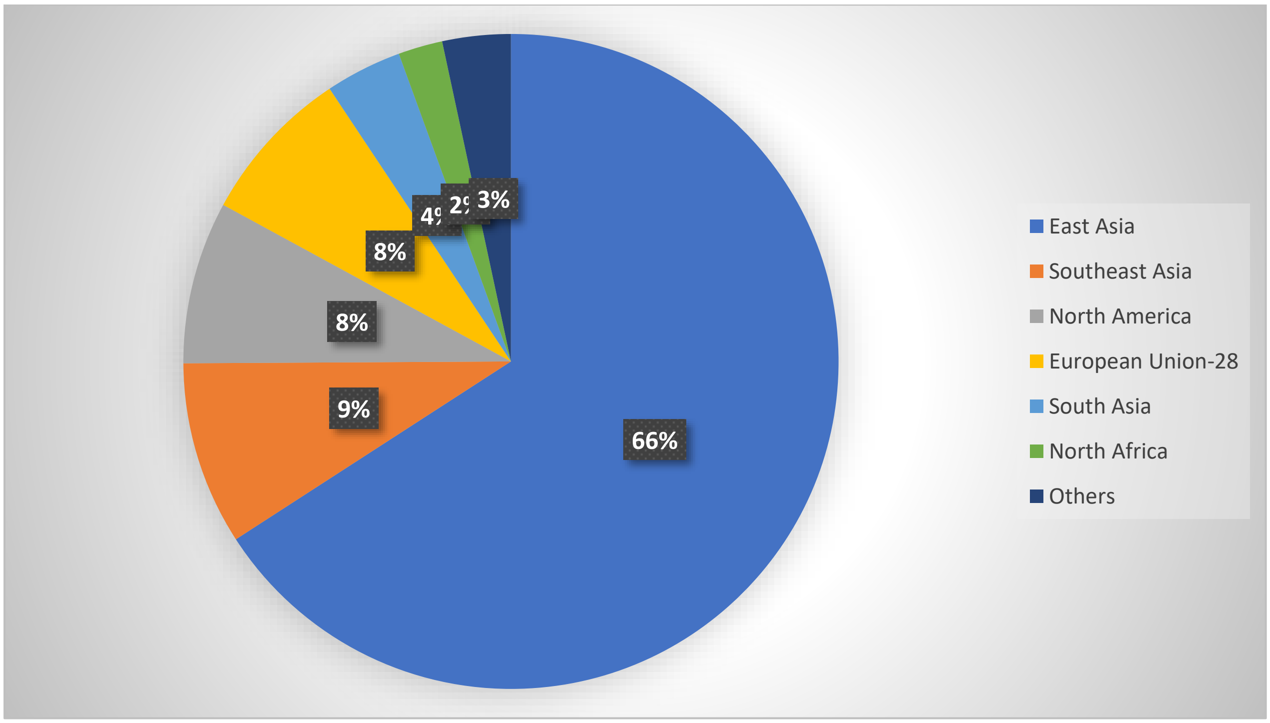

Figure 5.2: Share of U.S. Soybean Exports by Region

5.4.2.2. Trade Facilitation Indicators

Trade facilitation indicators have become important determinants of the direction of trade in recent times. As thoroughly established in this literature, several nations following the reduction in tariff barriers via the efforts of the WTO have resorted to non-tariff measures and other trade restrictive mechanisms. This study uses the four trade facilitation indicators developed by the World Economic Forum and Global Alliance for Trade Facilitation.

In the corn model, the border administration is significant at 1%. This variable shows a coefficient of -0.512. Hence a unit increase in the border administration index leads to a 51.2% [32] decline in state corn exports. This does not conform to the 'a prior' expectation of trade. Implies the US states corn exports are reduced by high performance of countries in terms of their border administration index. Likewise, the open environment index is significant at 5% and has a negative effect on US state corn exports. A unit increase in the open environment index therefore leads to a 28.5% decrease in state exports. The only trade facilitation indicator that conforms to the theoretical underpinnings of international trade is the infrastructure index. A unit increase in this variable leads to 76.2% increase of corn exports.

The same variables are significant for the soybean model. A unit increase in the border administration index leads to a 44.6% decline in soybean exports. The border administration index is significant at 1%. The infrastructure index is significant at 10% and has a negative impact on soybean exports. A unit increase in the infrastructure index leads to 34.9% decrease in soybean exports. The open environment index is significant at 1% and has a 0.473 elasticity on soybean exports.

In the wheat model, the border administration, infrastructure and open environment indexes are significant at 1%, 5% and 10% respectively. They all have negative effects on state wheat exports. A unit increase in the border administration will lead to a 49.1% decrease in wheat expects while the same increase of the infrastructure index will lead to a 25.3% decrease in wheat exports. Increasing the open environment index of a country by 1 unit leads to a 26.3% decrease in wheat export to that destination.

[32] The trade facilitation indicators are interpreted as for log-linear functional forms because they are incorporated as indices ranging from 1 to 7. Hence, the effect we seek to explain is the impact of a unit change in the index. Multiplying the coefficient of the TFI enables the response rate to be discussed in semi-elasticity terms. E.g. 1 unit increase in border administration will lead to a [100(0.512)] % decline in corn exports

In several studies estimating the impact of trade facilitation indicators, they tend to have a positive impact. Iwanow and Kirkpatrick (2007) found export growth to be significantly affected by the improvements in trade facilitation. Shepherd and Wilson (2009) found infrastructure and ICT to positively affect trade among Southeast Asian countries. However, Wilson et al., (2003) observed a negative effect of regulatory environment on trade flows among Asian countries. They explained that regulations are used as border barriers and are as such represent a typical example of nonmarket barriers to trade. It is important to note that most of these studies focussed on the importance of improving the trade facilitation indicators on a country on its own exports. Practically, no study from our thoroughly searched review has looked at the effects of improving a country's trade facilitation indicators on its product origin's exports.

These coefficients not conforming to the 'a prior' expectation reveal a dimension with regards to trade facilitation indicator that might have been pushed under the carpet over the years. The biasedness with these indicators is that most policy makers look at them from the perspective of the country exporting. Even at the level of the WTO, the impact on an exporter of its destination's trade facilitations dynamics have not been given due attention. For instance, the WTO (2015) report predicts export gains of between US$750 billion and US$ 1 trillion dollars per annum from the implementation of trade facilitation agreements using a computable general equilibrium simulation.

5.4.2.3. GERI: A Possible Threat to World Demand for U.S. Corn and Soybean

The chronic case of global food insecurity has been discussed on several platforms. Alternative plans have been formulated by various institutions and countries with the aim of combatting this issue, for instance the US has a Government Global Food Security Strategy document with which it intends to reduce world food insecurity. The USAID (2016) suggested three strategies; i) inclusive and sustainable agricultural-led economic growth; ii) strengthening resilience among people and systems and iii) improving the nutritional needs of women and children.

On the other hand, science has also always devised ways to relieve humanity from challenges. Improvements in biotechnology has led to the introduction of genetically engineered organisms. Considering the strengths of GE products, global food insecurity issues can be combatted through them. Some advantageous characteristics of GE crops are those engineered for herbicide resistance, insect resistance and those improved for diverse stacked trait. Despite these documented advantages, there has been resistances across several parts of the world due to perceived potential harm. This poses a significant challenge to US agricultural exports, particularly corn and soybean. The genetically engineered restrictive index created in this study is used to assess the impact of these restrictions on corn, soybean and wheat exports.

The coefficient of corn and soybean are negative and significant at 1% and 5% respectively. The corn coefficient of -0.138 indicates that a 1% increase in the GERI of a country will lead to a 0.138% decline of exports to that country. In the soybean random effects model, a 1% increase in the GERI of a country will lead to a 0.313% decrease in exports from the US states. On the contrary, the wheat random effects model shows a positive effect. A 1% increase in the GERI index leads to a 0.326% increase wheat exports. The results obtained for the three crops show an offsetting relationship. The U.S. corn and soybean are genetically engineered while its wheat is not genetically produced on commercial basis. Hence, the negative effect of the index on the two crops and positive effect on wheat implies that states tend to substitute the GE crops by wheat in countries where the restrictive index is high.

5.4.2.4. Free Trade Agreements

The importance of Free Trade Agreements in trade openness can be seen by its multiplicative proliferation over the years. To observe its impact on states exports, three U.S. FTAs are incorporated in the model; bilateral trade agreement, NAFTA and CAFTA. In the corn model, CAFTA and NAFTA are significant at 1% and have a positive impact on state corn exports. Following from AW (2003), its marginal effect as a dummy variable is measured by [exp (1-β) *100]. Hence, being a member of CAFTA leads to 173.84% increase in state corn exports while being a NAFTA leads to 96.85% increase in corn exports. In the soybean model, having a bilateral trade agreement with the US is the only significant FTA at 5%. Have a bilateral trade agreement with the US leads to a 190.02 % in soybean exports. In the wheat model, all three FTAs are significant in determining trade. Having a bilateral trade agreement with the U.S. and being a member of CAFTA increases wheat exports at 1% and 10% significance levels respectively. A bilateral trade agreement with U.S. increases wheat exports by 164.21% while CAFTA membership increases wheat export by 202.18 %. On other hand being a member of NAFTA decreases wheat export by 235.14%.

Table 5.5: Final Model Using the ERS Data

	Corn		Soybean		Wheat	
Variable	**Fixed Eff**	**Random Eff**	**Fixed Eff**	**Random Eff**	**Fixed Eff**	**Random Eff**
LnSGDP	0.314	-0.089	-0.377	-0.257	0.782***	0.363**
	(0.261)	(0.169)	(0.391)	(0.161)	(0.275)	(0.176)
LnDestGDP	0.326***	0.337***	0.934***	0.923***	0.344***	0.363***
	(0.031)	(0.03)	(0.055)	(0.053)	(0.04)	(0.04)
LnEx	0.178***	0.178***	0.177***	0.177***	-0.015	-0.015
	(0.012)	(0.012)	(0.016)	(0.016)	(0.014)	(0.014)
Lntdiff	-0.927***	-0.916***	-0.400***	-0.399***	-0.551***	-0.548***
	(0.067)	(0.067)	(0.123)	(0.122)	(0.079)	(0.079)
LnpRatio	0.15	0.254	0.424	0.414	0.477	0.654*
	(0.205)	(0.204)	(0.362)	(0.362)	(0.341)	(0.34)
Borderadmin	-0.512***	-0.508***	-0.465***	-0.446***	-0.490***	-0.491***
	(0.097)	(0.097)	(0.168)	(0.167)	(0.102)	(0.103)
Infrastructure	0.762***	0.742***	-0.349*	-0.345*	-0.221*	-0.253**
	(0.108)	(0.108)	(0.193)	(0.193)	(0.126)	(0.126)
Marketaccess	-0.012	-0.008	0.139	0.127	0.057	0.053
	(0.067)	(0.067)	(0.115)	(0.115)	(0.07)	(0.07)
Openvironment	-0.285**	-0.272**	0.481***	0.473***	-0.292**	-0.263*
	(0.112)	(0.112)	(0.174)	(0.173)	(0.141)	(0.141)
LnGERI	-0.138*	-0.149**	-0.323**	-0.313**	0.337***	0.326***
	(0.071)	(0.071)	(0.144)	(0.144)	(0.097)	(0.098)
Bilateral	0.104	0.125	-0.362**	-0.358**	0.466***	0.504***
	(0.109)	(0.109)	(0.179)	(0.178)	(0.138)	(0.138)
CAFTA	0.447***	0.483***	-0.202	-0.195	0.232	0.296*
	(0.137)	(0.137)	(0.339)	(0.337)	(0.158)	(0.158)
NAFTA	1.032***	1.041***	0.291	0.333	-0.655***	-0.629***
	(0.166)	(0.166)	(0.292)	(0.291)	(0.199)	(0.2)
Constant	-8.974***	-4.199**	-10.946**	-12.244***	-9.669***	-3.214
	(3.204)	(2.105)	(4.818)	(2.253)	(3.65)	(2.693)
Observations	5,335	5,335	2,703	2,703	3,133	3,133
Number of PanelID	39	39	30	30	41	41
R-squared	0.258		0.236		0.157	

5.5. State Export Efficiency

To mitigate the ‘I-State’ paradox, the ERS data is used to estimate the export efficiency of the states for each of the crops. From Table 5.6, border administration and open environment index affect export efficiency negatively with coefficients of 0.509 and 0.263 respectively. Their significance levels are 1% and 5% respectively. Infrastructure index affected U.S state level corn export efficiency significantly at 1% with a coefficient of 0.73. For soybean, its export efficiency is affected negatively by border administration and infrastructure at 1% and 10% significance with coefficients of 0.450 and 0.345 respectively. The open environment index has a positive effect on the soybean export efficiency at 1% with a coefficient of 0.474. Finally, the state level wheat export efficiency is negatively affected by border administration, infrastructure index and open environment at 1%, 5% and 5% with coefficients of 0.492, 0.241 and 0.271 respectively.

The genetically engineered restrictive index has a negative impact on corn and soybean export efficiency with coefficients of 0.154 and 0.314 respectively at 5% significance level. The wheat export efficiency is affected positively by the genetically engineered restrictive index of the destination at 1% significance level with a coefficient of 0.330.

Table 5.6: Parameter Coefficients of State Export Efficiency Using FAS Export Values

Variables	**Corn**	**Soybean**	**Wheat**
Deterministic Component of Stochastic Frontier Model			
State GDP	-0.356**	-0.268	0.494**
	-0.163	-0.171	-0.199
Destination GDP	0.346***	0.924***	0.356***
	-0.03	-0.053	-0.04
Exchange Rate	0.178***	0.177***	-0.015
	-0.012	-0.016	-0.014
Tariff Difference	-0.912***	-0.398***	-0.546***
	-0.067	-0.122	-0.078
Price Ratio	0.26	0.416	-0.532
	-0.203	-0.36	-0.339
Border Administration Index	-0.509***	-0.450***	-0.492***
	-0.097	-0.167	-0.102
Infrastructure Index	0.731***	-0.345*	-0.241*
	-0.107	-0.193	-0.125
Open Environment Index	-0.263**	0.474***	-0.271*
	-0.111	-0.173	-0.14
Market Access Index	-0.006	0.129	0.055
	-0.067	-0.114	-0.07
Genetically Engineered Restrictive Index	-0.154**	-0.314**	0.330***
	-0.071	-0.143	-0.097
Bilateral Trade Agreements Dummy	0.147	-0.359**	0.492***
	-0.108	-0.177	-0.137
CAFTA Membership Dummy	0.508***	-0.198	0.274*
	-0.136	-0.336	-0.157
NAFTA Membership Dummy	1.062***	0.329	-0.630***
	-0.165	-0.29	-0.198
Constant	1.092	-10.108***	-2.122
	-2.021	-2.344	-2.821
Mean of Underlying Truncated Distribution			
Constant	0.21	1.992***	2.413**
	-2.205	-0.637	-1.029
Scale Parameters of the Random Components of e(i)			
In_sigmaU	2.408***	1.771***	2.247***
	-0.425	-0.056	-0.272
In_sigmaV	0.47	-1.828***	0.504
	-0.691	-0.368	-0.436
Observations	5,335	2,703	3,133
Number of PanelID	39	30	41

Table 5.7: State Export Efficiency for the Three Crops Using ERS Data

Crop	**Corn**		**Soybean**		**Wheat**	
State	Efficiency	Rank	Efficiency	Rank	Efficiency	Rank
Alabama	0.52	38	0.55	33	0.64	25
Alaska	0.78	17	0.50	36	0.66	22
Arizona	0.32	46	0.68	18	0.14	45
Arkansas	0.77	18	0.36	45	0.42	36
California	0.32	47	**0.91**	**1**	0.22	42
Colorado	0.72	24	0.80	6	0.66	21
Connecticut	**0.90**	**2**	**0.85**	**3**	**0.91**	**1**
Delaware	0.82	14	.	.	0.68	18
Florida	0.19	49	0.74	14	0.48	33
Georgia	0.89	6	0.63	22	0.60	28
Hawaii	0.80	15	0.50	37	0.78	8
Idaho	0.48	40	**0.83**	**5**	0.30	40
Illinois	0.55	36	0.61	27	0.65	24
Indiana	**0.92**	**1**	**0.85**	**4**	**0.89**	**3**
Iowa	**0.57**	**33**	**0.60**	**28**	**0.86**	**4**
Kansas	0.75	20	0.34	46	0.49	31
Kentucky	0.77	19	0.80	7	0.82	7
Louisiana	0.33	44	0.18	48	0.14	46
Maine	0.87	7	0.75	12	0.74	10
Maryland	0.86	9	0.69	17	0.72	15
Massachusetts	0.83	12	0.75	13	0.74	11
Michigan	0.65	29	0.38	43	0.69	16
Minnesota	0.75	21	0.59	30	0.61	27
Mississippi	0.82	13	0.76	10	0.76	9
Missouri	0.48	39	0.38	42	0.68	17
Montana	0.36	42	0.72	15	0.19	44
Nebraska	0.32	45	0.48	39	0.89	2
Nevada	0.74	23	0.72	16	0.66	23
New Hampshire	0.70	26	0.68	19	0.74	12
New Jersey	0.64	30	0.30	47	0.42	37
New Mexico	0.34	43	.		0.59	30
New York	0.56	34	0.53	34	0.47	34
North Carolina	0.83	11	0.52	35	0.72	14
North Dakota	0.43	41	0.38	44	0.48	32
Ohio	0.54	37	0.63	23	0.83	6
Oklahoma	0.78	16	0.60	29	0.32	39
Oregon	0.28	48	0.79	8	0.04	48
Pennsylvania	**0.89**	**5**	0.75	11	0.67	19
Rhode Island	0.66	27	0.62	24	.	.
South Carolina	**0.89**	**3**	0.45	40	0.73	13
South Dakota	**0.89**	**4**	0.78	9	**0.85**	**5**

5.6. Post Estimation Diagnostic Tests and Remediation Models for Both Data Sources

Post estimation tests were conducted to ensure validity of estimates obtained. The tests conducted are test for autocorrelation, multicollinearity and heteroskedasticity. Performing a first order correlation test for both the FAS and ERS data models revealed the absence of serial correlation.

The test for multicollinearity using variance inflation factor (VIF) indicates infrastructure index as having high values of 12.84, 15.4 and 12.92 for corn. The rule of thumb indicates that the decision rule on multicollinearity may be based on cut off points of either 5 or 10. Persistent multicollinearity in a model neither affects the overall fitness of the model nor produce a bad prediction. Hence in cases such as that for the infrastructure index where the VIFs do not deviate severely from the target value of 10, it is not necessary to exclude the variable based on this. Moreover, it has no significant effect on the overall VIF which is 3.81, 4.23 and 3.93 for corn, soybean and wheat respectively.

The test for heteroskedasticity is based on the modified Wald test. Based on this test, the chi-square values are significant and hence the null hypothesis of homoscedasticity is rejected. Results are found in Table 5.10.

Table 5.8: Results of Autocorrelation

Model	F-Cal. Value	Prob >F	Decision Rule	Conclusion
		Model with FAS Data Set		
Corn	F (1, 26) ~ 0.864	0.3612	Fail to Reject Null Hypothesis	No Auto-Correlation
Soybean	F (1,24) ~ 0.022	0.8840	Fail to Reject Null Hypothesis	No Auto-Correlation
		Model with ERS Data Set		
Corn	F (1,28) ~ 1.198	0.2830	Fail to Reject Null Hypothesis	No Auto-Correlation
Soybean	F (1,23) ~ 0.814	0.3762	Fail to Reject Null Hypothesis	No Auto-Correlation
Wheat	F (1,31) ~ 0.047	0.8290	Fail to Reject Null Hypothesis	No Auto-Correlation

NB: The values test for the wheat model did not obtain a convergence using the FAS data. Hence no results to show for wheat.

Table 5.9: Variance Inflation Factor for Independent Variables

Variable	VIF Corn	VIF Soybean	VIF Wheat
Bilateral Trade Agreements with US	1.14	1.46	1.36
Border Administration Index	8.98	9.89	8.41
CAFTA membership	1.74	1.59	1.7
Infrastructure	12.84	15.4	12.92
Destination GDP	3.75	3.4	4.36
Exchange Rate	1.17	1.28	1.2
GER Index	1.74	2.38	1.99
Global Price to Domestic Price Ratio	1.02	1.01	1.01
State GDP	1.03	1.03	1.05
Tariff difference	3.68	4.65	4.24
Market Access Index	2.31	2.35	1.98
NAFTA Membership	3.04	4.64	3.84
Open Environment Index	7.13	5.89	7.09
Mean VIF	**3.81**	**4.23**	**3.93**

Table 5.10: Results for Homogeneity of Variance Test

Model	Chi2 Value	Prob>chi2	Decision Rule	Conclusion
		Model with FAS Export Value		
Corn	chi (39) = 1208.97	0.0000	Reject Null Hypothesis	Heteroskedasticity
Soybean	chi (30) = 944.90	0.0000	Reject Null Hypothesis	Heteroskedasticity
Wheat	chi (42) = 2517.39	0.0000	Reject Null Hypothesis	Heteroskedasticity
		Model with ERS Export Value		
Corn	chi2 (39) = 1659.44	0.0000	Reject Null Hypothesis	Heteroskedasticity
Soybean	chi2 (30) = 32004.08	0.0000	Reject Null Hypothesis	Heteroskedasticity
Wheat	chi2 (41) = 1200000.00	0.0000	Reject Null Hypothesis	Heteroskedasticity

5.6.1. Heteroskedasticity Correcting Models

The suggested correction models to correct for heteroskedasticity are PPML and the Heckman Selection model. Results are shown in Tables 5.11 and 5.12. From the results of both models, estimates obtained are not improved compared to the Fixed and Random effects models selected. This implies that the consequences of heteroskedasticity in the model are not severe. Furthermore, employing fixed or random effects models are themselves corrective models for heteroskedasticity.

Table 5.11: Heckman Selection Model for Both FAS and ERS Export Sources

	FAS Export Value			**ERS Export Value**		
	Corn	Soybean	Wheat	Corn	Soybean	Wheat
State GDP	-0.205***	0.314***	0.236***	-0.343***	-0.015	0.116**
	(0.044)	(0.071)	(0.045)	(0.041)	(0.059)	(0.047)
Destination GDP	0.138***	0.537***	-0.054*	0.202***	0.470***	0.096***
	(0.022)	(0.048)	(0.029)	(0.021)	(0.034)	(0.030)
Constant	7.737	-7.405	10.540	3.531	-5.769	1.764
	(0.735)	(1.458)	(0.813)	(0.666)	(1.028)	(0.882)
Select						
Exchange Rate	0.043***	0.075***	0.007*	0.040***	0.080***	0.002
	(0.004)	(0.006)	(0.004)	(0.003)	(0.005)	(0.004)
Lntdiff	-0.252***	0.167***	-0.064***	-0.203***	0.114***	-0.038*
	(0.022)	(0.038)	(0.020)	(0.018)	(0.032)	(0.021)
LnpRatio	0.302***	-0.276**	0.502***	0.374***	-0.162***	0.225***
	(0.064)	(0.114)	(0.075)	(0.054)	(0.096)	(0.080)
Border Administration Index	-0.094***	-0.092*	-0.103***	-0.071***	-0.056	-0.027
	(0.030)	(0.052)	(0.025)	(0.025)	(0.042)	(0.029)
Infrastructure Index	0.407***	0.246***	0.204***	0.356***	0.153***	0.074***
	(0.029)	(0.054)	(0.027)	(0.0250	(0.048)	(0.029)
Market Access	-0.035*	-0.001	-0.019	-0.013	-0.055***	-0.062***
	(0.020)	(0.033)	(0.017)	(0.017)	(0.029)	(0.019)
Open Environment	-0.191***	-0.002	-0.296***	-0.195***	0.011	-0.228***
	(0.033)	(0.052)	(0.034)	(0.028)	(0.045)	(0.036)
Genetically Engineered Restrictive Index	-0.029	0.183***	0.110***	-0.017	0.149***	0.131***
	(0.022)	(0.037)	(0.023)	(0.019)	(0.032)	(0.025)
Bilateral Trade Agreement with US	0.012	-0.025	0.202***	-0.026	-0.032	0.194***
	(0.035)	(0.054)	(0.035)	(0.029)	(0.047)	(0.038)
CAFTA Membership	0.320***	0.134	0.199***	0.254***	0.120	0.347***
	(0.046)	(0.095)	(0.044)	(0.039)	(0.080)	(0.045)
NAFTA Membership	0.486***	1.150***	0.238***	0.606***	1.193***	0.693***
	(0.058)	(0.094)	(0.062)	(0.048)	(0.084)	(0.059)

Table 5.11: Heckman Selection Model for Both FAS and ERS Export Value Source (Continued)

	FAS Export Value			**ERS Export Value**		
	Corn	Soybean	Wheat	Corn	Soybean	Wheat
Constant	-0.458	-2.318	-2.210	-0.543	-1.697	-0.005
	(0.121)	(0.210)	(0.347)	(0.100)	(0.184)	(0.114)
/athrho	-0.803***	0.022	-1.721***	-1.456***	-1.198***	-1.518***
	(0.039)	(0.112)	(0.066)	(0.038)	(0.065)	(0.055)
/lnsigma	1.203***	1.081***	1.422***	1.351***	1.226***	1.461***
	(0.018)	(0.014)	(0.024)	(0.016)	(0.027)	(0.023)
Rho	-0.666	0.022	-0.938	-0.897	-0.833	-0.908
	(0.022)	(0.112)	(0.008)	(0.008)	(0.020)	(0.010)
Sigma	3.330	2.949	4.144	3.862	3.408	4.312
	(0.061)	(0.040)	(0.100)	(0.063)	(0.093)	(0.100)
Lambda	-2.217	0.066	-3.887	-3.464	-2.838	-3.916
	(0.109)	(0.330)	(0.123)	(0.082)	(0.140)	(0.127)
Number of Observations	15816	7854	10867	15816	7854	10867
Censored Observations	10481	5151	7731	10481	5151	7734
Uncensored Observations	5335	2703	3136	5335	2703	3133
Wald chi2(2)	63.03	149.67	33.17	163.94	188.9	14.97
Prob > chi2	0.000	0.000	0.000	0.000	0.000	0.0006
Loglikelihood	-22649.03	-11541.5	-13592.7	-22141.8	-11041.6	-13865.7

Table 5.12: Poisson Pseudo Maximum Likelihood Estimation

Variable	FAS Corn	FAS Soybean	FAS Wheat	ERS Corn	ERS Soybean	Wheat
State GDP	-0.059*	-0.069	0.208***	-0.177***	-0.215***	-0.109**
	(0.035)	(0.047)	(0.037)	-0.054	-0.055	-0.052
Destination GDP	0.400***	1.513***	0.513***	0.448***	0.853***	0.431***
	(0.081)	(0.149)	(0.047)	-0.048	-0.074	-0.076
Exchange Rate	0.316***	0.032	0.089***	0.163***	0.107***	-0.02
	(0.023)	(0.025)	(0.017)	-0.016	-0.02	-0.017
Tariff Difference	-2.219***	-0.314**	-0.268**	-0.981***	-1.156***	-0.276**
	(0.19)	(0.132)	(0.113)	-0.12	-0.116	-0.129
Price Ratio	0.283	-0.472	-1.507***	1.493***	-0.028	3.823***
	(0.361)	(0.635)	(0.318)	-0.417	-0.508	-0.512
Border Administration Index	-2.570***	-1.690***	-0.516***	-0.588***	-0.416**	0.085
	(0.454)	(0.293)	(0.137)	90.194)	-0.197	-0.141
Infrastructure Index	2.801***	0.252	0.03	0.505***	-0.666***	-1.308***
	(0.411)	(0.345)	(0.205)	-0.163	-0.201	-0.275
Market Access Index	-0.26	0.755***	0.035	-0.218**	-0.119	-0.195*
	(0.162)	(0.202)	(0.106)	-0.109	-0.119	-0.114
Open Environment Index	0.662**	0.778***	-0.159	0.375***	0.994***	0.546**
	(0.295)	(0.251)	(0.161)	-0.142	-0.177	-0.246
Genetically Engineered Restrictive Index	0.591***	-0.415*	0.305***	0.001	0.195	0.409***
	(0.183)	(0.245)	(0.099)	-0.117	-0.219	-0.121
Bilateral Trade Agreement with US	-0.227	-0.066	0.095	-0.048	-0.224	0.622***
	(0.253)	(0.256)	(0.17)	-0.172	-0.193	-0.194
CAFTA Membership	1.584***	1.569***	0.767***	0.438***	0.173	0.291
	(0.3)	(0.488)	(0.16)	-0.165	-0.312	-0.271
NAFTA Membership	-1.691***	-0.432	-0.283	0.990***	-0.419*	0.886***
	(0.366)	(0.273)	(0.258)	-0.232	-0.254	-0.291
Constant	-0.664	-20.338***	-1.837*	-4.011***	-9.547***	16.016***
	(1.54)	(4.536)	(1.003)	-1.05	-1.433	-3.02
Observations	15,789	7,839	10,828	5,335	2,703	3,136
R-squared	0.054	0.059	0.027	0.199	0.24	0.119

CHAPTER SIX. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1. Summary of Results

Trade facilitation agreements have been very important in recent times considering the use of non-tariff measures by nations to resist trade. This study examines the asymmetric impact of trade facilitation indicators and genetically engineered restrictive index on US states agricultural exports and efficiency. Three major US grain crops are considered in the process; corn, soybean and wheat. To ensure validity of the results for inference, the relevant pre-estimation and post-estimation tests are conducted. The tests for stationarity, serial correlation, multicollinearity and heteroskedasticity are sufficiently discussed in relevance to the estimates obtained. Data issues on FAS report of port values of commodity exports at the state level leads to the use of ERS export values for comparison.

Two specific objectives were considered to achieve the goal of the study; i) To estimate the effects of destination TFIs and GERI on state level export and ii) To determine the impact of destination TFI and GERI on export efficiency. State level export data of corn, soybean and wheat spanning from 2004 to 2015 is used. The short period of this data is attributed to the unavailability of a longer time span from the FAS website. The first estimation process for both objectives and crops are based on the FAS export values followed by using the ERS export values in the second group of estimations. Other sources of data are the enabling trade indexes from the World Economic Forum, gravity model variables from CEPII, state GDP from BEA and trade agreements information from USTR website. Country data on genetically engineered regulations was obtained from the FAO and the Center for food safety.

6.1.1. Importance of Destinations TFIs and GERI on Their Exports

In estimating the first objective, the time series properties are tested to ensure non-spurious estimates. Having confirmed the absence of unit roots, panel fixed effects and panel random effects estimations are conducted for all three crops. Prior to selection of the final model, various iterations and variable combinations are estimated to establish consistency with ‘a prior’ expectations based on existing literature. The Hausman test is conducted for the final model of each crop to identify which model is consistent. The corn model proposes the fixed effects model while the soybean and wheat models identify the random effects model as appropriate.

From the corn fixed effects model, state GDP, destination GDP, exchange rate and tariff difference are the gravity model variables found to be significant. All these variables except for exchange rate with an ambiguous expectation conform to existent literature in terms of both magnitude and direction (Anderson and Wincoop, 2003; Head and Meyer, 2013). The case of exchange rate is peculiar (McKenzie, 1999), as its sign depends on factors such as the measurement, partners and sectors involved in the trade activity. Similar signs and significant variables are obtained in the soybean model. The only difference from the wheat model is a negative sign obtained for the exchange rate.

The variables of interest reveal diverse levels of significance and directions. Ideally, it is expected that the improvement of the TFI of a commodity destination should lead to improvements in exports from the commodity origin. The infrastructure index and market access index are positive for corn and soybean respectively, conforming to the ‘a prior’ expectations. Contrarily, improvements in border administration index of the destination countries leads to decline in US state level exports of all three crops to the destinations. Infrastructure improvements lead to decline in wheat exports to the destinations. Destinations with improvements in open environment index experience decline in US corn and wheat exports to those destinations. This variable affects soybean positively.

The genetically engineered restrictive index yields effects that conform to the 'a prior' expectations. Corn and soybean which are dominated by GE varieties in US yielded negative effects while wheat which is produced only on experimental basis in the country show a positive effect from this variable.

6.1.2. Impacts of TFIs and GERI on State Export Efficiency

The time invariant truncated normal stochastic frontier model is employed to identify the export efficiencies of the states for the three crops. The states with highest corn export efficiency are Connecticut, Maine, Louisiana, Massachusetts and Mississippi. Soybean export efficiency is dominated by California, Washington, Connecticut, Idaho and Louisiana while the top 5 states in terms of wheat export efficiency are Oregon, Connecticut, Louisiana, Kansas and Hawaii.

It is significant to note that the Midwest states with high grain production capacities in the US reveal low export efficiency. This presents a paradox which we term the I-State paradox. These states include Iowa, Indiana, Nebraska, Kansas, Illinois and Minnesota just to mention a few. In quantifying the average export potential lost, Illinois has deficits of US$ 111,929, 290.00, US$ 127,560,930.00 and US$ 2,803,449.00 for corn, soybean and wheat respectively. The Iowa state revealed a state export potential deficit of US$ 29,976,600.00, US$ 27,593,130.00 and US$662,648.60 for corn, soybean and wheat respectively. Other states with large value of export gaps include Washington, Nebraska, North Dakota, Missouri, Texas and Louisiana.

6.2. Conclusions and Implications

The importance of developing the TFIs of trade partners cannot be overstated. Several researches have revealed that improvements in trade facilitation can lead to trade reduction costs. Hence it is essential to have a set of indicators that will predict and monitor the improvements of this variable among trade partners. This study set out to examine the impact of US export partners' TFI on US state level agricultural exports and efficiency. Three major grain crops are used for this objective, corn, soybean and wheat. In recent times, there have been concerns about the about the real benefits the US derives from trade enhancement policies such as trade agreements and the others. The main concerns have been whether there are issues of the US being deliberately exploited behind the curtain of globalization. To minimize this perceived exploitation, successive governments of the country have employed diverse strategies.

For instance, on January 2017, the President of the United States of America in his first executive order withdrew[33] the country from the negotiation process over the Trans-Pacific Partnership, yielding a controversial ripple effect across the country. Genuinely, his reasons were intended for the good of the American people. Opening trade may not necessarily be a positive-sum game as widely proclaimed. To a large extent, trade facilitation will go a long way to benefit some countries, especially developing countries. However, the results obtained may proxy that advanced economies will have to brace themselves with a strategy to relevantly benefit from the trade facilitation improvements of their export destinations. This study is timely, given the recent intensification of trade disputes between the US and other countries on their role in enhancing US exports.

[33] https://www.vox.com/policy-and-politics/2017/1/23/14356398/trump-pull-out-tpp-nafta

6.2.1. Trade Facilitation Indicators: Zero-Sum Game or Positive-Sum Game?

The results reveal that improvements in border administration index of a country lead to decline in USA corn, soybean and wheat exports. Other trade facilitation indicators of the destination that lead to decline in USA grain exports are infrastructure index for wheat and open environment index for corn and wheat. This may contradict the popular accession that trade is a positive sum game where both partners either into trade due to the perception of expected gains. A few conclusions can be drawn from this result;

First, it can be concluded that the United States is truly being robbed by other countries in a mannequin which has being dressed up and labelled as trade, thereby vindicating the President's decision. The World Economic Forum[34] cites several exporters have cited that the indicators of that are measured as improvement in border administration rather tend to reduce the ease of export. This subsequently reduce the exports rather than the perceived increment in exports. This is further consolidated by Fefer and Jones (2017) who expressed US exporters' concern of destination countries not being open enough for US trade commodities. This may intuitively imply that, even though countries may reveal high border administration index, there may be an inbuilt mechanism to limit US agricultural imports.

Secondly, another conclusion may be drawn from the perspective of the report of the World Economic Forum[35] which suggests that about half (3.8 billion) of the world population live in countries ranked in the bottom half of the overall ETI. Meanwhile majority of these countries live below the international poverty line. However, advanced countries are more efficient in enabling

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[34] Page 4 of the World Economic Forum (2016) Report cited reveals interviews of exporters who indicated that most of the border facilitation improvements tend to have a negative impact on exports.

[35] A full report on the methodology and current impact of the enabling trade indexes can be found here; http://www3.weforum.org/docs/WEF_GETR_2016_report.pdf

trade than poor countries. This may imply a quadratic relationship between trade facilitation and exports for some of the TFIs.

On the third account, the computational nature off some of the indicators may have led to these results having a negative impact on US exports to those countries despite claims of improved trade facilitation indicators by those countries. Consider the border administration index, the index is measured by a combination of indicators which captures the efficiency, transparency and costs associated with importing and exporting goods. Obviously, this is likely to generate a bias in measurement in that, a country performing well on these indicators for their exporting goods may not necessarily be doing well for importing goods. Hence, even though they may be doing well in terms of the overall index, their performance for the import facilitation may be low.

6.2.2. Genetically Engineered Restrictive Index

The concerns on the impact of genetically engineered crops on trade has gradually gained attention. Anderson et al., (2001) explained that the differences in preferences and views on environmental issues and consumers' right to know about food ingredients are unlikely to disappear in the foreseeable future. Subsequently, the issue on genetically engineered organisms have been widely studied and discussed on various platforms. The results from this study provides evidence on the negative effects of its restriction by countries on the US. It can be concluded that the corn and soybean sector struggle from the restrictions imposed by countries on genetically engineered crops. On the positive, there is an indication from the results that nations with highly genetically engineered restrictive index tend to demand more of US wheat (which has no commercial genetically engineered varieties being produced).

6.2.3. Export Efficiency Among States

Finally, the efficiency of states' agricultural exports based on their characteristics and destination TFIs and GERI presents certain dimensions that must be attended to. For the three commodities, the states that are known to be leading producer are found to be less export efficiency. Drawing a conclusion on the ranks of export efficiency maybe somewhat malicious, given that the FAS data records port values as the export values for the states. This implies that states such as Louisiana, Oregon, Connecticut which have ports are revealed to be more export efficient than leading producers in Midwest who do not have ports. This situation leads to a paradox which we term the 'I-State Paradox'. To solve this paradox in this study, the export values from the ERS are employed. However, the results obtained from the export efficiency ranking of the states do not particularly differ from the FAS results. The flaw from the ERS export values is that, it does not record the individuals export destinations of the states.

From the FAS results, the top five export efficient states for corn are Connecticut, Maine, Louisiana, Massachusetts and Mississippi while the top five for soybean are California, Washington, Connecticut, Indiana and Idaho.

6.3. Policy Recommendations

The results of the impact of trade facilitation indicators on US export for the three crops present a spectrum of challenges that could be resolved to a considerable extent if these recommendations are considered. Despite the negative effects of some of the indices, it is seen that the indicators for measurement represent both export and import indicators. Hence, it is difficult to determine which specific attribute of the destination country influences trade facilitation (import facilitation or export facilitation). It is therefore recommended that the World Economic Forum should consider their enabling trade indices as distinct import and export indices. should consider measures of both export facilitator. For instance, border administration is measured for both import and export indicators. Hence, an overall high magnitude may not necessarily be representative of the destination's extent of import facilitation. On the part of the United States, agricultural exports values to specific destinations should be attributed to specific states of origin rather than the port of exports. This is because trade values recorded at port values tend to misrepresent the states' export efficiency leading to the 'I-State' paradox.

The negative effect of GERI on corn and soybean exports reveal a possible negative perception on genetically engineered organisms by such countries. Two recommended approaches may be helpful. The first is to conform to the GE requirements of such countries during the export procedure. Base on the variables used in the construction of the index, labeling policies on GE should be synchronized to match the requirements of the destination countries. Essentially, discrete labelling will also reduce traceability requirements and hence reducing the extent of restrictions. In addition to this, information on GE foods must be persistently transparent along with its enhance dissemination to change destination countries' negative perception of this technology. This can help ease the GE approval process in these countries.

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APPENDIX

Table A1: Summary of Relevant Empirical Literature by Category

Authors	Title
Anderson and Wincoop (2003)	Gravitas with Gravitas: A Solution to the Border Puzzle
Wilson et al., (2003)	Trade Facilitation and Economic Development: A New Approach to Quantifying the Impact
Baier and Bergstrand (2007)	Do free trade agreements actually increase members' international trade?
Shepherd and Wilson (2009)	Trade facilitation in ASEAN member countries: Measuring progress and assessing priorities
Khan and Kalirajan (2011)	Impact of trade costs on exports: An empirical modelling
Portugal-Perez and Wilson (2012)	Export Performance and Trade Facilitation Reform: Hard and Soft Infrastructure
Atici C. (2014)	Econometric Analysis of LLP on Trade Flow: The Case of Maize
Ferro et al., (2015)	The effect of product standards on agricultural exports
Hoekman and Shepherd (2015)	Who profits from trade facilitation initiatives? Implications for African countries
Beverelli et al., (2015)	Export Diversification Effects of the WTO Trade Facilitation Agreement
Bergstrand et al., (2015)	Economic integration agreements, border effects, and distance elasticities in the gravity equation
Seck A. (2016)	Trade facilitation and trade participation: Are sub-Saharan African firms different?

Table A2: Studies on the Application of Stochastic Frontier Gravity Model

Authors	Title
Kalirajan K. (1999)	Stochastic varying coefficients gravity model: An Application in Trade Analysis
Kalirajan K. (2007)	Regional Cooperation and Bilateral Trade Flows: An Empirical Measurement of Resistance
Ravishankar G. and Stack M.M. (2014)	The gravity model and trade efficiency: A stochastic frontier analysis of Eastern European countries' potential trade. The World Economy
Sheng Y. et al., (2015)	Energy trade efficiency and its determinants: A Malmquist index approach
Rao M.A. et al., (2016)	Pakistan's agricultural exports, determinants and its potential: An application of the stochastic frontier gravity model
Doan T.N. and Xing Y. (2018)	Trade efficiency, free trade agreements and rules of origin.

Table A3: Basic Gravity Model for the Three Commodities Using FAS Export Value

Variable	Corn				Soybean				Wheat			
Model	**One**	**Two**	**Three**	**Four**	**One**	**Two**	**Three**	**Four**	**One**	**Two**	**Three**	**Four**
Expfixed		0.068***		0.069***		0.141***		0.140***		0.052***		0.049**
		(0.014)		-0.014		(0.021)		(0.021)		(0.02)		(0.02)
Impfixed			0.0001	0.0001			0.0001	0.0001			0.0001***	0.0001***
			(0.0001)	(0.0001)			(0.0001)	(0.0001)			(0.0001)	(0.0001)
LnSGDP	1.769***				3.168***				2.341***			
	(0.428)				(0.627)				(0.528)			
LnDestGDP	0.331***				0.334***				-0.120***			
	(0.029)				(0.046)				(0.033)			
Lnpop_d	0.073**	0.322***	0.327***	0.323***	0.319***	0.577***	0.607***	0.593***	0.508***	0.377***	0.395***	0.392***
	(0.029)	(0.019)	(0.019)	(0.019)	(0.052)	(0.038)	(0.04)	(0.04)	(0.043)	(0.03)	(0.03)	(0.03)
LnSPop	-4.482**	-2.858	4.016***	-2.884	-3.192	-4.546*	9.496***	-4.593*	-0.222	2.478	6.512***	2.651
	(1.786)	(1.76)	(1.04)	(1.76)	(2.908)	(2.707)	(1.739)	(2.707)	(1.986)	(1.834)	(1.001)	(1.827)
LnDist	-0.485***	-0.595***	-0.631***	-0.629***	0.991***	0.774***	0.662***	0.693***	0.235*	0.404***	0.176	0.188
	(0.108)	(0.108)	(0.111)	(0.111)	(0.178)	(0.175)	(0.19)	(0.188)	(0.135)	(0.129)	(0.135)	(0.135)
Contig	0.979***	1.600***	1.595***	1.616***	2.199***	2.586***	2.463***	2.525***	-1.522***	-1.690***	-1.713***	-1.693***
	(0.159)	(0.151)	(0.152)	(0.151)	(0.286)	(0.283)	(0.29)	(0.287)	(0.198)	(0.192)	(0.191)	(0.191)
comlang_off	-0.504***	-0.612***	-0.614***	-0.620***	-1.289***	-1.362***	-1.334***	-1.343***	-0.028	0.072	0.043	0.039
	(0.074)	(0.074)	(0.075)	(0.075)	(0.128)	(0.128)	(0.13)	(0.129)	(0.095)	(0.093)	(0.093)	(0.093)
Comcur	0.17	-0.113	-0.137	-0.143	-0.721	-1.212**	-1.166**	-1.254**	-0.418	-0.328	-0.45	-0.479*
	(0.238)	(0.24)	(0.242)	(0.241)	(0.547)	(0.547)	(0.552)	(0.548)	(0.283)	(0.281)	(0.281)	(0.281)
LnEx	0.168***	0.124***	0.125***	0.124***	0.077***	0.027	0.029*	0.025	-0.047***	-0.029**	-0.033**	-0.034**
	(0.012)	(0.012)	(0.012)	(0.012)	(0.018)	(0.017)	(0.017)	(0.017)	(0.015)	(0.014)	(0.014)	(0.014)
Lntdiff	-0.594***	-0.315***	-0.302***	-0.291***	-0.575***	-0.309**	-0.290**	-0.288**	-0.997***	-1.139***	-1.019***	-1.017***
	(0.08)	(0.076)	(0.079)	(0.078)	(0.138)	(0.133)	(0.136)	(0.135)	(0.101)	(0.097)	(0.1)	(0.1)
LnpRatio	-0.201	-0.197	-0.136	-0.198	0.472	0.443	0.492	0.445	0.089	0.307	0.23	0.32
	(0.203)	(0.206)	(0.206)	(0.206)	(0.356)	(0.358)	(0.361)	(0.358)	(0.353)	(0.353)	(0.35)	(0.352)
Constant	20.743*	12.511	-25.013***	12.883	-18.676	-9.559	-81.070***	-8.18	-19.091	-34.501***	-49.613***	-33.796***
	(11.712)	(12.017)	(9.16)	(12.021)	(19.735)	(18.668)	(15.402)	(18.703)	(11.992)	(10.788)	(8.739)	(10.745)
Observations	5,418	5,437	5,437	5,437	2,740	2,746	2,746	2,746	3,138	3,165	3,165	3,165

Table A3: Basic Gravity Model for the Three Commodities Using FAS Export Value (Continued)

Variable	**Corn**				**Soybean**				**Wheat**			
Model	**One**	**Two**	**Three**	**Four**	**One**	**Two**	**Three**	**Four**	**One**	**Two**	**Three**	**Four**
Number of PanelID	39	39	39	39	30	30	30	30	42	42	42	42
R-squared	0.251	0	0.228	0.231	0.283	0.273	0.261	0.273	0.129	0.121	0.127	0.129

*, ** and *** indicates 10, 5 and 1% levels of significance respectively. Model One represents the model with no control for heterogeneity. Model Two controls for heterogeneity using the exporter fixed effects. Model Three controls for heterogeneity using the importer fixed effects. The control for Model four is by the inclusion of importer and exporter fixed effects. It must be noted that models two, three and four that control for heterogeneity excludes the GDPs. This preamble applies to all the tables in the appendix.

Table A4: Basic Gravity Model with Trade Facilitation Indicators Using FAS Export Value

Variable	Corn				Soybean				Wheat			
Model	**One**	**Two**	**Three**	**Four**	**One**	**Two**	**Three**	**Four**	**One**	**Two**	**Three**	**Four**
Expfixed		0.061***		0.061***		0.143***		0.138***		0.051***		0.051***
		(0.014)		(0.014)		(0.021)		(0.021)		(0.019)		(0.019)
Impfixed			0.000***	0.000***			0.001***	0.001***			0.0001	0.0001
			(0.0001)	(0.0001)			(0.0001)	(0.0001)			(0.0001)	(0.0001)
LnSGDP	2.163***				2.934***				1.666***			
	(0.43)				(0.633)				(0.521)			
LnDestGDP	0.009				0.539***				0.293***			
	(0.059)				(0.101)				(0.071)			
Lnpop_d	0.270***	0.264***	0.275***	0.271***	0.204**	0.627***	0.708***	0.691***	0.042	0.272***	0.279***	0.276***
	(0.046)	(0.023)	(0.024)	(0.024)	(0.09)	(0.044)	(0.048)	(0.048)	(0.066)	(0.033)	(0.034)	(0.034)
LnSPop	-4.004**	-2.727	3.347***	-2.805	-3.434	-4.202	9.647***	-4.286	-0.094	2.666	6.659***	2.691
	(1.769)	(1.723)	(1.019)	(1.722)	(2.908)	(2.689)	(1.727)	(2.684)	(1.936)	(1.788)	(0.98)	(1.788)
LnDist	-0.685***	-0.643***	-0.735***	-0.729***	0.905***	0.706***	0.368*	0.414*	0.713***	0.597***	0.547***	0.558***
	(0.114)	(0.111)	(0.116)	(0.115)	(0.201)	(0.197)	(0.215)	(0.213)	(0.146)	(0.134)	(0.142)	(0.142)
Contig	0.908***	0.916***	0.875***	0.904***	2.148***	2.161***	1.776***	1.856***	-1.200***	-1.242***	-1.285***	-1.256***
	(0.161)	(0.159)	(0.159)	(0.159)	(0.292)	(0.292)	(0.306)	(0.304)	(0.207)	(0.206)	(0.207)	(0.207)
comlang_off	-0.555***	-0.550***	-0.569***	-0.572***	-1.372***	-1.346***	-1.285***	-1.292***	0.08	0.114	0.112	0.105
	(0.075)	(0.074)	(0.075)	(0.074)	(0.131)	(0.131)	(0.133)	(0.131)	(0.098)	(0.098)	(0.099)	(0.099)
Comcur	-0.359	-0.395	-0.496**	-0.491**	-0.685	-1.106**	-1.251**	-1.316**	-0.08	-0.274	-0.283	-0.309
	(0.249)	(0.241)	(0.244)	(0.244)	(0.561)	(0.556)	(0.562)	(0.558)	(0.289)	(0.283)	(0.286)	(0.286)
LnEx	0.162***	0.160***	0.163***	0.162***	0.081***	0.060***	0.062***	0.058***	-0.054***	-0.061***	-0.059***	-0.061***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.018)	(0.018)	(0.018)	(0.017)	(0.015)	(0.015)	(0.015)	(0.015)
Lntdiff	-0.681***	-0.713***	-0.693***	-0.679***	-0.477***	-0.496***	-0.477***	-0.474***	-1.093***	-1.129***	-1.122***	-1.114***
	(0.084)	(0.084)	(0.085)	(0.085)	(0.152)	(0.153)	(0.154)	(0.152)	(0.111)	(0.107)	(0.108)	(0.108)
LnpRatio	-0.179	-0.2	-0.149	-0.204	0.485	0.434	0.493	0.445	0.093	0.277	0.187	0.279
	(0.201)	(0.202)	(0.202)	(0.202)	(0.356)	(0.356)	(0.358)	(0.355)	(0.344)	(0.344)	(0.343)	(0.344)
Borderadmin	-0.715***	-0.709***	-0.689***	-0.680***	-0.214	0.009	-0.061	-0.031	-0.398***	-0.409***	-0.406***	-0.400***
	(0.094)	(0.094)	(0.094)	(0.094)	(0.165)	(0.16)	(0.161)	(0.16)	(0.106)	(0.105)	(0.105)	(0.105)

Table A4: Basic Gravity Model with Trade Facilitation Indicators Using FAS Export Value (Continued)

Variable	Corn				Soybean				Wheat			
Model	**One**	**Two**	**Three**	**Four**	**One**	**Two**	**Three**	**Four**	**One**	**Two**	**Three**	**Four**
Infrastructure	1.098***	1.113***	1.092***	1.087***	-0.358*	0.221	0.221	0.213	-0.037	0.419***	0.415***	0.405***
	(0.118)	(0.087)	(0.088)	(0.087)	(0.198)	(0.168)	(0.169)	(0.168)	(0.158)	(0.105)	(0.106)	(0.106)
Marketaccess	0.033	0.009	-0.016	-0.013	0.133	0.08	0.069	0.067	0.028	0.005	-0.005	-0.003
	(0.065)	(0.063)	(0.064)	(0.064)	(0.116)	(0.114)	(0.115)	(0.114)	(0.072)	(0.069)	(0.07)	(0.07)
Openvironment	-0.096	-0.121	-0.06	-0.072	0.499***	0.216	0.420**	0.388**	-0.528***	-0.703***	-0.677***	-0.676***
	(0.113)	(0.109)	(0.111)	(0.111)	(0.174)	(0.166)	(0.174)	(0.173)	(0.144)	(0.136)	(0.14)	(0.14)
Constant	17.879	13.833	-18.830	14.913	-16.691	-14.88	-83.074	-11.156	-18.012	-34.171	-50.276	-34.043
	(11.603)	(11.76)	(8.971)	(11.759)	(19.735)	(18.572)	(15.317)	(18.562)	(11.692)	(10.515)	(8.56)	(10.517)
Observations	5,418	5,437	5,437	5,437	2,740	2,746	2,746	2,746	3,138	3,165	3,165	3,165
Number of PanelID	39	39	39	39	30	30	30	30	42	42	42	42
R-squared	0.267	0.264	0.263	0.265	0.286	0.283	0.275	0.287	0.175	0.167	0.165	0.167

Table A5: Basic Gravity Model with Trade Facilitation Indicators and GERI Using FAS Export Value

Variable	Corn				Soybean				Wheat			
Model	**One**	**Two**	**Three**	**Four**	**One**	**Two**	**Three**	**Four**	**One**	**Two**	**Three**	**Four**
Expfixed		0.058***		0.058***		0.143***		0.139***		0.051***		0.051***
		(0.014)		(0.014)		(0.021)		-0.021		(0.019)		-0.019
Impfixed			0.0001***	0.0001***			0.001***	0.001***			0.0001	0.0001
			(0.0001)	(0.0001)			(0.0001)	(0.0001)			(0.0001)	(0.0001)
LnSGDP	2.050***				2.692***				1.740***			
	(0.432)				(0.637)				(0.52)			
LnDestGDP	0.03				0.628***				0.259***			
	(0.062)				(0.107)				(0.071)			
Lnpop_d	0.300***	0.305***	0.320***	0.316***	0.240***	0.699***	0.791***	0.766***	0.025	0.237***	0.246***	0.243***
	(0.047)	(0.025)	(0.025)	(0.025)	(0.091)	(0.048)	(0.052)	(0.051)	(0.066)	(0.035)	(0.035)	(0.035)
LnSPop	-3.821**	-2.471	3.228***	-2.576	-2.929	-4.105	9.745***	-4.21	-0.09	2.76	6.766***	2.804
	(1.775)	(1.731)	(1.025)	(1.73)	(2.898)	(2.684)	(1.722)	(2.678)	(1.932)	(1.783)	(0.978)	(1.783)
LnDist	-0.716***	-0.672***	-0.779***	-0.773***	0.897***	0.733***	0.368*	0.430**	0.744***	0.607***	0.536***	0.547***
	(0.114)	(0.112)	(0.116)	(0.116)	(0.2)	(0.198)	(0.215)	(0.214)	(0.146)	(0.134)	(0.142)	(0.141)
Contig	0.840***	0.858***	0.818***	0.847***	1.933***	1.976***	1.568***	1.650***	-1.136***	-1.182***	-1.230***	-1.201***
	(0.162)	(0.16)	(0.16)	(0.16)	(0.293)	(0.293)	(0.307)	(0.305)	(0.208)	(0.207)	(0.207)	(0.207)
comlang_off	-0.515***	-0.508***	-0.535***	-0.540***	-1.374***	-1.244***	-1.197***	-1.178***	0.093	0.122	0.115	0.108
	(0.077)	(0.077)	(0.077)	(0.077)	(0.14)	(0.139)	(0.141)	(0.14)	(0.098)	(0.098)	(0.099)	(0.099)
Comcur	-0.28	-0.345	-0.448*	-0.443*	-0.446	-1.040*	-1.173**	-1.266**	-0.252	-0.411	-0.444	-0.471
	(0.252)	(0.242)	(0.244)	(0.244)	(0.564)	(0.555)	(0.562)	(0.557)	(0.293)	(0.284)	(0.288)	(0.288)
LnEx	0.160***	0.157***	0.160***	0.159***	0.079***	0.055***	0.057***	0.054***	-0.054***	-0.059***	-0.057***	-0.059***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.018)	(0.017)	(0.018)	(0.017)	(0.015)	(0.015)	(0.015)	(0.015)
Lntdiff	-0.623***	-0.664***	-0.630***	-0.617***	-0.470***	-0.549***	-0.518***	-0.531***	-1.136***	-1.146***	-1.131***	-1.123***
	(0.087)	(0.086)	(0.087)	(0.087)	(0.155)	(0.155)	(0.156)	(0.154)	(0.112)	(0.106)	(0.108)	(0.108)
LnpRatio	-0.181	-0.201	-0.151	-0.204	0.482	0.458	0.518	0.473	0.089	0.284	0.194	0.286
	(0.202)	(0.203)	(0.203)	(0.203)	(0.354)	(0.355)	(0.357)	(0.354)	(0.343)	(0.343)	(0.342)	(0.343)
Borderadmin	-0.591***	-0.589***	-0.555***	-0.549***	-0.066	0.176	0.111	0.135	-0.436***	-0.451***	-0.445***	-0.440***
	(0.097)	(0.096)	(0.097)	(0.097)	(0.167)	(0.162)	(0.163)	(0.162)	(0.106)	(0.105)	(0.106)	(0.106)

Table A5: Basic Gravity Model with Trade Facilitation Indicators and GERI Using FAS Export Value (Continued)

Variable	Corn				Soybean				Wheat			
Model	**One**	**Two**	**Three**	**Four**	**One**	**Two**	**Three**	**Four**	**One**	**Two**	**Three**	**Four**
Infrastructure	1.010***	1.047***	1.027***	1.025***	-0.397**	0.162	0.182	0.147	-0.102	0.287***	0.272**	0.262**
	(0.119)	(0.09)	(0.09)	(0.09)	(0.197)	(0.174)	(0.175)	(0.174)	(0.159)	(0.11)	(0.112)	(0.112)
Marketaccess	-0.002	-0.037	-0.061	-0.055	0.099	-0.028	-0.03	-0.047	-0.028	-0.036	-0.052	-0.05
	(0.069)	(0.065)	(0.066)	(0.066)	(0.121)	(0.118)	(0.119)	(0.118)	(0.074)	(0.069)	(0.07)	(0.07)
Openvironment	-0.122	-0.149	-0.094	-0.106	0.438**	0.176	0.376**	0.362**	-0.435***	-0.568***	-0.523***	-0.522***
	(0.114)	(0.112)	(0.113)	(0.113)	(0.174)	(0.168)	(0.177)	(0.175)	(0.146)	(0.14)	(0.145)	(0.145)
LnGERI	-0.212***	-0.187***	-0.219***	-0.217***	-0.566***	-0.297**	-0.355***	-0.286**	0.328***	0.360***	0.373***	0.374***
	(0.073)	(0.069)	(0.07)	(0.069)	(0.137)	(0.13)	(0.13)	(0.13)	(0.098)	(0.094)	(0.095)	(0.095)
Constant	18.227	13.501	-16.877*	14.954	-17.949	-15.006	-82.786***	-11.045	-19.296*	-35.853***	-51.935***	-35.729***
	(11.66)	(11.829)	(9.04)	(11.829)	(19.652)	(18.516)	(15.288)	(18.502)	(11.676)	(10.496)	(8.55)	(10.496)
Observations	5,362	5,381	5,381	5,381	2,723	2,729	2,729	2,729	3,136	3,163	3,163	3,163
Nos of PanelID	39	39	39	39	30	30	30	30	42	42	42	42
R-squared	0.27	0.267	0.266	0.268	0.295	0.291	0.282	0.295	0.178	0.171	0.17	0.171

Table A6: Basic Gravity Model with TFI, GERI and Trade Agreements Using FAS Export Value

Variable	**Corn**				**Soybean**				**Wheat**			
Model	**One**	**Two**	**Three**	**Four**	**One**	**Two**	**Three**	**Four**	**One**	**Two**	**Three**	**Four**
Expfixed		0.056***		0.055***		0.147***		0.142***		0.036*		0.035*
		(0.014)		(0.014)		(0.021)		(0.021)		(0.019)		(0.019)
Impfixed			0.000***	0.000***			0.001***	0.001***			0.0001	0.0001
			(0.0001)	(0.0001)			(0.0001)	(0.0001)			(0.0001)	(0.0001)
LnSGDP	2.018***				2.730***				1.446***			
	(0.436)				(0.641)				(0.524)			
LnDestGDP	0.005				0.638***				0.260***			
	(0.063)				(0.108)				(0.073)			
Lnpop_d	0.318***	0.322***	0.339***	0.335***	0.234**	0.703***	0.793***	0.766***	0.019	0.216***	0.229***	0.228***
	(0.049)	(0.026)	(0.026)	(0.026)	(0.093)	(0.049)	(0.052)	(0.052)	(0.068)	(0.04)	(0.04)	(0.04)
LnSPop	-3.725**	-2.39	2.964***	-2.483	-3.055	-4.193	9.673***	-4.29	0.031	3.171*	5.917***	3.216*
	(1.777)	(1.732)	(1.043)	(1.73)	(2.906)	(2.688)	(1.751)	(2.682)	(1.926)	(1.786)	(0.991)	(1.786)
LnDist	-0.782***	-0.788***	-0.911***	-0.906***	0.965***	0.743***	0.390*	0.455**	0.950***	0.817***	0.738***	0.729***
	(0.122)	(0.12)	(0.126)	(0.126)	(0.211)	(0.207)	(0.224)	(0.222)	(0.169)	(0.162)	(0.174)	(0.174)
comlang_off	-0.521***	-0.527***	-0.560***	-0.565***	-1.339***	-1.211***	-1.186***	-1.158***	0.087	0.109	0.096	0.091
	(0.078)	(0.077)	(0.078)	(0.078)	(0.143)	(0.142)	(0.143)	(0.142)	(0.099)	(0.099)	(0.1)	(0.1)
Comcur	-0.398	-0.414*	-0.519**	-0.521**	-0.308	-1.010*	-1.132**	-1.231**	-0.213	-0.456	-0.495*	-0.519*
	(0.261)	(0.248)	(0.251)	(0.25)	(0.578)	(0.566)	(0.573)	(0.569)	(0.306)	(0.295)	(0.298)	(0.298)
LnEx	0.162***	0.161***	0.164***	0.163***	0.081***	0.058***	0.058***	0.056***	-0.062***	-0.068***	-0.067***	-0.068***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.018)	(0.018)	(0.018)	(0.018)	(0.015)	(0.015)	(0.015)	(0.015)
Lntdiff	-0.633***	-0.636***	-0.579***	-0.577***	-0.491***	-0.614***	-0.525***	-0.575***	-1.107***	-1.135***	-1.102***	-1.098***
	(0.089)	(0.088)	(0.09)	(0.09)	(0.161)	(0.161)	(0.162)	(0.161)	(0.112)	(0.112)	(0.115)	(0.115)
LnpRatio	-0.2	-0.217	-0.166	-0.219	0.489	0.46	0.519	0.473	0.089	0.247	0.187	0.253
	(0.203)	(0.204)	(0.203)	(0.204)	(0.356)	(0.357)	90.359)	(0.356)	(0.342)	(0.343)	(0.341)	(0.343)
Borderadmin	-0.645***	-0.649***	-0.616***	-0.605***	-0.098	0.172	0.076	0.132	-0.477***	-0.496***	-0.491***	-0.485***
	(0.098)	(0.098)	(0.099)	(0.099)	(0.175)	(0.17)	(0.1710	(0.17)	(0.106)	(0.105)	(0.106)	(0.106)
Infrastructure	1.082***	1.092***	1.073***	1.064***	-0.304	0.237	0.239	0.201	-0.074	0.296***	0.276**	0.266**
	(0.122)	(0.093)	(0.094)	(0.094)	(0.211)	(0.19)	(0.192)	(0.19)	(0.158)	(0.114)	(0.116)	(0.116)

Table A6: Basic Gravity Model with TFI, GERI and Trade Agreements Using FAS Export Value (Continued)

Variable	**Corn**				**Soybean**				**Wheat**			
Model	**One**	**Two**	**Three**	**Four**	**One**	**Two**	**Three**	**Four**	**One**	**Two**	**Three**	**Four**
Openvironment	-0.11	-0.115	-0.058	-0.065	0.376**	0.137	0.349*	0.324*	-0.510***	-0.631***	-0.582***	-0.575***
	(0.115)	(0.114)	(0.115)	(0.115)	(0.179)	(0.175)	(0.184)	(0.182)	(0.148)	(0.144)	(0.149)	(0.149)
LnGERI	-0.208***	-0.213***	-0.241***	-0.244***	-0.615***	-0.376***	-0.367***	-0.340**	0.406***	0.468***	0.483***	0.479***
	(0.073)	(0.07)	(0.071)	(0.071)	(0.146)	(0.14)	(0.142)	(0.141)	(0.1)	(0.099)	(0.099)	(0.099)
Bilateral	0.178	0.179	0.245**	0.201*	-0.145	-0.196	0.018	-0.131	0.588***	0.659***	0.705***	0.673***
	(0.11)	(0.11)	(0.11)	(0.11)	(0.179)	(0.18)	(0.181)	(0.18)	(0.14)	(0.14)	(0.139)	(0.14)
CAFTA	-0.078	-0.093	-0.035	-0.09	0.225	-0.179	0.113	-0.099	0.588***	0.518***	0.551***	0.509***
	(0.147)	(0.145)	(0.144)	(0.145)	(0.35)	(0.348)	(0.35)	(0.348)	(0.186)	(0.183)	(0.182)	(0.183)
NAFTA	0.786***	0.772***	0.771***	0.764***	1.965***	1.821***	1.598***	1.569***	-0.644***	-0.691***	-0.707***	-0.721***
	(0.183)	(0.182)	(0.182)	(0.182)	(0.336)	(0.336)	(0.345)	(0.342)	(0.241)	(0.239)	(0.24)	(0.24)
Constant	18.758	14.328	-13.63	15.939	-18.035	-15.691	-82.331***	-11.609	-18.176	-35.297***	-45.967***	-34.998***
	(11.709)	(11.852)	(9.19)	(11.852)	(19.73)	(18.557)	(15.525)	(18.553)	(11.651)	(10.527)	(8.629)	(10.528)
Observations	5,335	5,350	5,350	5,350	2,703	2,709	2,709	2,709	3,136	3,152	3,152	3,152
No. of PanelID	39	39	39	39	30	30	30	30	42	42	42	42
R-squared	0.271	0.27	0.27	0.272	0.296	0.293	0.283	0.296	0.184	0.178	0.177	0.178

Table A7: Basic Gravity Model for the Three Commodities

	Corn				Soybean				Wheat			
Model	**One**	**Two**	**Three**	**Four**	**One**	**Two**	**Three**	**Four**	**One**	**Two**	**Three**	**Four**
Expfixed		0.057***		0.057***		0.024		0.024		0.043**		0.040**
		(0.014)		(0.014)		(0.021)		(0.021)		(0.019)		(0.019)
Impfixed			0.0001	0.0001			0.0001	0.0001			0.000***	0.000***
			(0.0001)	(0.0001)			(0.0001)	(0.0001)			(0.0001)	(0.0001)
LnSGDP	0.133				1.161*				1.181**			
	(0.429)				-0.618				(0.524)			
LnDestGDP	0.352***				0.366***				-0.096***			
	(0.029)				-0.045				(0.033)			
Lnpop_d	0.057*	0.320***	0.325***	0.321***	0.281***	0.569***	0.578***	0.576***	0.478***	0.366***	0.382***	0.379***
	(0.03)	(0.019)	(0.019)	(0.019)	(0.051)	(0.037)	(0.04)	(0.04)	(0.042)	(0.03)	(0.03)	(0.03)
LnSPop	1.71	-1.008	4.765***	-1.024	-5.827**	-2.863	-0.49	-2.883	2.062	1.92	5.240***	2.081
	(1.789)	(1.761)	(1.04)	(1.761)	(2.868)	(2.685)	(1.712)	(2.686)	(1.973)	(1.817)	(0.992)	(1.811)
LnDist	-0.484***	-0.606***	-0.630***	-0.627***	0.936***	0.683***	0.643***	0.648***	0.250*	0.399***	0.188	0.197
	(0.108)	(0.108)	(0.111)	(0.111)	(0.175)	(0.174)	(0.187)	(0.187)	(0.134)	(0.128)	(0.134)	(0.134)
Contig	0.978***	1.651***	1.643***	1.661***	2.277***	2.669***	2.632***	2.642***	-1.177***	-1.296***	-1.315***	-1.299***
	(0.159)	(0.151)	(0.152)	(0.152)	(0.282)	(0.281)	(0.285)	(0.285)	(0.196)	(0.19)	(0.19)	(0.19)
comlang_off	-0.435***	-0.552***	-0.552***	-0.557***	-1.267***	-1.344***	-1.334***	-1.335***	-0.029	0.048	0.02	0.017
	(0.074)	(0.074)	(0.075)	(0.075)	(0.126)	(0.127)	(0.128)	(0.128)	(0.095)	(0.092)	(0.092)	(0.092)
Comcur	0.222	-0.078	-0.092	-0.097	-0.584	-1.071**	-1.074**	-1.089**	-0.302	-0.258	-0.375	-0.398
	(0.238)	(0.24)	(0.242)	(0.242)	(0.54)	(0.543)	(0.544)	(0.544)	(0.281)	(0.278)	(0.279)	(0.279)
LnEx	0.172***	0.125***	0.125***	0.125***	0.089***	0.038**	0.038**	0.037**	-0.028*	-0.015	-0.019	-0.02
	(0.012)	(0.012)	(0.012)	(0.012)	(0.018)	(0.017)	(0.017)	(0.017)	(0.015)	(0.014)	(0.014)	(0.014)
Lntdiff	-0.602***	-0.296***	-0.290***	-0.281***	-0.514***	-0.221*	-0.212	-0.212	-0.966***	-1.083***	-0.971***	-0.969***
	(0.08)	(0.076)	(0.079)	(0.078)	(0.136)	(0.132)	(0.134)	(0.134)	(0.101)	(0.096)	(0.099)	(0.099)
LnpRatio	0.123	0.118	0.169	0.116	0.367	0.406	0.415	0.407	0.487	0.629*	0.567	0.641*
	(0.204)	(0.207)	(0.206)	(0.207)	(0.351)	(0.355)	(0.355)	(0.355)	(0.35)	(0.35)	(0.347)	(0.348)
Constant	-19.312	-6.076	-37.635	-5.837	20.333	8.711	-3.116	9.302	-30.083	-31.082	-43.657	-30.374
	(11.729)	(12.023)	(9.159)	(12.027)	(19.294)	(18.383)	(14.967)	(18.421)	(11.836)	(10.787)	(8.664)	(10.75)

Table A7: Basic Gravity Model for the Three Commodities (Continued)

	Corn				Soybean				Wheat			
Model	**One**	**Two**	**Three**	**Four**	**One**	**Two**	**Three**	**Four**	**One**	**Two**	**Three**	**Four**
Obs	5,418	5,437	5,437	5,437	2,740	2,746	2,746	2,746	3,135	3,162	3,162	3,162
No of PanelID	39	39	39	39	30	30	30	30	41	41	41	41
R-Squared	0.25	0.231	0.228	0.231	0.272	0.253	0.252	0.253	0.121	0.118	0.123	0.124

Table A8: Basic Gravity Model with Trade Facilitation Indicators

	Corn				**Soybean**				**Wheat**			
Model	**One**	**Two**	**Three**	**Four**	**One**	**Two**	**Three**	**Four**	**One**	**Two**	**Three**	**Four**
Expfixed		0.050***		0.050***		0.026		0.022		0.042**	0.0001	0.041**
		(0.014)		(0.014)		(0.02)		(0.02)		(0.019)	(0.0001)	(0.019)
Impfixed			0.000**	0.000**			0.001***	0.001***				0.0001
			(0.0001)	(0.0001)			(0.0001)	(0.0001)				(0.0001)
LnSGDP	0.51				1.044*				0.57			
	(0.431)				(0.624)				(0.52)			
LnDestGDP	0.046				0.457***				0.275***			
	(0.059)				(0.099)				(0.071)			
Lnpop_d	0.252***	0.269***	0.278***	0.275***	0.262***	0.626***	0.689***	0.686***	0.059	0.268***	0.275***	0.272***
	(0.046)	(0.023)	(0.024)	(0.024)	(0.089)	(0.044)	(0.047)	(0.047)	(0.066)	(0.033)	(0.033)	(0.033)
LnSPop	2.137	-0.931	4.054***	-1.003	-5.894**	-2.451	-0.276	-2.529	2.194	2.107	5.363***	2.133
	(1.774)	(1.724)	(1.019)	(1.723)	(2.868)	(2.659)	(1.694)	(2.654)	(1.931)	(1.779)	(0.975)	(1.779)
LnDist	-0.688***	-0.658***	-0.742***	-0.737***	0.817***	0.634***	0.355*	0.362*	0.672***	0.577***	0.527***	0.536***
	(0.114)	(0.111)	(0.116)	(0.115)	(0.198)	(0.194)	(0.21)	(0.211)	(0.145)	(0.133)	(0.141)	(0.141)
Contig	0.906***	0.946***	0.911***	0.935***	2.191***	2.176***	1.879***	1.892***	-0.883***	-0.905***	-0.943***	-0.920***
	(0.162)	(0.159)	(0.159)	(0.159)	(0.288)	(0.289)	(0.301)	(0.301)	(0.207)	(0.205)	(0.206)	(0.206)
comlang_off	-0.483***	-0.486***	-0.504***	-0.507***	-1.357***	-1.332***	-1.281***	-1.282***	0.077	0.101	0.098	0.092
	(0.075)	(0.074)	(0.075)	(0.075)	(0.129)	(0.129)	(0.13)	(0.13)	(0.098)	(0.098)	(0.098)	(0.098)
Comcur	-0.27	-0.34	-0.432*	-0.427*	-0.668	-0.991*	-1.176**	-1.186**	0.024	-0.19	-0.205	-0.227
	(0.249)	(0.241)	(0.244)	(0.244)	(0.554)	(0.55)	(0.552)	(0.552)	(0.289)	(0.281)	(0.284)	(0.284)
LnEx	0.166***	0.162***	0.165***	0.164***	0.092***	0.075***	0.075***	0.074***	-0.035**	-0.042***	-0.041***	-0.042***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.018)	(0.017)	(0.017)	(0.017)	(0.015)	(0.015)	(0.015)	(0.015)
Lntdiff	-0.672***	-0.693***	-0.673***	-0.661***	-0.447***	-0.461***	-0.441***	-0.440***	-1.039***	-1.079***	-1.069***	-1.063***
	(0.084)	(0.084)	(0.085)	(0.085)	(0.15)	(0.151)	(0.151)	(0.151)	(0.111)	(0.106)	(0.108)	(0.108)
LnpRatio	0.145	0.113	0.156	0.11	0.394	0.401	0.419	0.411	0.492	0.603*	0.53	0.605*
	(0.202)	(0.202)	(0.202)	(0.202)	(0.351)	(0.352)	(0.351)	(0.351)	(0.343)	(0.342)	(0.341)	(0.342)
Borderadmin	-0.687***	-0.678***	-0.660***	-0.652***	-0.082	0.095	0.053	0.058	-0.362***	-0.374***	-0.369***	-0.365***
	(0.094)	(0.094)	(0.094)	(0.094)	(0.163)	(0.158)	(0.158)	(0.158)	(0.105)	(0.104)	(0.105)	(0.105)

Table A8: Basic Gravity Model with Trade Facilitation Indicators (Continued)

	Corn				**Soybean**				**Wheat**			
Model	**One**	**Two**	**Three**	**Four**	**One**	**Two**	**Three**	**Four**	**One**	**Two**	**Three**	**Four**
Infrastructure	1.042	1.104	1.085	1.081	-0.343	0.149	0.142	0.141	-0.013	0.419***	0.413***	0.405***
	(0.119)	(0.087)	(0.088)	(0.088)	(0.195)	(0.166)	(0.166)	(0.166)	(0.157)	(0.105)	(0.106)	(0.106)
Marketaccess	0.06	0.029	0.006	0.009	0.084	0.04	0.029	0.029	0.047	0.013	0.003	0.005
	(0.066)	(0.063)	(0.064)	(0.064)	(0.114)	(0.113)	(0.113)	(0.113)	(0.072)	(0.069)	(0.069)	(0.069)
Openvironment	-0.068	-0.116	-0.061	-0.071	0.545***	0.312*	0.477***	0.472***	-0.506***	-0.676***	-0.649***	-0.648***
	(0.113)	(0.109)	(0.111)	(0.111)	(0.172)	(0.164)	(0.171)	(0.171)	(0.144)	(0.136)	(0.139)	(0.139)
Constant	-21.908	-4.512	-31.255	-3.522	20.801	2.231	-6.012	5.651	-29.181	-30.972	-44.392	-30.829
	(11.634)	(11.765)	(8.971)	(11.765)	(19.296)	(18.227)	(14.836)	(18.222)	(11.593)	(10.563)	(8.521)	(10.564)
Obs	5,418	5,437	5,437	5,437	2,740	2,746	2,746	2,746	3,135	3,162	3,162	3,162
No. PanelID	39	39	39	39	30	30	30	30	41	41	41	41
R-squared	0.264	0.264	0.263	0.265	0.275	0.269	0.271	0.272	0.16	0.155	0.154	0.156

Table A9: Basic Gravity Model with Trade Facilitation Indicators and Genetically Engineered Restrictive Index

	Corn				Soybean				Wheat			
Model	**One**	**Two**	**Three**	**Four**	**One**	**Two**	**Three**	**Four**	**One**	**Two**	**Three**	**Four**
Expfixed		0.048***		0.047***		0.028		0.024		0.042**		0.041**
		(0.014)		(0.014)		(0.02)		(0.02)		(0.019)		(0.019)
Impfixed			0.0001***	0.000***			0.001***	0.001***			0.0001	0.0001
			(0.0001)	(0.0001)			(0.0001)	(0.0001)			(0.0001)	(0.0001)
LnSGDP	0.414				0.91				0.638			
	(0.433)				(0.628)				(0.519)			
LnDestGDP	0.062				0.505***				0.244***			
	(0.062)				(0.105)				(0.071)			
Lnpop_d	0.284***	0.307***	0.320***	0.316***	0.316***	0.693***	0.760***	0.756***	0.046	0.237***	0.245***	0.243***
	(0.047)	(0.025)	(0.025)	(0.025)	(0.09)	(0.048)	(0.051)	(0.051)	(0.066)	(0.035)	(0.035)	(0.035)
LnSPop	2.281	-0.731	3.947***	-0.825	-5.477*	-2.388	-0.078	-2.486	2.188	2.189	5.456***	2.233
	(1.779)	(1.731)	(1.025)	(1.73)	(2.859)	(2.653)	(1.689)	(2.647)	(1.928)	(1.775)	(0.974)	(1.775)
LnDist	-0.717***	-0.682***	-0.778***	-0.773***	0.830***	0.678***	0.382*	0.393*	0.699***	0.585***	0.517***	0.525***
	(0.114)	(0.112)	(0.116)	(0.116)	(0.198)	(0.196)	(0.211)	(0.211)	(0.146)	(0.133)	(0.141)	(0.141)
Contig	0.839***	0.886***	0.852***	0.875***	1.980***	1.988***	1.667***	1.681***	-0.830***	-0.853***	-0.896***	-0.872***
	(0.162)	(0.16)	(0.16)	(0.16)	(0.289)	(0.289)	(0.301)	(0.301)	(0.208)	(0.206)	(0.206)	(0.207)
comlang_off	-0.440***	-0.438***	-0.463***	-0.467***	-1.299***	-1.202***	-1.143***	-1.140***	0.091	0.11	0.102	0.096
	(0.077)	(0.077)	(0.077)	(0.077)	(0.138)	(0.137)	(0.138)	(0.138)	(0.098)	(0.098)	(0.098)	(0.098)
Comcur	-0.201	-0.298	-0.391	-0.386	-0.515	-0.946*	-1.143**	-1.159**	-0.127	-0.314	-0.352	-0.374
	(0.252)	(0.242)	(0.244)	(0.244)	(0.556)	(0.549)	(0.551)	(0.551)	(0.292)	(0.283)	(0.287)	(0.287)
LnEx	0.165***	0.160***	0.162***	0.162***	0.088***	0.070***	0.070***	0.069***	-0.035**	-0.041***	-0.039***	-0.040***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.018)	(0.017)	(0.017)	(0.017)	(0.015)	(0.015)	(0.015)	(0.015)
Lntdiff	-0.620***	-0.654***	-0.622***	-0.612***	-0.475***	-0.531***	-0.511***	-0.513***	-1.078***	-1.095***	-1.079***	-1.072***
	(0.087)	(0.086)	(0.087)	(0.087)	(0.152)	(0.153)	(0.153)	(0.153)	(0.111)	(0.106)	(0.107)	(0.107)
LnpRatio	0.131	0.101	0.141	0.098	0.409	0.433	0.455	0.447	0.494	0.613*	0.54	0.615*
	(0.203)	(0.203)	-0.203	(0.203)	(0.35)	(0.351)	(0.35)	(0.35)	(0.342)	(0.342)	(0.34)	(0.342)
Borderadmin	-0.568***	-0.567***	-0.537***	-0.531***	0.08	0.264*	0.222	0.226	-0.394***	-0.411***	-0.405***	-0.401***
	(0.097)	(0.096)	(0.097)	(0.097)	(0.165)	(0.16)	(0.16)	(0.16)	(0.106)	(0.105)	(0.105)	(0.105)

Table A9: Basic Gravity Model with Trade Facilitation Indicators and Genetically Engineered Restrictive Index (Continued)

	Corn				Soybean				Wheat			
Model	**One**	**Two**	**Three**	**Four**	**One**	**Two**	**Three**	**Four**	**One**	**Two**	**Three**	**Four**
Infrastructure	0.956***	1.032***	1.014***	1.012***	-0.400**	0.063	0.054	0.048	-0.07	0.298***	0.281**	0.273**
	(0.12)	(0.09)	(0.09)	(0.09)	(0.195)	(0.172)	(0.172)	(0.172)	(0.158)	(0.109)	(0.111)	(0.111)
Marketaccess	0.02	-0.022	-0.043	-0.039	0.006	-0.087	-0.102	-0.105	-0.004	-0.025	-0.041	-0.039
	(0.069)	(0.065)	(0.066)	(0.066)	(0.12)	(0.117)	(0.117)	(0.117)	(0.074)	(0.069)	(0.07)	(0.07)
Openvironment	-0.089	-0.132	-0.083	-0.093	0.495***	0.285*	0.462***	0.459***	-0.424***	-0.552***	-0.507***	-0.506***
	(0.114)	(0.112)	(0.113)	(0.113)	(0.171)	(0.166)	(0.173)	(0.173)	(0.146)	(0.14)	(0.144)	(0.144)
LnGERI	-0.192***	-0.154**	-0.183***	-0.181***	-0.437***	-0.247*	-0.249*	-0.237*	0.288***	0.326***	0.340***	0.340***
	(0.073)	(0.069)	(0.07)	(0.069)	(0.135)	(0.129)	(0.128)	(0.128)	(0.097)	(0.094)	(0.095)	(0.095)
Constant	-21.425	-4.671	-29.537	-3.361	19.26	1.732	-7.019	5.398	-30.233	-32.416	-45.807	-32.280
	(11.687)	(11.831)	(9.038)	(11.833)	(19.218)	(18.164)	(14.802)	(18.154)		(10.548)	(8.515)	(10.547)
Obs	5,362	5,381	5,381	5,381	2,723	2,729	2,729	2,729		3,160	3,160	3,160
No.PanelID	39	39	39	39	30	30	30	30		41	41	41
R-squared	0.267	0.267	0.266	0.268	0.282	0.276	0.279	0.279		0.159	0.159	0.16

Table A10: Basic Gravity Model with Trade Facilitation Indicators, GERI and Trade Agreements

	Corn				**Soybean**				**Wheat**			
Model	**One**	**Two**	**Three**	**Four**	**One**	**Two**	**Three**	**Four**	**One**	**Two**	**Three**	**Four**
Expfixed		0.045***		0.044***		0.031		0.027		0.025		0.024
		(0.014)		(0.014)		(0.021)		(0.021)		(0.019)		(0.019)
Impfixed			0.000***	0.000***			0.001***	0.001***			0.0001	0.0001
			(0.0001)	(0.0001)			(0.0001)	(0.0001)			(0.0001)	(0.0001)
LnSGDP	0.337				0.981				0.266			
	(0.437)				(0.632)				(0.522)			
LnDestGDP	0.047				0.510***				0.271***			
	(0.064)				(0.106)				(0.073)			
Lnpop_d	0.290***	0.319***	0.333***	0.330***	0.315***	0.697***	0.762***	0.757***	0.02	0.223***	0.236***	0.235***
	(0.049)	(0.026)	(0.026)	(0.026)	(0.091)	(0.048)	(0.051)	(0.051)	(0.067)	(0.039)	(0.04)	(0.04)
LnSPop	2.293	-0.692	3.599***	-0.775	-5.583*	-2.501	0.047	-2.592	2.341	2.659	4.586***	2.704
	(1.781)	(1.732)	(1.043)	(1.731)	(2.865)	(2.656)	(1.716)	(2.651)	(1.92)	(1.778)	(0.986)	(1.778)
LnDist	-0.737***	-0.757***	-0.866***	-0.862***	0.883***	0.693***	0.410*	0.422*	1.020***	0.860***	0.779***	0.772***
	(0.123)	(0.12)	(0.126)	(0.126)	(0.208)	(0.204)	(0.219)	(0.219)	(0.169)	(0.161)	(0.173)	(0.173)
comlang_off	-0.435***	-0.447***	-0.477***	-0.481***	-1.259***	-1.168***	-1.123***	-1.118***	0.098	0.11	0.096	0.092
	(0.078)	(0.077)	(0.078)	(0.078)	(0.141)	(0.14)	(0.141)	(0.141)	(0.098)	(0.098)	(0.099)	(0.099)
Comcur	-0.252	-0.321	-0.415*	-0.416*	-0.403	-0.906	-1.094*	-1.113**	0.035	-0.254	-0.3	-0.317
	(0.262)	(0.248)	(0.251)	(0.25)	(0.57)	(0.56)	(0.562)	(0.562)	(0.305)	(0.293)	(0.296)	(0.297)
LnEx	0.167***	0.164***	0.167***	0.166***	0.090***	0.073***	0.072***	0.071***	-0.042***	-0.049***	-0.048***	-0.049***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.018)	(0.017)	(0.017)	(0.017)	(0.015)	(0.015)	(0.015)	(0.015)
Lntdiff	-0.618***	-0.622***	-0.571***	-0.570***	-0.516***	-0.592***	-0.546***	-0.555***	-1.061***	-1.086***	-1.051***	-1.048***
	(0.089)	(0.089)	(0.09)	(0.09)	(0.159)	(0.159)	(0.159)	(0.159)	(0.111)	(0.111)	(0.114)	(0.114)
LnpRatio	0.123	0.092	0.133	0.09	0.415	0.436	0.457	0.448	0.492	0.571*	0.531	0.577*
	(0.204)	(0.204)	(0.2030	(0.204)	(0.351)	(0.353)	(0.352)	(0.352)	(0.341)	(0.342)	(0.34)	(0.342)
Borderadmin	-0.628***	-0.630***	-0.600***	-0.592***	0.057	0.249	0.201	0.212	-0.436***	-0.459***	-0.452***	-0.448***
	(0.099)	(0.098)	(0.099)	(0.099)	(0.173)	(0.168)	(0.168)	(0.168)	(0.106)	(0.105)	(0.105)	(0.105)
Infrastructure	1.036***	1.094***	1.076***	1.069***	-0.299	0.15	0.124	0.117	-0.04	0.346***	0.323***	0.316***
	(0.122)	(0.093)	(0.094)	(0.094)	(0.208)	(0.188)	(0.188)	(0.188)	(0.158)	(0.113)	(0.115)	(0.115)

Table A10: Basic Gravity Model with Trade Facilitation Indicators, GERI and Trade Agreements (Continued)

	Corn				Soybean				Wheat			
Model	**One**	**Two**	**Three**	**Four**	**One**	**Two**	**Three**	**Four**	**One**	**Two**	**Three**	**Four**
Marketaccess	0.003	-0.008	-0.032	-0.025	0.038	-0.059	-0.084	-0.085	-0.095	-0.133*	-0.148**	-0.143*
	(0.07)	(0.066)	(0.067)	(0.067)	(0.122)	(0.119)	(0.119)	(0.119)	(0.076)	(0.075)	(0.075)	(0.075)
Openvironment	-0.096	-0.116	-0.066	-0.072	0.433**	0.241	0.422**	0.417**	-0.530***	-0.652***	-0.602***	-0.597***
	(0.116)	(0.114)	(0.115)	(0.115)	(0.177)	(0.173)	(0.18)	(0.18)	(0.147)	(0.143)	(0.149)	(0.149)
LnGERI	-0.184**	-0.174**	-0.199***	-0.202***	-0.505***	-0.324**	-0.295**	-0.290**	0.356***	0.416***	0.429***	0.427***
	(0.073)	(0.07)	(0.071)	(0.071)	(0.144)	(0.139)	(0.139)	(0.139)	(0.099)	(0.098)	(0.098)	(0.098)
Bilateral	0.18	0.155	0.210*	0.174	-0.191	-0.178	-0.089	-0.117	0.554***	0.606***	0.642***	0.620***
	(0.11)	(0.11)	(0.11)	(0.11)	(0.177)	(0.178)	(0.177)	(0.178)	(0.139)	(0.139)	(0.138)	(0.139)
CAFTA	0.081	0.022	0.069	0.025	0.091	-0.128	-0.013	-0.053	0.819***	0.702***	0.722***	0.692***
	(0.147)	(0.145)	(0.144)	(0.145)	(0.345)	(0.344)	(0.343)	(0.344)	(0.185)	(0.182)	(0.181)	(0.182)
NAFTA	0.877***	0.870***	0.868***	0.862***	1.940***	1.853***	1.622***	1.616***	-0.214	-0.283	-0.303	-0.313
	(0.183)	(0.182)	(0.182)	(0.182)	(0.331)	(0.332)	(0.339)	(0.338)	(0.24)	(0.238)	(0.239)	90.239)
Constant	-20.152*	-3.611	-25.922	-2.178	18.803	1.376	-8.253	5.152	-29.703**	-32.72***	-40.256***	-32.40***
	(11.734)	(11.856)	(9.19)	(11.858)	(19.287)	(18.2)	(15.03)	(18.2)	(11.548)	(10.579)	(8.593)	(10.58)
Obs	5,335	5,350	5,350	5,350	2,703	2,709	2,709	2,709	3,133	3,149	3,149	3,149
PanelID	39	39	39	39	30	30	30	30	41	41	41	41
R-squared	0.269	0.27	0.27	0.271	0.284	0.277	0.28	0.28	0.17	0.166	0.167	0.167

Table A11: Final Empirical Model with Fixed Effects, Random Effects and PPML Estimations

	Corn			Soybean			Wheat		
Model	**F.E**	**R.E**	**PPML**	**F.E**	**R.E**	**PPML**	**F.E**	**R.E**	**PPML**
LnSGDP	0.314	-0.089	-0.177***	-0.377	-0.257	-0.215***	0.782***	0.363**	-0.109**
	(0.261)	(0.169)	(0.054)	(0.391)	(0.161)	(0.055)	(0.275)	(0.176)	(0.052)
LnDestGDP	0.326***	0.337***	0.448***	0.934***	0.923***	0.853***	0.344***	0.363***	0.431***
	(0.031)	(0.03)	(0.048)	(0.055)	(0.053)	(0.074)	(0.04)	(0.04)	(0.076)
LnEx	0.178***	0.178***	0.163***	0.177***	0.177***	0.107***	-0.015	-0.015	-0.02
	(0.012)	(0.012)	(0.016)	(0.016)	(0.016)	(0.02)	(0.014)	(0.014)	(0.017)
Lntdiff	-0.927***	-0.916***	-0.981***	-0.400***	-0.399***	-1.156***	-0.551***	-0.548***	-0.276**
	(0.067)	(0.067)	(0.12)	(0.123)	(0.122)	(0.116)	(0.079)	(0.079)	(0.129)
LnpRatio	0.15	0.254	1.493***	0.424	0.414	-0.028	0.477	0.654*	3.823***
	(0.205)	(0.204)	(0.417)	(0.362)	(0.362)	(0.508)	(0.341)	(0.34)	(0.512)
Borderadmin	-0.512***	-0.508***	-0.588***	-0.465***	-0.446***	-0.416**	-0.490***	-0.491***	0.085
	(0.097)	(0.097)	90.194)	(0.168)	(0.167)	(0.197)	(0.102)	(0.103)	(0.141)
Infrastructure	0.762***	0.742***	0.505***	-0.349*	-0.345*	-0.666***	-0.221*	-0.253**	-1.308***
	(0.108)	(0.108)	(0.163)	(0.193)	(0.193)	(0.201)	(0.126)	(0.126)	(0.275)
Marketaccess	-0.012	-0.008	-0.218**	0.139	0.127	-0.119	0.057	0.053	-0.195*
	(0.067)	(0.067)	(0.109)	(0.115)	(0.115)	(0.119)	(0.07)	(0.07)	(0.114)
Openvironment	-0.285**	-0.272**	0.375***	0.481***	0.473***	0.994***	-0.292**	-0.263*	0.546**
	(0.112)	(0.112)	(0.142)	(0.174)	(0.173)	(0.177)	(0.141)	(0.141)	(0.246)
LnGERI	-0.138*	-0.149**	0.001	-0.323**	-0.313**	0.195	0.337***	0.326***	0.409***
	(0.071)	(0.071)	(0.117)	(0.144)	(0.144)	(0.219)	(0.097)	(0.098)	(0.121)
Bilateral	0.104	0.125	-0.048	-0.362**	-0.358**	-0.224	0.466***	0.504***	0.622***
	(0.109)	(0.109)	(0.172)	(0.179)	(0.178)	(0.193)	(0.138)	(0.138)	(0.194)
CAFTA	0.447***	0.483***	0.438***	-0.202	-0.195	0.173	0.232	0.296*	0.291
	(0.137)	(0.137)	(0.165)	(0.339)	(0.337)	(0.312)	(0.158)	(0.158)	(0.271)
NAFTA	1.032***	1.041***	0.990***	0.291	0.333	-0.419*	-0.655***	-0.629***	0.886***
	(0.166)	(0.166)	(0.232)	(0.292)	(0.291)	(0.254)	(0.199)	(0.2)	(0.291)
Constant	-8.974***	-4.199**	-4.011***	-10.946**	-12.244***	-9.547***	-9.669***	-3.214	16.016***
	(3.204)	(2.105)	(1.05)	(4.818)	(2.253)	(1.433)	(3.65)	(2.693)	(3.02)

Table A11: Final Empirical Model with Fixed Effects, Random Effects and PPML Estimations (Continued)

	Corn			Soybean			Wheat		
Model	**F.E**	**R.E**	**PPML**	**F.E**	**R.E**	**PPML**	**F.E**	**R.E**	**PPML**
Observations	5,335	5,335	5,335	2,703	2,703	2,703	3,133	3,133	3,136
Number of PanelID	39	39		30	30		41	41	
R-squared	0.258		0.199	0.236		0.24	0.157		0.119

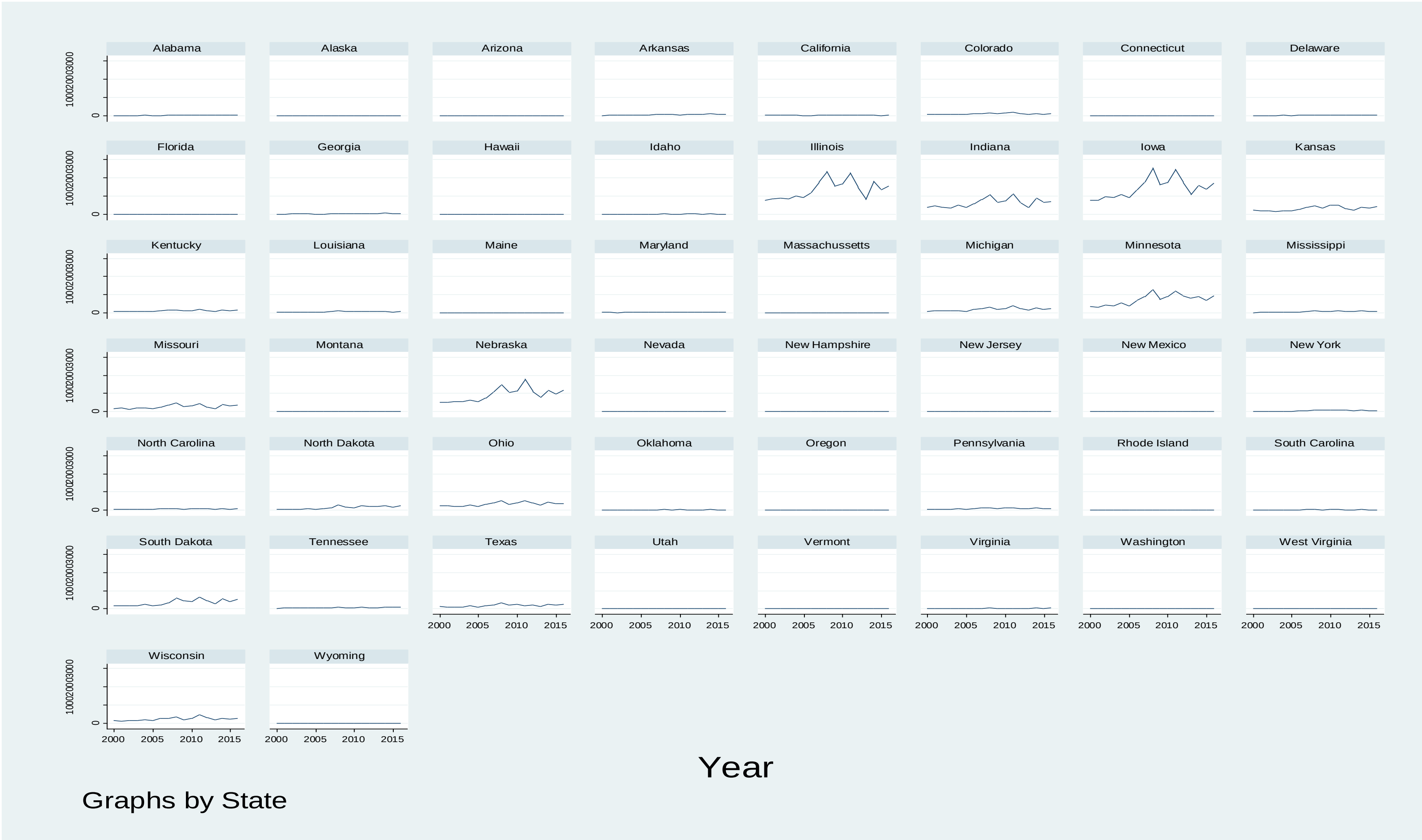

Figure A1: Corn Exports by States in the U.S.

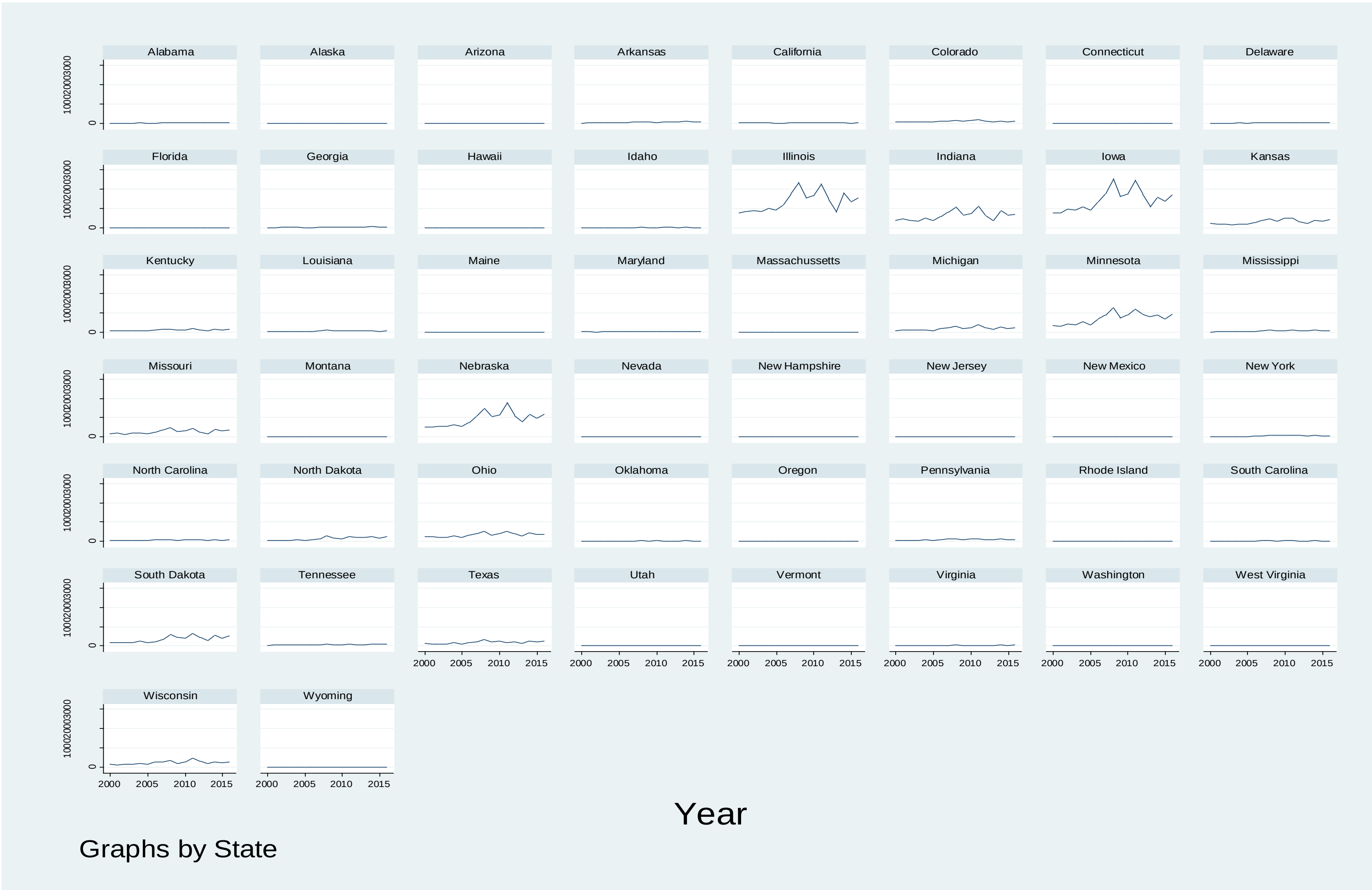

Figure A2: Soybean Exports by States in the U.S.

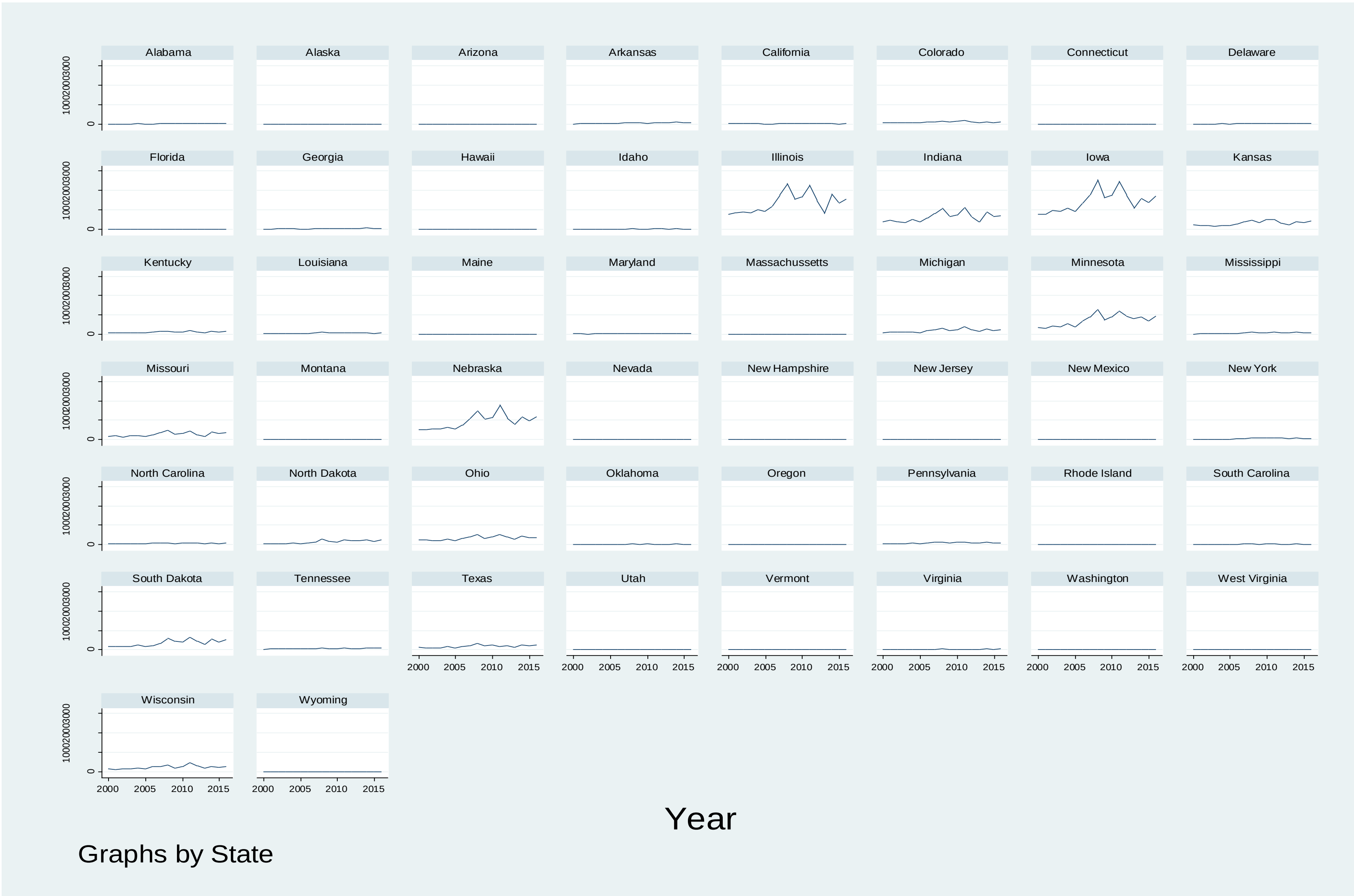

Figure A3: Wheat Exports by States in the U.S.