

GLOBAL IMPACT OF THE U.S.-CHINA TRADE WAR IN AGRICULTURAL SECTOR

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Graduate School

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**Title**

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Enoch Adom

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The Supervisory Committee certifies that this *disquisition* complies with North Dakota State University's regulations and meets the accepted standards for the degree of

**MASTER OF SCIENCE**

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## **ABSTRACT**

This thesis examined the impact of the U.S-China trade war on the global, U.S, and China's agricultural exports while considering the competing suppliers' effect using a highly disaggregated HS 6-digit trade flow data in the structural gravity model. The empirical results indicate that the trade war caused about 8.6% and 17% reduction in U.S and China's agricultural exports, respectively. However, global agricultural export was not negatively impacted during the trade war. Finally, the results also showed that tariff increases by U.S caused an increased in U.S competing suppliers' exports to China. Similarly, China's retaliatory tariffs caused an increase in China's competing suppliers' exports to the U.S.

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## **DEDICATION**

I dedicate this thesis to my family in Ghana especially my parents, Anthony and Francisca. I am extremely grateful for all their sacrifices, words of encouragement and prayers.

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# CHAPTER ONE. INTRODUCTION

## 1.1. Background

The U.S. and China are the world's two largest economies and combinedly contribute 39.1% to the world GDP (International Monetary Fund, 2018). China is also among the fastest growing economies globally and has been the top trading partner for the U.S. for the last decade. In 2018, the total value of merchandise trade between the U.S. and China was about \$660 billion and represented about 15.7% of U.S. trade in value terms. The U.S.-China bilateral trade is increasing, and so is the trade deficit between the two countries. The U.S. trade deficit with China has almost doubled from \$268 billion in 2008 to about \$440 billion in 2018. But, this trade imbalance between the two countries is comparable to the global trade imbalances as identified by International Monetary Fund's (IMF) report on tackling global imbalances released in July 2018. Figure 1.1 shows the trade balance between U.S and China between 2013 – 2018.

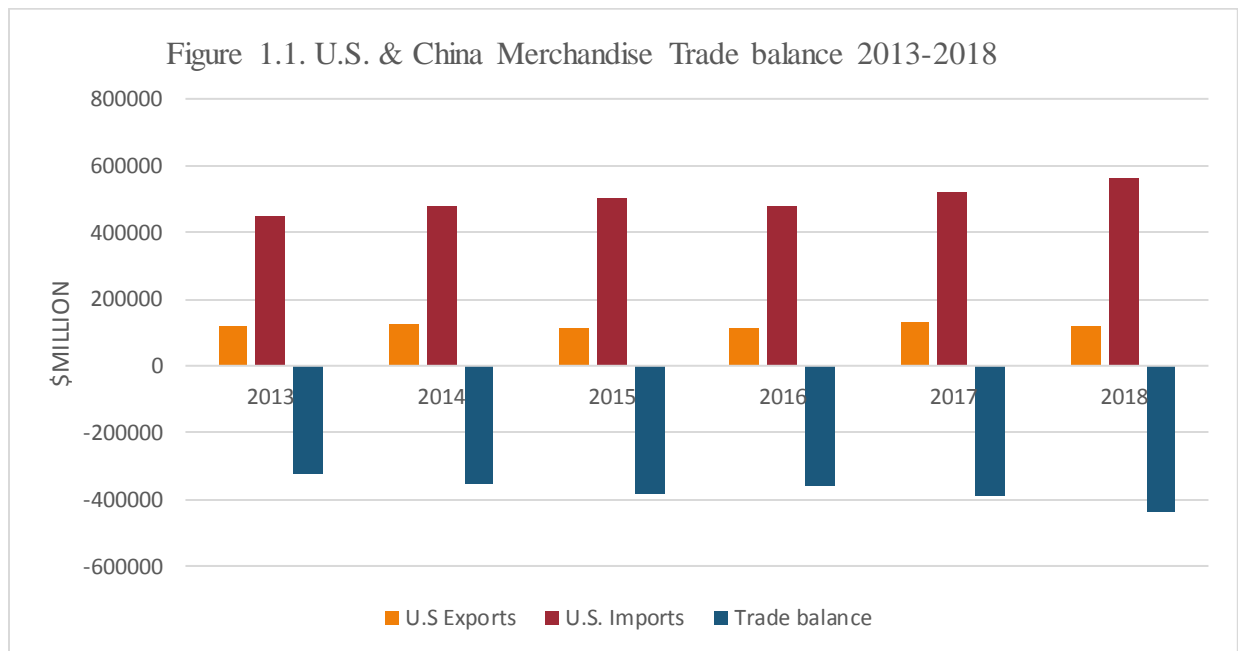


Figure 1.1. U.S. & China Merchandise Trade Balance 2013-2018

## **1.2. U.S. Trade Actions and Response from Partners During the Trade War Period**

There has been remarkable decline in U.S average tariffs levels since 1934 after tariff-setting powers was transferred from congress to the President (Baldwin, 2009). For instance, U.S. average duty in 1946 was about 26.3 percent just before the first round of GATT negotiations and about 4.8 percent in 2004 (Irwin, 2007). Despite U.S. efforts towards trade liberalization through tariff reduction, the Trump administration over the course of 2018 to 2019, imposed import tariffs on series of products from China and other trading partners. Specifically, as of December 2019, approximately \$550 billion of Chinese goods were affected by the U.S import tariffs, while about \$185 billion of U.S goods were affected by the Chinese retaliatory tariffs. This protectionist policy is expected to have significant impact on the U.S and China's economy. In addition, the tariff increases by the U.S and subsequent retaliation by China and other U.S bilateral trade partners is expected to impact the global economy as well.

## **1.3. Genesis of the US-China Trade Dispute**

The trade dispute was initiated by the U.S government following the United States International Trade Commission (USITC) reports in October and November 2017. According to the report, imports of solar panels and washing machines have caused considerable damage to the U.S. solar panel and washing machine industries. The commission therefore, recommended the president to impose "global safeguard" restrictions. These tariffs were justified as "safeguard measures" under the General Agreement on Tariffs and Trade (GATT) Article XIX. However, the trade war escalated after two investigation reports were released in 2018 (Waugh, 2019). These two investigations were conducted by the US Department of Commerce and US Trade Representative (USTR) under section 232 of the trade Expansion Act of 1962 and Section 301 of the trade Act of 1974. The Department of Commerce on the 16th of February 2018, released its

report findings which suggested that the imports of steel and aluminum threatens National Security. According to the report, domestic production of steel and aluminum is essential for national security. However, the excess production of both aluminum and steel by its trading partners depressed the world and domestic prices, resulting in the shutting of factories in the U.S. In this regard, the department considered importing of the two metals in excess as a national economic threat to the U.S. Similarly, U.S Trade Representative report also determined that China's acts, policies and practices related to technology transfer, intellectual property, and innovation are unreasonable or discriminatory and burden or restrict U.S. economy.

#### **1.4. Profiles of the Trade War Tariffs and Retaliatory Tariffs**

Following the findings of these investigations, a series of actions from both the U.S. and China set forth the trade dispute. The U.S. announced the first wave of tariff in January 2018. President Trump approved this global safeguard tariff on January 22, which was imposed on a total of about \$10.3 billion imports of solar panels and washing machines (Bown, 2018a). Following up on the solar panel and washing machines tariff, the second wave of the tariff was announced on aluminum and steel in March 2018. This included a 25% tariff on steel and a 10% tariff on aluminum from all trading partners with an estimated total import value of about \$48 billion (Bown, 2018b). The third wave of tariffs started in July 2018 through to the third quarter of 2019. These tariffs were solely directed towards China on the grounds of unfair trade practices for technology and intellectual property. The first phase of these tariffs imposed on China started on July 6th, 2018 covering \$34 billion of Chinese imports. The second phase followed immediately in August 2018, covering about \$16 billion imports from China. The third and bigger tranche of the China-specific tariffs was announced in September 2018 and took effect that same month, wrapping about \$200 billion of Chinese imports (Bown, Jung, & Lu, 2018). Finally, two major

tariffs actions against China emerged in 2019. The first action was to revise the third tranche of the China-specific tariffs imposed in September 2018 from 10% to 25%. Part A of the fourth tranche of the China-specific tariffs was announced in August 2019 and covered about 15% of \$300 billion of final consumer goods, mainly clothing and accessories. Part B covering other final goods such as toys was postponed to December 2019 (Bown, 2019).

Subsequently, major trading partners such as China, Canada, Mexico, Turkey, and the E.U also followed suit and imposed a series of retaliatory tariffs on U.S exports. These combined retaliatory tariffs covered about \$87.88 billion of U.S annual agricultural exports spanning over 800 agricultural products. Data shows that the U.S exported approximately USD 150 billion worth of agricultural products to the world in 2017. However, the main retaliating partners - China, Mexico, Canada, EU, and India accounted for about 59% of U.S agricultural exports in 2017.

Table A2 in the appendix shows the profile of the retaliatory tariffs by these countries. As shown in the table, China imposed retaliatory tariffs on almost all U.S agricultural products exported to China in 2017. Canada imposed retaliatory tariffs on 16 agricultural products and Mexico on 24 agricultural products. Furthermore, Turkey and EU-28 also imposed retaliatory tariffs on 40 products each, while India imposed tariffs on about seven products. The retaliatory tariffs imposed by these five leading export destinations of U.S agricultural produce were estimated to be around \$26.79 billion. This accounted for 30% of all U.S agricultural exports to the five leading U.S export destinations and about 18% of all U.S agricultural export to the world in 2017.

### **1.5. Impact and Structure of the US-China Trade Dispute Tariffs**

Besides the magnitude of the tariffs imposed by the U.S and China, another distinctive feature of the current trade dispute is the structure of the protection across different sectors. It is

not an accident that, in retaliation, countries targeted industries that are economically important to the U.S. and including even those that went through liberalization in the recent decades. Consequently, wide ranges of products across sectors were affected by the tariff hikes. Despite the large number of products being affected, the magnitude of the tariffs still creates visible differences across products, time, and countries (Amiti, Redding, & Weinstein, 2018). Even within the agricultural sector, over 800 commodity lines (HTS) were affected by the retaliatory tariffs. For example, the retaliatory tariffs by China covered over 95% of US soybeans and all other agricultural exports in 2017 with an estimated value of \$22 billion (Figure 1.2) For comparison, the retaliatory tariffs covered about 68% of the manufacturing sector exports with an estimated value of \$64.3 billion during the same time frame.

Figure 1.2 U.S. Exports Affected by Retaliatory Tariff in China, Expressed in 2017 Export Values

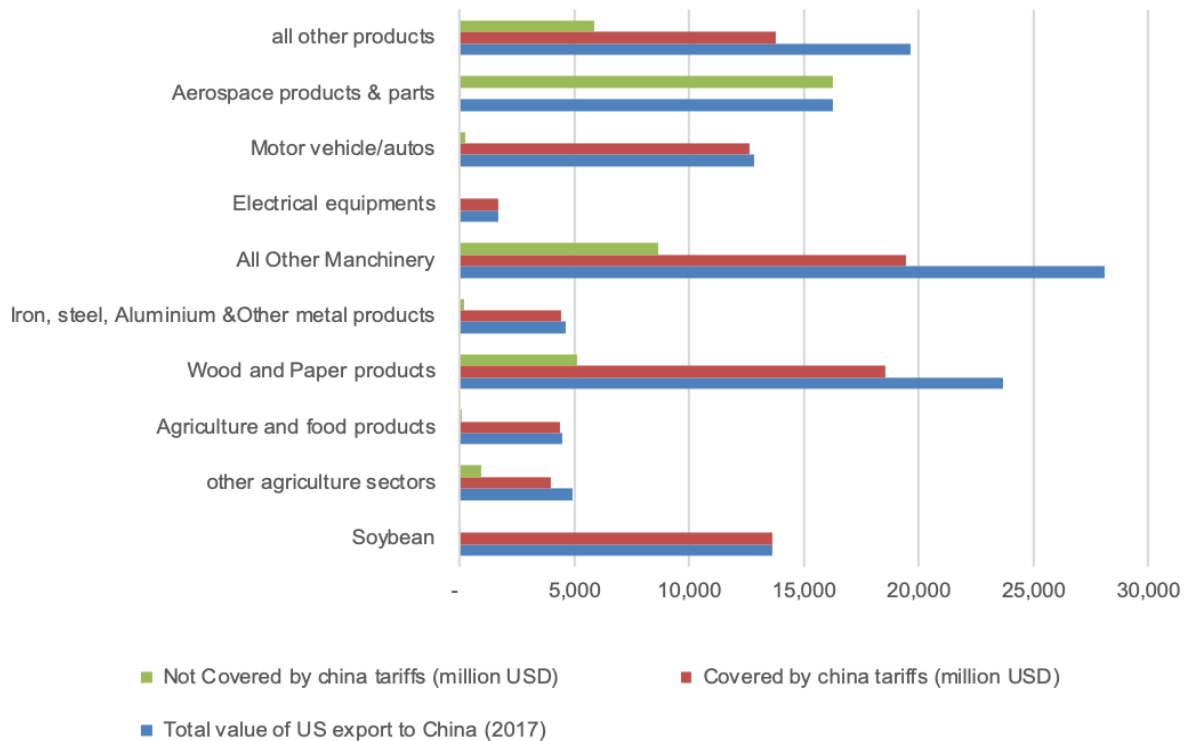


Figure 1.2. U.S Exports Affected by Retaliatory Tariff in China, Expressed in 2017 Export Values

The impact of retaliatory tariffs on US total export to China compared with other US top trading partners is shown in Figure 1.3. U.S. Export to China in 2018 decreased by about \$9.6 billion, while U.S. export to Canada, Brazil, EU, and Mexico is increasing. The impact of the retaliatory tariff on U.S exports to China is more profound in the agricultural sector, as shown in Figure 1.3b. U.S Agricultural export to China in 2018 decreased by about \$7.9 billion, representing about a 38% decline, while U.S total exports to China in the same year experienced about a 7.35% decline (Figure 1.3).

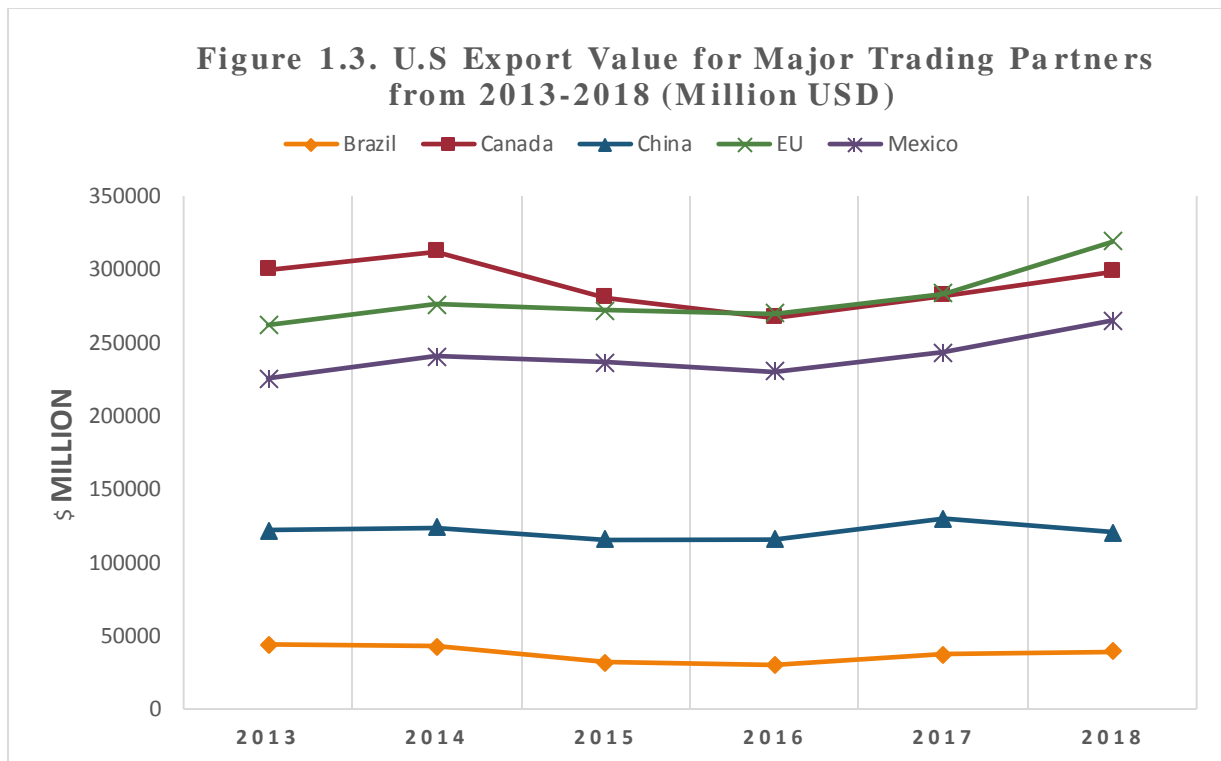


Figure 1.3. U.S Export Value for Major Trading Partners from 2013 – 2018 (Million USD)



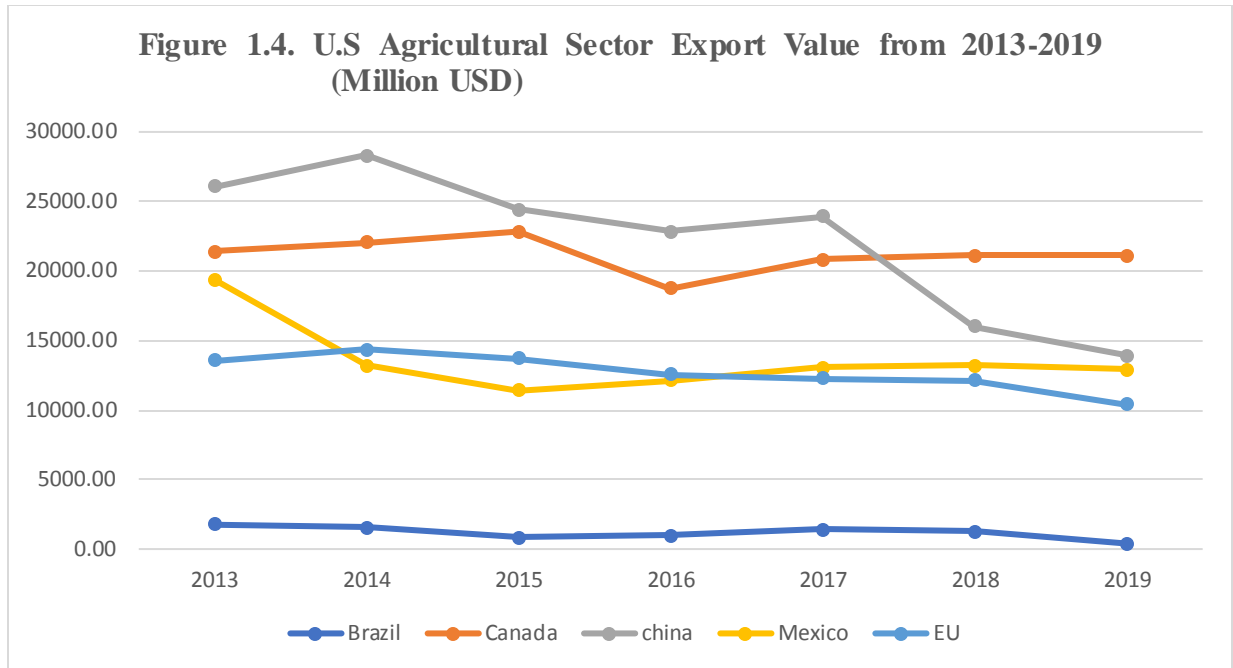


Figure 1.4. U.S Agricultural Sector Export Value from 2013-2019 (Million USD)

Although \$14.5 billion has been paid in the form of subsidies to help affected farmers, the effect on trade volume and shift in pattern could be significant.

### 1.6. Motivation for Research/Problem Statement

Since the formation of the General Agreements on Tariffs and Trade (GATT), the average tariff levels of GATT members reduced from about 40% to 22% in 1947. Following further negotiations after the establishment of WTO in 1995, the average tariff levels of members decreased even more to about 5%. Further trade liberalization following the Second World War served as the catalyst driving massive growth in world trade relative to world output. For instance, in the past two decades, the U.S entered into several preferential trade agreements, further liberalizing its economy (Sharma et al. 2021). The average tariff the U.S faces decreased from 3.92% in 1990 to about 1.66% in 2010. However, the several waves of tariff increase by the U.S and the retaliatory tariff increases from China, Canada, Mexico, EU, Turkey and India during 2018-2019 have led to an unparalleled return to protectionism. One distinct feature of these tariff

increases is the number of products and sectors affected. Because the retaliatory tariffs by U.S trading partners have extremely targeted agricultural products and, given the sector's importance to all countries involved in the trade war, this thesis focuses on the agricultural sector.

Data shows that, despite the U.S agricultural sector employing only 2% of the workforce, it is globally the most productive and efficient agriculture sector. The sector's efficiency gives the U.S. the ability to be the world's largest exporter of food and fiber, sending agricultural products worldwide. The U.S. exports more agricultural commodities than it imports, creating a positive agricultural trade balance. In the most recent five years (2012-2017) before the trade war, the United States exported more than 20% of its total agricultural production, worth \$140 billion in value terms. While the agricultural sector contributes only a small percentage to overall US exports, the industry depends heavily on international trade. In addition, the sector is also perceived to have a significant influence on domestic politics. For this reason, perhaps, U.S. agriculture is often targeted by most countries' retaliatory tariffs in the event of trade disputes. Similarly, the importance of the agricultural sector to the economy of China cannot be overemphasized. According to Shujie, 2000; Montalvo and Ravallion, 2010; van Arendon, 2015, the agriculture sector has been the main driving force for China's rapid economic growth and poverty reduction since the beginning of the 1980s. Even though China has been a major supplier of primary agricultural products, the sector still depends heavily on international imports for its production process. For example, China is the largest importer of soybean, and its hog herd production depends on soybean imported from China's trading partners such as the U.S, Brazil, and Argentina.

An initial look at available data shows that U.S import tariffs covered almost all Chinese products. Figure 1.8 illustrate the value of the U.S agricultural imports from China and other major trading partners between 2016 and 2019. While there is an evident decline in US agricultural

imports from China following the tariff escalation, the effect kicked off with some time lag. For example, the U.S total agricultural imports from China in 2018 were still higher than the previous year in the first, third, and fourth quarters. However, there was a sharp decline in imports in 2019. Similarly, there was a significant drop in China's agricultural imports from the U.S (Figure 1.5 and Figure 1.6). But, there was no significant increase in U.S agricultural exports to other major trading partners at the sector level. In contrast, China's agricultural import from other major trading partners almost doubled in 2018, that is increased from \$7.2 billion in 2017 to about \$13.2 billion in 2018. The China-specific tariffs imposed by the U.S might have led to a contemporaneous increase in China's imports from ROW (competing suppliers to the United States). It might have been relatively cheaper for China to trade with ROW than with the United States because of the trade war.

The main idea is that a change in trade costs between any given pair of countries and products in the world may potentially affect prices in all other countries and products in the world. It is one of the robust predictions in international trade consistent with many different theories of international trade (Sharma et al., 2021; Fugazza and Nicita, 2013; Low et al., 2009; Inama, 2006). Yet, most studies evaluating the impact of the U.S. - China trade war have focused only on these two direct participants. This thesis evaluates how the U.S-China trade war has affected the global and U.S. agricultural exports while considering the competing suppliers' effect. Using a highly disaggregated HS-6 trade flow data in the structural gravity model, the thesis examines the contemporaneous changes in the global agricultural trade flows vis-à-vis the changes in U.S and China's agricultural trade flows. A distinct benefit of using the structural gravity model is related to the fact that other factors may have a confounding effect on bilateral trade at the sector level. For example, good weather conditions in 2018/2019 led to a good harvest of over 4.5 billion

bushels of soybean (Hitchner et al., 2019). The outbreak of the African swine fever in China caused an approximately 50% decline in China’s hog herd in 2019. Using the structural gravity equation allows controlling for both observed and unobserved confounding factors in the model. Most tariffs are administered at the HS 8-digit level. Nevertheless, the HS 6-digit agricultural data also reveal enormous heterogeneity across countries and products in how countries respond to the tariff changes and at the same time offer comparability across countries as tariffs are globally harmonized at that level. For example China imposed retaliatory tariffs on U.S soybeans at HS 8-digit level and it covered yellow soybeans (HS-8 code is 12019010), green soybeans (HS-8 code is 12019030) and other soybeans (HS-8 code is 12019090). However, the HS 6-digit code for these three products combined is 120190 (soybean).

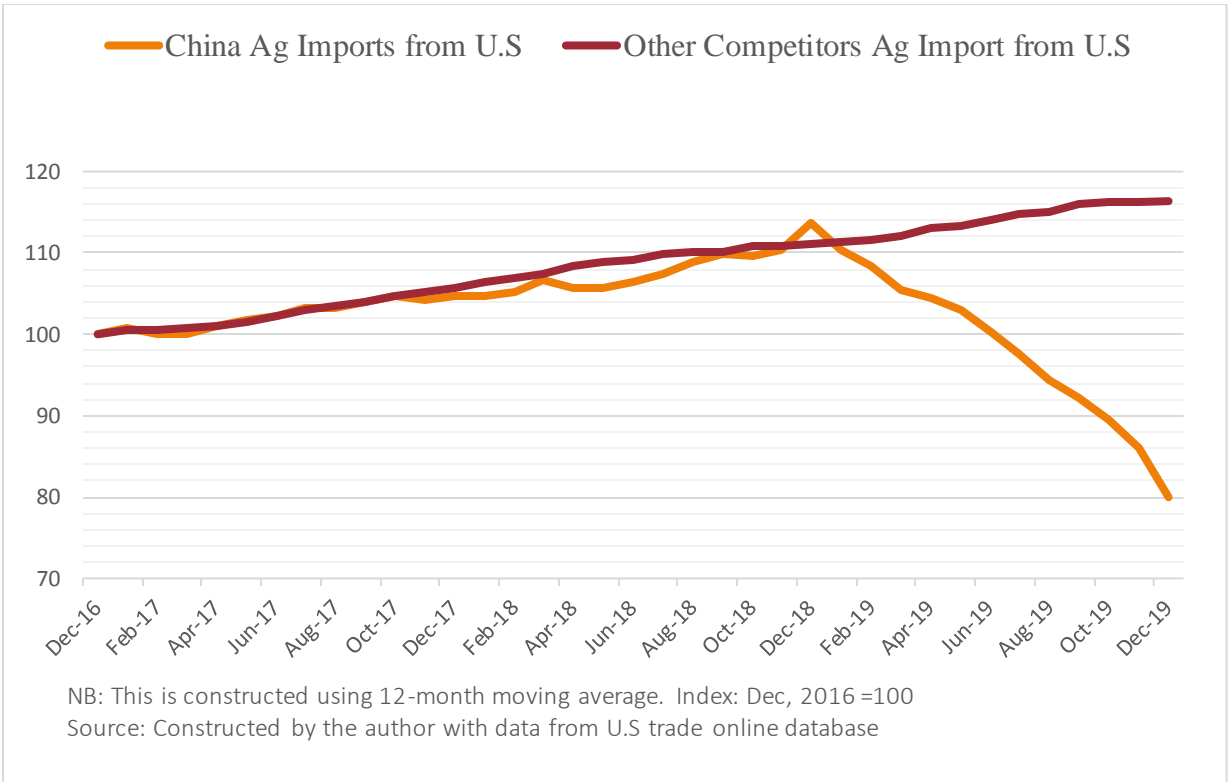


Figure 1.5. China's Agricultural Imports from U.S. vs other Major Competitors

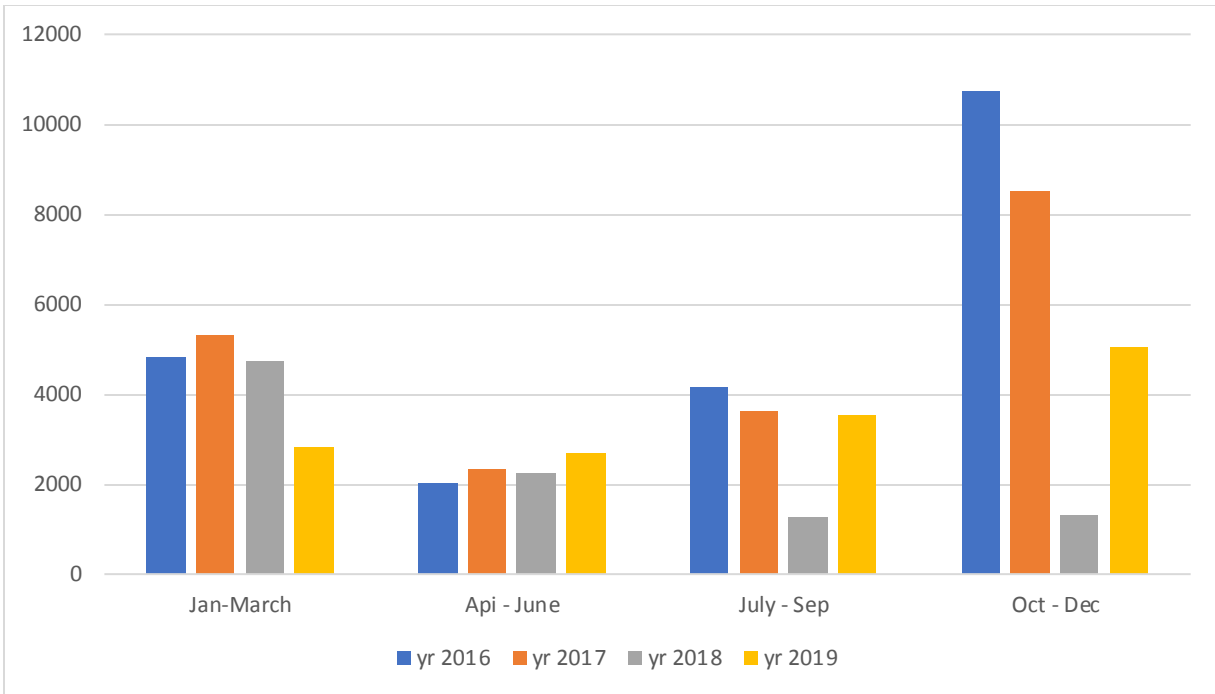


Figure 1.6. China's Agricultural Imports from the US

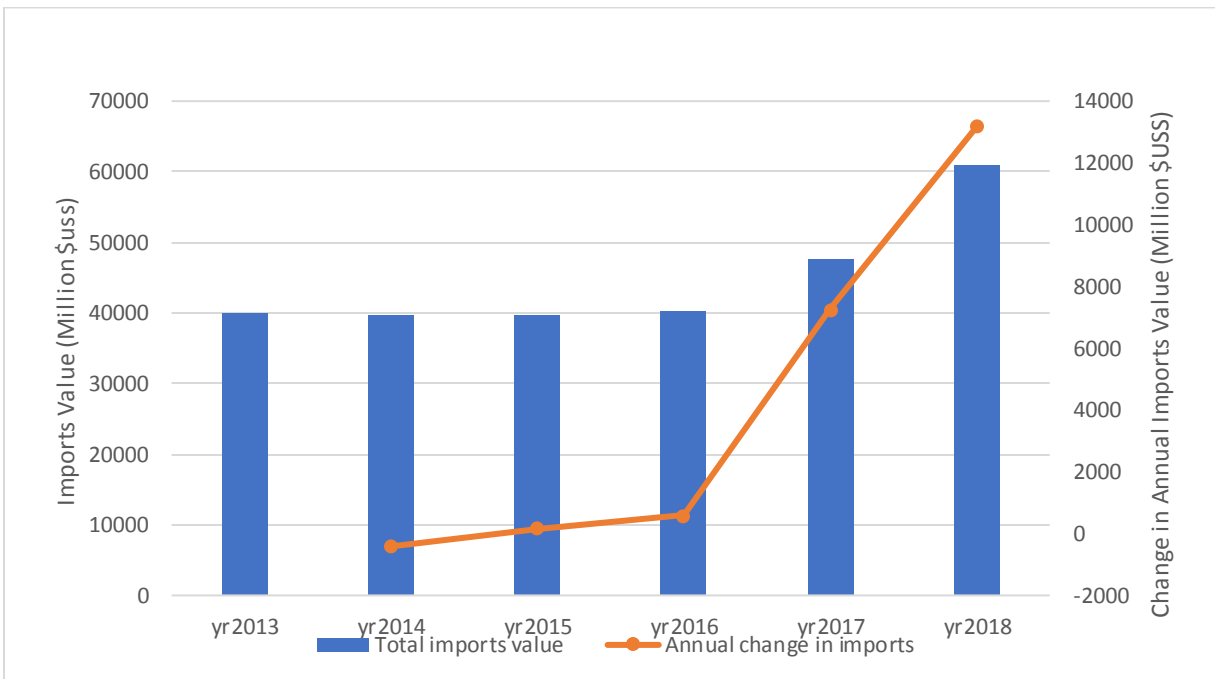


Figure 1.7. China's Agricultural Imports from Competing Suppliers

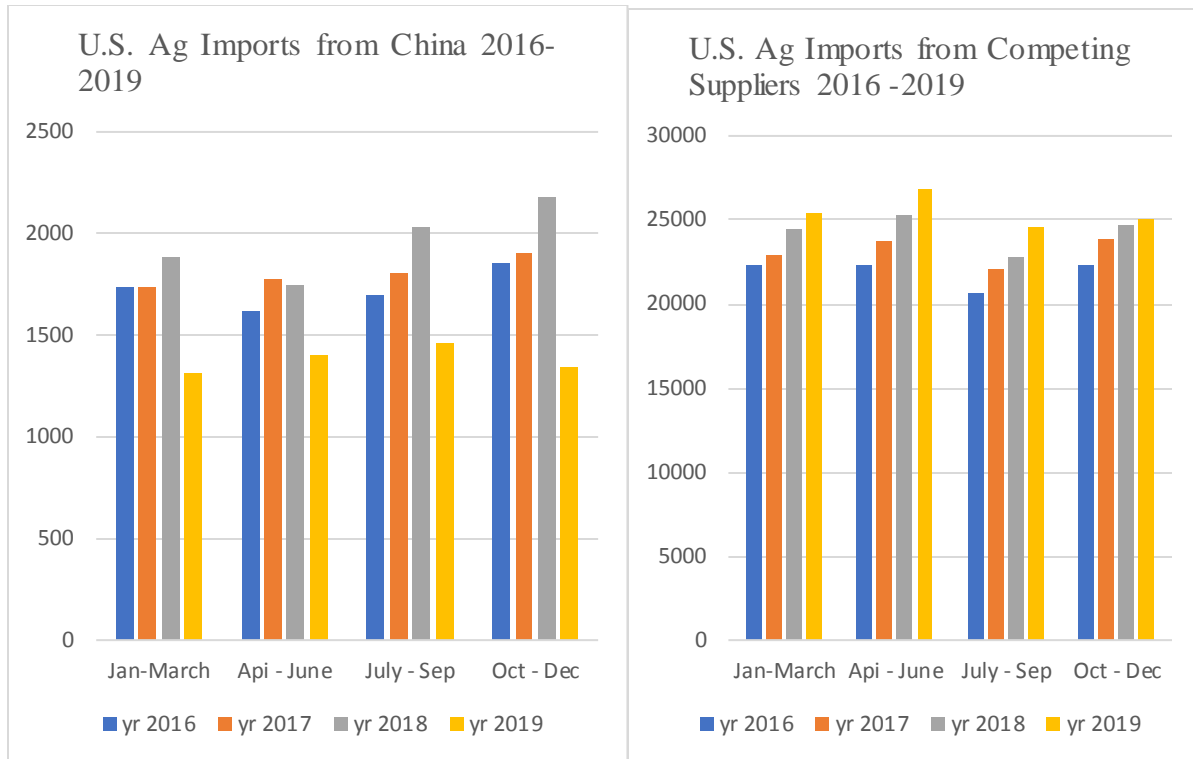


Figure 1.8. U.S. Agricultural Imports from China and other Competing Suppliers 2016-2019

## 1.7. Research Objective

The overall goal of this thesis is to evaluate the global trade response to the recent trade dispute between the U.S. and China using a comprehensive data set of Hs 6-digit agricultural data.

### 1.7.1. Specific Objectives

The three main specific objectives are:

- 1 To estimate the global impact of the trade war in the Agricultural sector.
- 2 To estimate the impact of the trade war on the U.S. Agricultural sector.
- 3 To estimate the impact of the trade war on the U.S. Agricultural sector while considering the competing suppliers' effect.

## 1.8. Organization of the Thesis

The study is organized into five distinct chapters. Chapter 2 presents a literature review focusing on the theoretical and empirical literature on trade liberalization and specific literature on

the 2018 U.S-China trade war. Chapter three provides a discussion of the theoretical and empirical framework. The chapter also describes the data, the source of the data, and the data construction approach for missing information. Chapter four presents the results and discussions of the study, while chapter five presents the conclusions and summary of the thesis.

## **CHAPTER TWO. LITERATURE REVIEW**

### **2.1. Trade Liberalization**

This chapter provides an overview of the theoretical and empirical literature on trade liberalization and a survey of trade literature on the 2018 U.S-China trade dispute related to the research question.

Trade liberalization is considered as one of the driving factors of world trade growth (Rose, 1991; Feenstra, 1998; Baier and Bergstrand, 2001; Dean, 2004). According to Baier and Bergstrand (2001), twenty five percent of world trade growth among OECD countries between the late 1950s and the 1980s was due to tariff reductions. Similarly, Dean (2004) estimated that growth in the productivity of tradable goods sector and reduction in tariff rates among major economies accounts for about 65% increase in trade to total final expenditure ratio between 1999-2000. Trade liberalization and its impacts on economic growth has therefore attracted several theoretical and empirical studies over the years (Bernard et al., 2006; Fajgelbaum et al., 2019).

In the course of history, several theories have emerged explaining causes and mechanism why trade liberalization is beneficial. Following several criticisms of the mercantilism theory of trade, Adam Smith in his book titled “Wealth of Nations” (1776) argued that a country should produce and export goods that it can produce at a cheaper cost through specialization, while importing goods that will be very expensive to produce. This idea known as the absolute advantage theory of trade was the complete opposite of the idea of Mercantilism where trade is seen as a zero-sum game. However, the theory of Absolute advantage was unable to explain the reason why a country which has absolute advantage in all goods still engage in trade with other country. Consequently, David Ricardo in 1815 came up with the comparative advantage theory. By this theory, in a world of two countries, two goods, two factors of production, the pattern of trade



between these two countries will be driven solely by differences in their technology of production. This implies that even though a country may have an absolute advantage in both goods it can still engage in trade by producing only the good which has lower opportunity cost in production.

One of the earliest neoclassical work which expanded on the theory of comparative advantage is the Heckscher-Ohlin model developed in the early 1900s. In the Heckscher-Ohlin model, the two countries are similar except for their factor abundances (capital and labor). When they are allowed to trade, a country will produce more of capital-intensive good if it is relatively abundant in the capital but less of labor-intensive good. A country will become net exporter of capital-intensive goods if it is relatively capital abundant, but a net importer of labor-intensive goods. As a result of trade, the price of the abundant factor increases and that of scarce factor decreases.

Subsequently, Stolper and Samuelson (1941) derived a basic theorem from the Heckscher-Ohlin model known as the Stolper-Samuelson theorem or the “Income distribution Theorem”. According to the theorem, an increase in the relative price of a good will cause an increase in the real income of the factor which is used intensively in the production of that good and conversely, a decrease in the real income of the second factor of production based on the assumption of constant return to scale and perfect competition. Krueger (1998) and Bhagwati (1978), using Heckscher-Ohlin framework, postulate that economic growth results from trade liberalization efforts because trade stimulates specialization in sectors which increases efficiency and productivity.

One of such theory that explains trade between similar countries is based on monopolistic competition between firms. The model of Dixit and Stiglitz (1977) is regarded as the first model based on monopolistic competition which explains economic integration and economies of scale.

This model has seen wide usage in different fields such as growth theory, macroeconomics as well as International trade. Subsequently, based on Dixit and Stiglitz (1977), Paul Krugman (1979) developed a model with increasing returns to scale and monopolistic competition to explain intra-industry trade. The model predicts that when there is an economic integration between countries through trade, there is an increase in the number of varieties and the market size which allows firms to lower their average cost of production.

However, above studies do not explain why only few firms were engaged in trade/export. For example, according to Bernard et al. (2007), in the year 2000, about 5.5 million firms were operating in the U.S, but only 4 percent of these firms were exporting. Even more surprising is that 10% of the exporting firms account for about 96% of U.S total exports by value. Melitz (2003) developed a model based on firm heterogeneity to explain this phenomenon. The main results in his model follow from the idea that firms incur fixed costs to enter the export market above and beyond the typical fixed cost in starting the operation that the earlier literature along this line emphasized. The model predicted that only highly productive firms are able to cover this large fixed cost of exports. Benard and Jensen (1999) had found suggestive evidence that entrance of firms into the export market is based on their past productivity performance. This is similar to Clerides, Lach, and Tybout (1998), who found that more productive firms self-select into the export market. In addition, Aw, Chung, and Roberts (2000) showed that inefficient firms are forced to exit the market as exposure to trade (foreign competition) increases. Thus, reducing the market share of domestic firms and reallocating market share to efficient firms. Helpman et al. (2004) expanded on Melitz (2003) model. The model explains the importance of within-sector productivity with emphasis on firm's choice between exports and foreign direct investment (FDI).

In addition, the model predicts that among high-productivity firms that serve foreign markets, only higher productivity firms participate in FDI.

This thesis uses theoretically consistent structural gravity equation to estimate the global trade impact. While structural gravity equation based on Melitz (2003) would have been ideal to exploit micro-level heterogeneity across firms, product-level studies can provide equally rigorous information on the policy impact at a lower computational cost. Therefore, this thesis uses structural gravity equation for products based on country level differences.

## **2.2. Empirical Literature on Trade Liberalization**

The relationship between trade liberalization and economic growth has been investigated in two different ways. One through trade openness and individual country's per capita GDP growth (Dollar 1992; Sachs et al. 1995; Rodriguez and Rodrik 2000) and next, through countries' firm/sector's productivity and trade policies (Melitz 2003; Amiti and Konings 2007; Autor et al. 2014; McCaig and Pavcnik 2018).

Earlier studies, Dollar (1992), Sachs et al. (1995), Edwards (1998), Rivera-Batiz and Romer (1991), and Dar and Amirkhalkhali (2003) show a positive relationship between trade openness and economic growth. Dar and Amirkhalkhali (2003) and Rivera-Batiz and Romer (1991) assert that trade openness enhances economic growth in the long run through economic integration. In an integrated world, both goods and ideas flow freely, and it also provides market incentives through scale opportunities. However, the positive relationship between trade openness and economic growth literature was put into doubt by Rodrik and Rodriguez (2000) in their paper titled "Trade policy and Economic Growth: A skeptics Guide to the Cross-National Evidence." Their criticism revolves around the measure of trade openness as adopted in Dollar (1992) and Sachs and Warner (1995), the applied methodology used by Edwards (1998), instrumentation

strategy, where trade share is instrumented by geographically constructed trade share in Frankel and Romer (1999). Rodrik and Rodriguez (2000) argued that geography can affect income through several other channels apart from trade. Nevertheless, additional empirical works by David Dollar and Kraay (2004), Freund and Bolaky (2008), Huchet-Bourdon et al (2017), Keho (2017) all show positive relationship between trade openness and economic growth. The studies discussed above focused on only the macroeconomic impact of trade liberalization. That is, it does not account for how trade liberalization affects individual sectors. In this thesis, the analysis will focus on trade liberalization on the agricultural sector instead of the aggregate economy while taking into account of host of geo-political observed and unobserved variables.

The second group of literature explores the microeconomic link between trade policies and their impacts on individual firms, sectors, or consumers. Most studies investigated whether reductions in tariffs had a significant impact on firm productivity (Amiti and Konings, 2007; Fernandes, 2007; Harrison, 1994; Pavcnik, 2002; Topalova and Khandelwal, 2011; Trefler, 2004) etc. Specifically, Pavcnik (2002) investigated the impact of freer trade on the productivity of firms in Chile and found out that trade liberalization caused an improvement in the within-plant productivity of firms in the import-competing sector. This evidence was similar to the findings of Blundell et al. (1999), who argued that innovation is prevalent among firms that are in an industry facing import competition and lower domestic concentration ratios. Bernard, Jensen & Schott (2006) examined the changes in industry-level tariffs on U.S manufacturing industries and plants/firms. The study supported the heterogenous-firm models which suggest that firms with high productivity benefit most as the costs of trade falls. In addition, the study also found a positive relationship between decrease in industry-level trade costs and growth in productivity within firms.

This thesis is different in approach from the above studies in that the scope of this thesis is limited to evaluating the global and U.S trade impact of the trade-war period tariffs and retaliatory tariffs on the Agricultural Sector. That is, this thesis does not explore through which channels these tariffs impact agricultural trade. That said, productivity differences across product and countries over time within the agricultural sector is controlled for by incorporating appropriate high-dimensional fixed effects in the models. Further, as the data corresponds to product-level trade at the country level, firm level effects cannot be explored. As such, this thesis adopts the structural gravity equation in the tradition of Anderson and Van Wincoop (2004) where products/varieties differ only by countries and not by firms.

Amiti and Konings (2007) also analyzed the effect of reducing tariffs on final goods and intermediate inputs. They find that a 10-percentage decrease in intermediate input tariffs caused a 12 percent gain in productivity for firms in Indonesia. In comparison, a percentage point decrease in the tariff of final goods caused more than a 20 percent gain in productivity. They associate the productivity gain for Indonesian firms with tougher import competition. In this regard, this thesis considers product linkages within and across countries and competing suppliers' effects using HS 6-digit comprehensive dataset in global agricultural trade.

Studies evaluating the tariff impact have also focused on Macro-economic impact. For example, Attanasio, Goldberg, & Pavcnik, (2004) study the impact of Columbia's tariff reduction policy between 1980s and 1990s on wage distribution. The study found a decreasing trend in wage premiums in sectors exposed to higher levels of tariff reductions while the informal sector of the economy was found to experience growth attributed to foreign competition. Topalova (2010) analyzed the India's trade liberalization policy through tariff cuts in 1991. The tariff cut was found to have a significant and decreasing effect on poverty. Specifically, they found both rural and urban

regions of India experienced massive reductions in poverty levels. Similarly, Goldberg, Khandelwal, Pavcnik, & Topalova (2010), Autor, Dorn, Hanson, & Song (2014) and Mccraig & Pavcnik (2018) have also examined the effect of ex post variation in tariffs on different sectors. They find that reduction in tariff caused considerable adjustment/reallocation of workers as well as increased access to new input varieties. Similar to this group of studies, this thesis exploits ex-post variation in tariff to evaluate the trade-war impact. This thesis incorporates relevant observable macro-economic variables to consider the macro-economic impacts the studies above predict while using the fixed effect terms to control for potential unobserved variables.

### **2.3. Overview of the 2018/2019 U.S-China Trade Dispute Literature**

Specific literature on the US-China trade dispute can be broadly classified into two groups. The first group of analytical studies precedes the actual dispute, which began officially in 2018 when the first U.S import tariff on solar panels and washing machines went into effect in January. The second group of studies comprises of ex-post analysis of the trade war. This group of studies utilized data realized after the trade war began to examine the impact of the trade war.

#### **2.3.1. Ex-ante Analysis of the U.S-China Trade Dispute**

Dong & Whalley (2012) explored the gains and losses of the potential U.S-China trade dispute that was anticipated following the trade collapse of 2008 when both China's trade surplus U.S. trade deficit were increasing. Using numerical general equilibrium model, they predicted welfare and terms of trade loss for both the U.S and China with high tariffs while gains accrued to U.S. and China with trade diversion. Bouët & Laborde (2018) drew similar conclusions. They argued that even though the U.S. may gain on some sectors; the general impact will be detrimental to both U.S and China. Furthermore, they forecasted a negative effect of the trade dispute on the

global economy. Other studies such as Gompert, Cevallos, & Garafola (2017), Li, He, & Lin (2018), and Rosyadi & Widodo (2018) also arrived at similar conclusions.

### **2.3.2. Ex-post Analysis of the U.S-China Trade Dispute**

A handful of studies evaluated the impact of the trade dispute using different approaches. Fajgelbaum et al. (2020) found a complete pass-through of retaliatory tariffs to foreign consumers. Similarly, Cavallo et al. (2019) noted sharp increases in prices of affected products but suggested that the immediate pass-through of tariffs may not persist into the future. Amiti et al. (2019a) also found a similar complete pass-through of tariffs and a reduced competition on the US market.

Another significant effect of the tariff increase pertains to welfare and employment. According to the estimations of Fajgelbaum et al. (2020), the 2018 trade dispute did not cause the prices of products targeted to decrease. This resulted in an annual welfare loss of about USD 51 billion. According to Waugh (2019), in contrast to the conventional supply-side negative impact of tariff increase, the US-China trade caused a substantial decrease in consumption (demand-side effect). Consequently, retaliatory trade policies by China cause concentrated welfare losses. Amiti, Redding, and Weinstein (2019) show that the imposition of tariffs by the U.S on its key trading partners caused an estimated \$1.4 billion reductions in real income monthly. They also estimated a deadweight loss of about USD 8.2 billion and an additional cost of \$14 billion to consumers and importers in the U.S.

According to Fajgelbaum et al. (2019), targeted varieties, products, and sectors all experienced import reduction. Specifically, their estimation shows that, as a result of the U.S. import tariffs, imports of targeted varieties, targeted products, and targeted sectors reduced by 31.7, 2.5, and 0.2 percent, respectively. In a similar vein, the retaliatory tariffs by different trading partners caused a large decline in export quantities and a minimal increase in export prices

(Fajgelbaum et al., 2020). In estimation, a 32 percent decline in trade is associated with 10% increase in retaliatory tariffs (Amiti, Redding and Weinstein, 2019). Jiang et al. (2019) studied the impact of the trade war on other key trading partners such as the EU. They find that the subsequent retaliations by China caused significant increase in trade between China and the EU. Li, He, and Lin (2018) explained that despite the increase in trade between China and the EU, the trade war still caused import prices to increase and negatively impacted the Chinese economy. The negative impact (market failures and reduction in trade) of the trade war on the Chinese economy surpasses any possible benefit associated with the trade war (Xia et al., 2019).

Most of the above studies have either focused on the manufacturing sector or the whole economy. A very few studies have examined the impact of the trade war on either the U.S agriculture sector or single agricultural products such as soybean. Carter & Steinback (2020) investigated the effect of retaliatory tariffs on U.S agricultural exports. Their results indicate that the retaliatory tariffs caused a huge decline in U.S agricultural exports. Specifically, the study found that during the trade war, the increase in U.S exports to non-retaliatory countries was lower than the decline in exports to retaliatory countries resulting in a net loss of about \$14.4 billion. In addition, the study attributed a net gain of about \$13.5 billion to countries mostly in South America and Europe. Finally, the study also identified soybean and meat products to have experienced the most redistribution as a result of the retaliatory tariffs. Adjemian et al (2019) evaluated the impact of the 2018 trade war on the global soybean market. The study used Relative Price of Substitute (RSP) method to determine that the retaliatory tariffs caused a \$0.65/bu decrease in U.S soybean export prices \$0.95/bu increase in Brazil soybean export prices. The study also suggests that the specific impact of china's 25% tariff increase on producers and buyers of U.S soybeans depends on other factors such as storage facility, transportation infrastructure, and crush facility proximity.



He et al. (2019) assess the implication of the trade war on environmental costs of agricultural production from a global perspective. Their results indicate that the changes in international trade pattern of soybean due to trade war can increase environmental costs due to the production of excess soybean in the U.S and the increase in transportation mileage.

## CHAPTER THREE. METHODOLOGY AND DATA

This chapter discuss the theoretical framework and the empirical model use for this study. The chapter also describes the data and data sources as well as the data construction approach.

### 3.1. Theoretical and Empirical Model

#### 3.1.1. The Gravity Model

The traditional gravity model since original formulation by Jan Tinbergen (1962) has attracted several theoretical works. The traditional gravity equation was once viewed as one lacking micro-economic foundation. Following the work by Anderson and van Wincoop (1979 and 2003), a modified gravity equation has received impressive micro-economic foundation and is consistent with wide varieties of theories in international trade (Andersen and van Wincoop, 2004; Eaton and Kortum, 2002, Melitz, 2003). The structural gravity equation has also been successfully taken to data with powerful econometric tools in explaining bilateral trade flows.

In definition, the traditional gravity equation predicts that trade between any two country-pair is directly proportional to the product of their economic sizes (GDPs) and inversely related to their geographic distances. The general gravity equation adapted from the Newton's equation can be expressed as shown in equation 3.1

$$X_{ij} = G \frac{M_i^\alpha M_j^\beta}{D_{ij}^\theta} \quad (3.1)$$

Where  $X_{ij}$  is the trade flow from country  $i$  (exporter) to country  $j$  (importer),  $M_i$  and  $M_j$  represents the economic size of country  $i$  and  $j$ , respectively. The economic size can either be measured by the Gross Domestic Products (GDPs) or the Gross National Incomes (GNIs) of the countries. Finally,  $D_{ij}$  represent the physical distance between the two countries.  $G$  is a constant in the equation and represents all other factors that affect bilateral trade flows. Most notable among

these factors include tariff and non-tariff barriers, preferential trade agreements, common language, colonial ties, and contiguity.

### 3.1.2. Theoretical Background of the Gravity Model

Despite the empirical success of the gravity equation in predicting bilateral trade flows, the model's predictive potential was initially undermined for lack of strong theoretical foundations. However, in 1979, Anderson attempted the first theoretical derivation of the gravity model. Bergstrand, 1985; Deardoff, 1998; Eaton and Kortum, 2002; Anderson and Van Wincoop, 2003; Melitz, 2003; Helpman et al., 2008; Chaney 2008 etc. show that the gravity equation can be derived under different theoretical assumptions. Anderson (1979) derived the model based on the assumptions of (i) differentiated goods by country of origin (Armington assumption) and (ii) identical homothetic consumers preferences across countries. Subsequent works by Bergstrand (1985) and Deardoff (1998) maintained the CES assumption and added monopolistic competition and traditional factor proportion explanation of trade by Heckscher-Ohlin to explain specialization. More recently, Melitz (2003), Helpman et al. (2008) and Chaney (2008) derived the gravity model in the presence of differentiated products and firm heterogeneity.

Following the Anderson (1979), the structural gravity model was further advanced by Anderson and van Wincoop (2004). They derived the model from the demand side based on the assumption that preferences are homothetic, and identical across consumers globally. They represented homothetic consumer preferences by a CES-utility function. Following Anderson and van Wincoop (2004), the CES-utility function for the importing country  $j$  can be written as;

$$\left( \sum_i \alpha_i^{\frac{1-\sigma}{\sigma}} C_{ij}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}} \quad (3.2)$$

Where  $\sigma > 1$  represents the elasticity of substitution between the different varieties of goods,  $\alpha_i > 0$  is the share or distribution parameter while  $C_{ij}$  represents consumption of different varieties of goods from country  $i$  in country  $j$ . The utility of consumers in country  $j$  represented by equation (3.2) is maximized subject to the standard budget constraint below:

$$\sum_i p_{ij} c_{ij} = E_j \quad (3.3)$$

Where  $E_j$  is the total expenditure in country  $j$  and is equal to the total amount consumers in country  $j$  spent on varieties from all countries, country  $j$  inclusive. Due to the varying trade cost across countries,  $p_{ij}$  which is the price consumers in country  $j$  pay for the varieties also differ across countries. Synonymous with the standard trade literature, the trade cost ( $\tau_{ij}$ ) is treated as an “iceberg” costs (Samuelson, 1952). In this regard, it is assumed that only fraction of the goods shipped from  $i$  arrives in country  $j$ .

Solving the consumer’s optimization problem gives rise to the total spending on goods exported from country  $i$  to country  $j$ . This is represented in equation (3.4) as:

$$X_{ij} = \left( \frac{\alpha_i p_i \tau_{ij}}{P_j} \right)^{(1-\sigma)} E_j \quad (3.4)$$

Where  $X_{ij}$  denotes exports from country  $i$  to country  $j$ . In equation (3.4),  $P_j$  is referred to as the CES consumer price index and given as:

$$P_j = \left[ \sum_i (\alpha_i p_i \tau_{ij})^{1-\sigma} \right]^{\frac{1}{1-\sigma}} \quad (3.5)$$

To complete the derivation of the structural gravity model, market clearance condition is imposed.

$$Y_i = \sum_j \left( \frac{\alpha_i p_i \tau_{ij}}{P_j} \right)^{1-\sigma} E_j \quad (3.6)$$

By this condition, it is assumed that the value of output in country  $i$  ( $Y_i$ ), must be equal to the total expenditure of this country's variety in all countries in the world, including  $i$  itself.

Now, let  $Y \equiv \sum_i Y_i$  and divide equation (3.6) through by  $Y$

$$\frac{Y_i}{Y} = \frac{\sum_j \left( \frac{\alpha_i p_i \tau_{ij}}{P_j} \right)^{1-\sigma} E_j}{Y} \quad (3.7a)$$

Rearranging equation (3.7a) gives:

$$(\alpha_i p_i)^{1-\sigma} = \frac{\frac{Y_i}{Y}}{\sum_j \left( \frac{\tau_{ij}}{P_j} \right)^{1-\sigma} \frac{E_j}{Y}} \quad (3.7b)$$

Following Anderson and van Wincoop (2004), the denominator in the right-side of equation (3.7b) can be expressed as:  $\pi_i^{1-\sigma} \equiv \sum_j \left( \tau_{ij}/P_j \right)^{1-\sigma} E_j/Y$  and substituted into equation (3.7b) to obtain:

$$(\alpha_i p_i)^{1-\sigma} = \frac{Y_i/Y}{\pi_i^{1-\sigma}} \quad (3.8)$$

Following the derivation of equation (3.8), equation (3.4) and (3.5) can be power transformed to obtain the term " $(\alpha_i p_i)^{1-\sigma}$ " in each of the each of the equation. Substituting for the power transform term in equation (3.4) and (3.5) and combining with the definition of  $\pi_i^{1-\sigma}$  gives rise to the structural gravity model as:

$$X_{ij} = \frac{Y_i E_j}{Y} \left( \frac{\tau_{ij}}{\pi_i P_j} \right)^{1-\sigma} \quad (3.9a)$$

Given the market clearance condition, the total expenditure is redefined as  $E_j = Y_j$ . Furthermore, in all the derivation, it must be noted that the time notation was omitted for simplicity

and clarity. Therefore, combining the time notation and the market clearance condition, the structural gravity model can be re-written as:

$$X_{ijt} = \frac{Y_{it}Y_{jt}}{Y_t} \left( \frac{\tau_{ijt}}{\pi_{it}P_{jt}} \right)^{1-\sigma} \quad (3.9b)$$

### 3.1.2. Empirical Model and Estimation Approach

The structural gravity model in equation (3.9b) can be estimated in its log-linear form using Ordinary Least Square (OLS) with fixed effects as proposed by Feenstra (2017). However, this estimation method is only unbiased if the dependent variable has only positive observations Helpman, Melitz, and Rubinstein (2008). As discussed in the data section, the dataset used for this work contains zero trade flow observations. In using the OLS method, the logarithmic transformation of the dependent variable leads to the loss of information contained in the zero trade flow values. This results in sample selection bias, as Helpman, Rubinstein, and Melitz (2008) noted. Heteroscedasticity and endogeneity are the other two major challenges in estimating the structural gravity model. The section below discusses these challenges.

#### 3.1.2.1. Zero Trade Flows

The zero trade flows challenge is more obvious in disaggregated data. During the US-China trade dispute, the main policy instrument of the dispute- tariff was applied at HS 8-digit level by the countries involved. Aggregating the HS 6-digit trade data moderates this issue somewhat but still contains zero trade flows. Different solutions have been suggested in the literature regarding modeling of zero trade flows (see, Frankel, 1997, pp145-146; Bikker, 1982, pp. 371-372). One such solution involves estimating the gravity model using non-zero observations. A similar approach involves adding a small random value less than 1 to replace the zero trade values. These

strategies were followed by Brada and Mendez (1985), Bikker (1987), Frankel (1997), Wang and Winters (1992), Raballand (2003) and others. Though, these approaches are easy and very convenient, Linders and de Groot (2006) argued that both approaches does not guarantee consistency of estimates. Head and Mayer (2014) argued that the results depend on the unit of measurement, and the gravity coefficients may not be interpreted as elasticities in the latter approach.

Other authors have suggested several different approaches to modeling zero trade flows. Eaton and Tamura (1995) and Martin and Pham (2008) propose the Tobit estimator method. Helpman et al. (2008) developed a theoretically consistent version of the Tobit estimator model. Egger et al. (2011) suggested a gravity model that breaks down the effects of the independent variables into effects on extensive and the intensive margin in two consecutive steps. The extensive margin effect measures the impact on the number of countries a country will decide to export to while the intensive margin measures impact on value of exports between existing bilateral trading partners. Despite all the suggested solutions above, ample theoretical and empirical evidence points to the Poisson Pseudo Maximum Likelihood (PPML) as the best solution for modeling zero trade flows. As proposed by Santos Silva and Tenreyro (2006) and extended in Silva and Tenreyro (2011), involves the estimation of the gravity model in a multiplicative form rather than the usual logarithmic form. In addition to being superior to other known methods, the PPML estimator also deals with the problem of heteroscedasticity as discussed in the next section.

### ***3.1.2.2. Heteroscedasticity***

According to Santos Silva and Tenreyro (2006), heteroscedasticity (owing to Jensen's inequality) causes the estimates of the effects of trade costs and trade policy to be biased and inconsistent when the log-linear form is used in the estimation. Anderson and Van Wincoop (2003)

suggested an approach that transforms the dependent variable into size-adjusted trade. However, this method corrects only the country-size induced heteroscedasticity and no other forms of heteroscedasticity (Yotov et al., 2016). Furthermore, this approach also does not eliminate the problem of zero trade flows. Hence, a more comprehensive approach to account for heteroscedasticity, as proposed by Santos Silva and Tenreyro (2006), is to apply the PPML estimator.

### 3.1.3. Empirical Specifications

The following benchmark structural gravity equation is used to examine the effect of trade-war on the agricultural sector. The log-linearized form of the gravity model can be specified as follows:

$$X_{ij,t} = \beta_0 + \beta_1 \ln Y_i + \beta_2 \ln Y_j + \beta_4 Z_{ij} + \epsilon_{ij} \quad (3.10)$$

where  $X_{ij}$  is the natural logarithm of value of goods imported by country  $j$  from country  $i$ ,  $Y_i$  is the GDP of country  $i$ , and  $Y_j$  is the GDP of country  $j$ ,  $Z_{ij}$  is a vector of explanatory variables, and  $\epsilon_{ij}$  is an i.i.d. error term with mean zero and variance one. The standard gravity variables included in  $Z_{ij}$  are distance between trading country-pair, border dummy, colonial tie, common language.

In order to capture the effect of the trade war tariffs on agricultural trade, a reduced-form of the gravity model is specified as follows:

$$\ln X_{ijgt} = \alpha_i + \alpha_j + \beta_1 \tau_{jigt} + \gamma Z_{ijt} + \epsilon_{ijgt} \quad (3.11)$$

Where  $\ln X_{ijgt}$  represents the log of exports of product  $g$  from country  $i$  to country  $j$  at time  $t$ .  $\gamma Z_{ijt}$  defines a set of explanatory variables that will be included in the estimation whiles  $\beta_1 \tau_{jigt}$  represent our main variable of interest. This variable measures the tariffs imposed on product  $g$  exported from country  $j$  into country  $i$ . Thus, equation (3.11) can be re-written as follows:



$$\begin{aligned}
\ln X_{ijgt} = & \alpha_i + \alpha_j + \beta_1 \text{appliedtariff}_{jigt} + \beta_2 \ln Y_i + \beta_3 \ln Y_j + \beta_4 \ln \text{Dist}_{ij} \\
& + \beta_5 \text{ComLang}_{ij} + \beta_6 \text{Conti}_{ij} + \beta_7 \text{Colony}_{ij} + \beta_{10} \text{RTA}_{ij,t} \quad (3.12) \\
& + \beta_{11} \text{Wto}_{imp_{i,t}} + \beta_{12} \text{Wto}_{exp_{j,t}} + \beta_{11} \text{Wto}_{both_{ij,t}} + \epsilon_{ijg,t}
\end{aligned}$$

Where in equation (3.12) *appliedtariff<sub>jigt</sub>* is our main variable of interest. This captures the tariff impact on trade. When interacted with appropriate time indicator to select trade war period, the interaction effect would provide global impact of the trade war on the agricultural sector. Similarly, a country and product specific binary variable is incorporated to select competing suppliers. Its interaction with the tariff variable would provide how the trade war would affect competing suppliers' exports.

*lnDist<sub>ij</sub>* is the log of the geographical distance between an importer and exporter, *Conti<sub>ij</sub>* is a dummy variable which indicates the whether the exporter and importer share borders, *Colony<sub>ij</sub>* is also a dummy variable and takes on the value of 1 if there exist a colonial relationship between the exporter and the importer.

*PTA<sub>ij,t</sub>*, *RTA<sub>ij,t</sub>*,  $\beta_{11} \text{Wto}_{imp_{i,t}}$  and  $\beta_{12} \text{Wto}_{exp_{j,t}}$  represent the trade policy variables in the model. *PTA<sub>ij,t</sub>* is a dummy variable which indicates whether the exporter and importer are in a Preferential Trade Agreement whiles *RTA<sub>ij,t</sub>* indicates whether the importer and exporter are in a Regional Trade Agreement at a particular time. Similarly,  $\beta_{11} \text{Wto}_{imp_{i,t}}$  and  $\beta_{12} \text{Wto}_{exp_{j,t}}$  are also dummy variables indicating whether either the importer or exporter is a member of WTO at a particular time.

Taking into consideration the presence of zero trade flows, the heteroscedasticity concerns and the endogeneity issues, the benchmark equation (3.12) can be re-written in its multiplicative form as follows:

$$\begin{aligned}
X_{ijgt} = \exp & \left[ \alpha_i + \alpha_j + \beta_1 \text{appliedtariff}_{jigt} + \beta_2 \ln Y_{it} + \beta_3 \ln Y_{jt} \right. \\
& + \beta_4 \ln \text{Dist}_{ij} + \beta_5 \text{ComLang}_{ij} + \beta_6 \text{Conti}_{ij} + \beta_7 \text{Colony}_{ij} \\
& + \beta_8 \text{RTA}_{ij,t} + \beta_9 \text{Wto}_{imp_{i,t}} + \beta_{10} \text{Wto}_{exp_{j,t}} \\
& \left. + \beta_{11} \text{Wto}_{both_{ijt}} \right] + \epsilon_{ijg,t}
\end{aligned} \tag{3.13}$$

### 3.2. Data

The trade data used for this analysis was obtained from the UN COMTRADE database. This database provides monthly data on import and export trade values and quantities for all countries at the HS6-digit level. The data sample covered the period between January 2013 to December 2019. However, this was an unbalanced panel dataset and contained monthly data for China between 201601 to 201712 only. To have monthly data for China for the missing years, the monthly trade values percentage of the total annual trade values in 2016 and 2017 is calculated. The steps below outline the process followed in constructing China's monthly trade flows between January 2018 to December 2019.

#### Step 1

First, the monthly trade flows data between 201601 and 201712 for China's import and export values was downloaded for all products at HS 6-digit level for all its trading partners. Then, all values were summed up across the 12-months for each year to obtain the annual 2016 and 2017 values and quantities. In the next step, the proportion of each months' trade flows in yearly values is calculated. Mathematically,

$$2016 \text{ January proportion} = \frac{2016 \text{ January trade value}}{2016 \text{ annual trade value}}$$

This process is repeated for all the subsequent months to December 2017. Given there are 24-months between January 2016 and December 2017, the average of each two-pair of months is calculated as follows:

$$january\ proportion = \frac{2016\ january\ percentage + 2017\ january\ percentage}{2}$$

Finally, China's annual trade data for 2013, 2014, and 2015 from the UN COMTRADE database is used to calculate the monthly data for China as follows:

$$January\ 2013\ value = annual\ 2013 * january\ proportion$$

The number of observations that was generated using the method above is about 636,622 which represents about 2.6% of the total observations. When a country pair is in a trading relationship but yet due to the inability of one of the countries to report trade flows for a particular product at a specific time, this leads to false zeros in unidirectional trade flow data. Therefore, to solve this problem, the “mirrored” technique (importers’ reported import from a particular partner is used to fill in the missing exports of an exporter) was used to fill in the missing information. Using import values and export values provided an important validation in this respect.

### **3.2.2. Agricultural Products**

In this analysis, the United States Department of Agriculture’s (USDA) definition of agricultural products rather than WTO’s definition of agricultural products was followed. All chapters between 01 and 24 of the Harmonized System (HS) is considered as agricultural products by this definition. One key difference between the WTO and USDA definition is that WTO does not include chapter 03 (ornamental fish, fresh or chilled fish, Frozen fish, fish fillets and other fish meat, dried or salted fish, crustaceans and Molluscs) as an agricultural product. Chapter three is included in the analysis but exclude 2208 and 2403 headings consisting of Ethyl alcohol, manufactured tobacco and manufactured tobacco substitutes from chapter 22 and chapter 24,

respectively. Furthermore, other relevant agricultural products such as essential oils (heading 3301) in chapter 33, natural rubbers (heading 4001) in chapter 40, raw hides (headings 4101, 4102, 4103, and 4104) in chapter 41, wool (headings 5101, 5102, 5103 and 5104) in chapter 51 and raw cotton (headings 5201 and 5202) chapter 52 were also included.

### **3.2.1. Tariff Data**

The tariff data for this analysis was compiled and constructed using different sources of data. In a given year, little to no changes in tariff data is anticipated before the trade dispute. In this regard, annual tariff data for 2013 to 2017 from the World Integrated Trade Solutions (WITS) is used. I use the effectively applied rates for each country pair.

Following the beginning of the trade war in 2018, monthly data for each country pair is constructed to reflect the various changes due to the tariff increases by the U.S. and other countries that retaliated. The monthly panel dataset on the trade war tariff increase was constructed by compiling data from official documents published by the office of the United States Trade Representative (USTR) and official websites of retaliating countries (Canada, China, EU, Mexico, India, and Turkey). Between 2017 and 2019, there were six waves of tariff increases and six retaliatory tariffs between the US and China only. These tariff increases are computed by summing the raw, effectively applied data from WITS and the announced tariff change for each country pair at the HS 6-digit level.

The tariff increases by the US and the retaliatory partners were mostly ad valorem tariffs and went into effect either at the beginning, middle, or ending of the months they were announced. Thus, tariffs increase which went into effect in the middle or end of the month were scaled to reflect the number of days the tariffs were in effect in a particular month. For example, the US tariff increase implemented in the second wave went into effect on the 23<sup>rd</sup> of August, 2018. Thus,

the number of days the tariff was in effect in August is eight days; hence the tariff is scaled by  $8/31$  multiplied by the tariff increase.

Other explanatory variables data are obtained from standard data sources. The data for gravity-model variables such as common official language, contiguity, colonial relationship, and distance are obtained from the Centre d'Etudes Prospective et d'Informations Internationales (CEPII) gravity database (Head, Mayer, & Ries, 2010; Head and Mayer, 2014). Data on GDP were obtained from World Bank's Development Indicators database (World Bank, 2019).

## **CHAPTER FOUR. RESULTS AND DISCUSSION**

This chapter presents and discusses the empirical results of the study. The chapter begins with descriptive statistics of the dependent variables and some key explanatory variables used in the empirical estimations. Secondly, results on impact of the trade dispute on the agricultural trade is presented. Finally, the chapter concludes with discussion on the results on the effect of the trade war tariffs and retaliatory tariffs on U.S and China's competing suppliers.

### **4.1. Descriptive Statistics**

Table 4.1 presents U.S Agricultural exports between 2013 to 2019. Panel A of table 4.1 summarizes U.S Agricultural exports to Retaliatory countries, while panel B describes U.S Agricultural exports to Non-Retaliatory countries. The average annual value of U.S Agricultural and food exports to retaliatory countries (table 4.1 panel A) before the trade war was USD 82.44 billion between 2013 to 2017. During the trade war between 2018 to 2019, the average value of U.S agricultural and food exports decreased to about USD 73.06 billion. In contrast, U.S agricultural and food exports to non-retaliatory countries increased during the trade war. The average value of U.S agricultural and food exports increased from USD 67.88 billion between 2013-2017 to about USD 76.39 billion between 2018-2019

Table 4.1. U.S. Agricultural Exports to Retaliatory and Non-retaliatory Countries

	<b>A: US Agricultural Exports to Retaliatory Countries</b>							<b>B: U.S Agricultural Exports to Non-Retaliatory Countries</b>						
	2013	2014	2015	2016	2017	2018	2019	2013	2014	2015	2016	2017	2018	2019
Jan	8.07	8.72	7.65	6.40	7.14	6.57	5.87	5.59	6.19	5.28	4.41	5.64	5.59	6.23
Feb	7.44	7.97	6.47	6.45	6.28	6.33	5.77	5.75	5.91	5.82	5.05	5.87	6.11	5.94
Mar	6.43	7.29	6.67	6.03	6.55	6.62	6.07	6.13	7.32	6.46	5.33	6.97	7.41	7.10
Apr	5.80	6.16	5.89	5.35	5.79	6.03	5.63	5.47	6.79	5.85	5.07	5.95	6.98	6.50
May	5.57	6.29	5.81	5.39	5.73	6.13	5.90	5.40	6.31	5.50	5.02	5.71	6.94	6.21
Jun	5.35	5.86	5.46	5.36	5.60	5.88	5.77	5.00	5.83	5.10	5.33	5.50	6.68	5.78
Jul	5.85	5.85	5.71	5.90	5.88	5.46	6.12	5.04	5.53	4.93	5.65	5.49	6.71	5.55
Aug	5.89	5.76	5.42	6.53	6.02	5.83	6.59	5.33	5.51	5.16	5.74	5.38	6.40	5.84
Sep	6.49	6.18	5.89	6.24	6.46	5.36	5.71	5.26	5.30	4.86	5.84	5.21	6.07	5.61
Oct	9.88	9.39	8.73	9.32	8.57	6.21	6.77	6.07	6.08	4.76	5.87	5.67	6.95	6.32
Nov	10.20	9.68	8.19	8.91	8.27	5.99	7.34	6.35	6.09	5.09	6.20	6.18	7.10	6.17
Dec	9.04	8.56	7.07	7.93	7.40	5.62	6.55	6.10	6.16	4.94	5.81	6.26	6.49	6.11

Further disintegration of U.S exports by destination countries reveals that Agricultural exports to China alone decreased by approximately \$10 billion between 2018 and 2019 (Figure 4.1). This is not surprising given that China’s retaliatory tariffs targeted almost all U.S Agricultural products. U.S Agricultural exports to other countries such as Dominican Republic, Mexico, Russia and Brazil also experienced average annual decline between 2018 and 2019. During the same period, U.S agricultural exports to countries such as South Korea (\$3.62 billion), Colombia (\$1.15 billion), Pakistan (\$0.72 billion), Philippines (\$0.69 billion), Argentina (\$0.40 billion), Morocco (\$0.30 billion), Germany (\$0.26 billion), Spain (\$0.17 billion), and Israel (\$0.14 billion) increased.

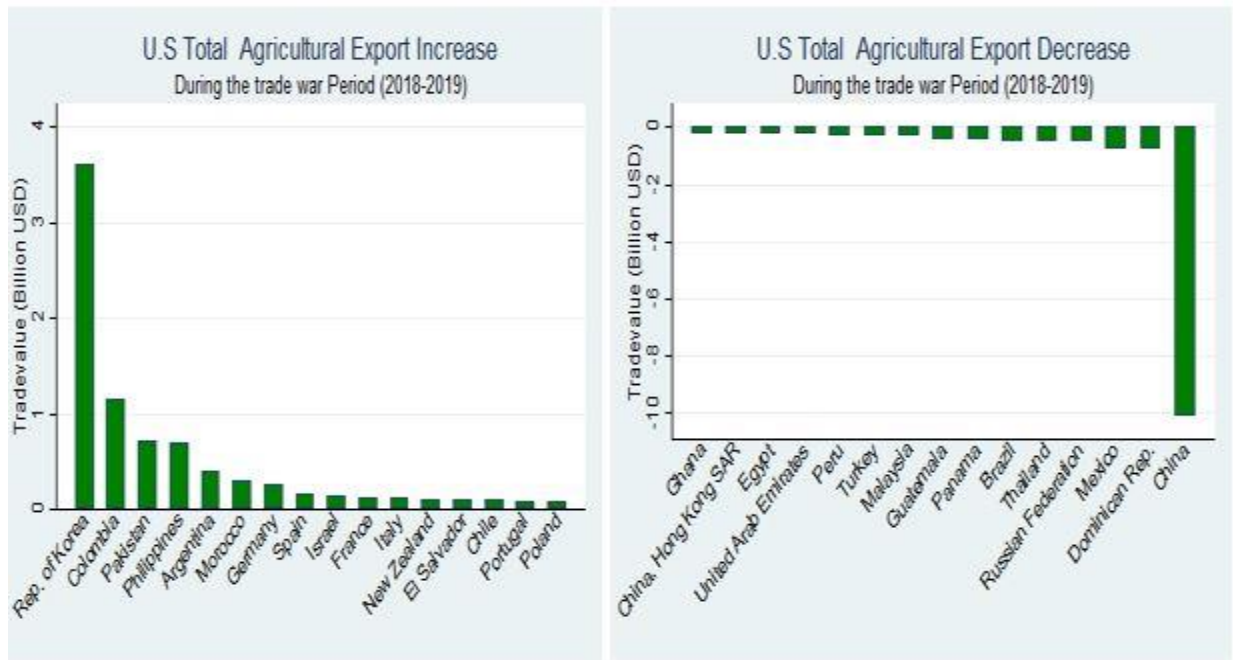


Figure 4.1. U.S. Agricultural Export Increase and Decrease During the Trade War

Figure 4.2 shows how China’s Agricultural exports were impacted during the trade war period between 2018 and 2019. China’s agricultural exports to Malaysia, Thailand, Russia, Brazil and the U.S. declined during the trade war period. China’s Agricultural exports to the U.S. declined by about \$0.29 billion. This might pale in comparison to the export loss faced by the U.S in Chinese



markets but is less surprising given that initial tariffs imposed by the U.S. were more diversified, covering products from different sectors of the Chinese economy.

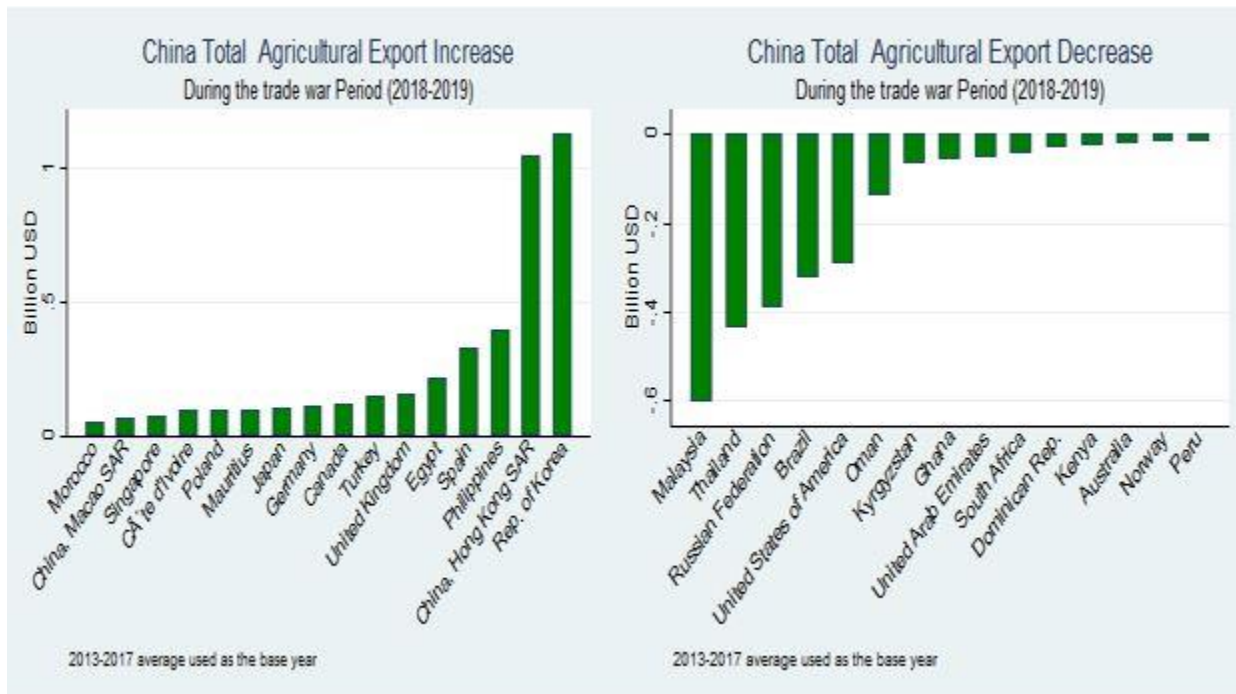


Figure 4.2. China Agricultural Export Increase and Decrease During the Trade War

#### 4.1.1. Export Shares

Growth in export market shares is an important measure of a country’s competitiveness in the international market. Table 4.2. and Table 4.3. show the descriptive statistics on the change in U.S and China’s top trading partners’ export shares before and during the 2018-2019 trade war. Between 2013-2017, that is before the trade war began, China’s average share of the U.S agricultural import market was about 20.12%, while that of Canada, Mexico, EU, and Japan was about 16.96%, 11.02%, 10.72%, and 11.69% respectively (Table 4.2). During the trade war period, the EU and China’s share of the U.S agricultural import market declined by about 0.51% and 6.6%, respectively. On the other hand, Canada gained about 2.18% to gain the position of the highest exporter to the U.S. Table 4.3 shows that the U.S average share of China’s agricultural import market experienced a small negative growth, decreasing from an average of 14.88% to 14.29%.

Other top trading partners such as Hon Kong, Japan, and South Korea experienced positive growths in their market shares in China's agricultural import market.

Table 4.2. Change in U.S Agricultural Market Share of its Top Trading Partners

	Canada	China	EU	Japan	Mexico
2013	16.03%	19.53%	10.25%	11.61%	14.51%
2014	17.16%	22.09%	11.24%	12.86%	10.27%
2015	18.81%	20.12%	11.33%	11.89%	9.37%
2016	16.67%	20.37%	11.24%	11.03%	10.81%
2017	16.15%	18.51%	9.56%	11.04%	10.12%
<i>Average</i>	<b>16.96%</b>	<b>20.12%</b>	<b>10.72%</b>	<b>11.69%</b>	<b>11.02%</b>
2018	17.50%	13.30%	10.13%	12.66%	10.97%
2019	20.79%	13.75%	10.30%	13.88%	12.72%
<i>Average</i>	<b>19.14%</b>	<b>13.52%</b>	<b>10.22%</b>	<b>13.27%</b>	<b>11.85%</b>
%Δ	2.18%	-6.60%	-0.51%	1.59%	0.83%

Table 4.3. Change in China's Agricultural Market Share of its Top Trading Partners

	Hong Kong SAR	EU	Japan	South Korea	U.S.
2013	9.92%	16.64%	20.07%	7.71%	14.96%
2014	12.12%	18.36%	20.88%	7.54%	15.72%
2015	13.73%	16.24%	18.28%	7.28%	14.91%
2016	13.12%	16.32%	17.86%	7.63%	14.52%
2017	12.52%	15.46%	17.07%	7.02%	14.27%
<i>Average</i>	<b>12.28%</b>	<b>16.60%</b>	<b>18.83%</b>	<b>7.43%</b>	<b>14.88%</b>
2018	13.22%	14.82%	17.69%	7.72%	15.27%
2019	16.19%	16.42%	21.10%	9.24%	13.31%
<i>Average</i>	<b>14.71%</b>	<b>15.62%</b>	<b>19.40%</b>	<b>8.48%</b>	<b>14.29%</b>
%Δ	2.42%	-0.98%	0.56%	1.05%	-0.59%

## **4.2. Econometric Results and Discussion**

The econometric results are organized into two broad sections. The first section presents and discuss results from econometric models which evaluates the impact of the trade dispute on the agricultural trade. The second section presents and discuss the results from the econometric models which examined the impact of the trade war tariffs on U.S and China's competing suppliers.

### **4.2.1. Evaluating the Impact of Tariffs on Agricultural Trade Flows**

Table 4.4 shows the tariff effect on agricultural trade flows. The FE-OLS estimates are presented in column 1. This estimate is generated using the command “`reghdfe`” in Stata by Correia (2014, 2016). The command estimates linear regression models with High Dimensional Fixed Effects (HDFE). The model is in the log-log form with standard gravity variables such as a log of bilateral distance, log of Gross Domestic Product (GDP) of importer and exporter, and other indicator variables such as official common language, contiguity, and Colonial relationship. In addition, policy variables such as membership in the common Regional Trade Agreement (RTA), exporter or importer as member of World Trade Organization (WTO), and both exporter and importer as WTO members are also included. More importantly, the model also contains  $\ln(1+\text{tariff})$ , which is the main variable of interest in the model.

The rest of the models in column 2 to column 4 were estimated in their multiplicative form. These models were estimated using the Stata command “`ppmlhdfe`” (Correia et al., 2018a; Correia et al., 2018b). In column 2, importer, exporter, product, and time fixed effects are included to absorb the unobserved variations along these dimensions. Columns 3 and 4 present country-specific results for the U.S and China's agricultural exports, respectively.

Table 4.4. Tariff Impact on Agricultural Trade

Variables	(1) FE-OLS (Full Sample)	(2) PPML (Full sample)	(3) PPML (U.S)	(4) PPML (China)
ln(1+tariff <sub>ijgt</sub> )	-0.843 *** (0.007)	-0.5921 *** (0.025)	-0.601 *** (0.0547)	-0.404 *** (0.0458)
Indistw <sub>ij</sub>	-0.380 *** (0.0009)	-0.241 *** (0.0026)		
lnGDP <sub>it</sub>	0.107 *** (.0077)	0.0615 (0.0538)	-0.117 (0.2154)	0.293 *** (0.0563)
lnGDP <sub>it</sub>	0.291 *** (0.0004)	0.05352 *** (0.0645)		
Colony	0.202 *** (0.0024)	0.1335 *** (0.0069)		
Comlang_off	0.0874 *** (0.002)	0.0273 *** (0.0069)		
Contiguity	0.480 *** (0.002)	0.4743 *** (0.0057)		
Common RTA	0.214 *** (0.0017)	0.2475 *** (0.0053)		
Exporter in WTO	-0.751 *** (0.0318)	-0.3086 *** (0.0787)		
Importer in WTO	-0.712 *** (0.021)	-0.4607 *** (0.0961)	-0.104 (0.215)	-0.095 (0.0953)
Both in WTO	0.661 *** (0.0182)	0.2476 *** (0.0765)		
_Cons	4.910 *** (0.209)	-10.211 *** (1.237)	4.671 (4.628)	-5.666 *** (1.2134)
Observations	22,257,391	22,731,209	1,095,182	866,566
R <sup>2</sup> /Pseudo R <sup>2</sup>	0.28	0.38	0.64	0.48
Exporter FE	Yes	Yes	No	No
Importer FE	Yes	Yes	Yes	Yes
Product FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Importer-Exporter- Product FE	No	No	No	No
Importer-Product- time FE	No	No	No	No
Exporter-Product- time FE	No	No	No	No

Notes: \*\*\*, \*\*, \* denote 1%, 5% and 10% significance levels, respectively  
 Robust standard errors are reported in parenthesis

The coefficient on the main variable of interest  $\ln(1+\text{tariff}_{ijgt})$  has the expected negative sign in all the models consistent with empirical trade literature. The negative sign indicates that all other variables held constant, an increase in tariff between any two bilateral trading partners reduced bilateral trade between those two countries. The coefficients are statistically significant at a 1% level for all the models. In column 1, the FE-OLS estimate shows that a one percent increase in tariffs causes approximately a 0.84 percent decrease in bilateral trade on average. The estimate in column 2 indicates that when tariffs increase by 1%, on average, global agricultural trade decreases by about 0.59%, all other variables being constant.

In column 3, the estimate shows the impact of a tariff increase on U.S agricultural exports. The result indicates that a 10% increase in tariff leads to about 6% reduction in U.S agricultural exports to all trading partners. In the case of China's agricultural exports in column 4, a 10% increase in the tariff it faces decreases the exports by about 4%.

Columns 1 and 2 include the gravity variable bilateral distance. Bilateral distance is directly proportional to trade cost or transportation cost and has proven to be a significant barrier to trade between bilateral pairs. In addition, the distance is even more important in the agricultural sector given the perishability of agricultural goods. In column 1, the result indicates a 1% increase in bilateral distance between trading partners cause about a 0.38% reduction in trade. Similarly, in column 2, the result shows a 1% increase in the bilateral distance reduces trade by approximately 0.24%. The coefficients in both models were statistically significant at the 1% level.

The coefficients on the importer's GDP are positive and statistically significant in columns 1 and 4. It implies that as the GDP of an importer increase, it can import more from other partners. In column 1, the results suggest a one percent increase in importer's GDP lead to about 0.11% increase in trade. In column 4, the result implies that given a one percent increase in the GDP of

an importer of China's products, trade in agricultural goods between that importer and China is expected to increase by about 0.29 percent. Similarly, the coefficients on the exporter's GDP are both statistically significant and positive in columns 1 and 2. In column 1, a one percent increase in exporter's GDP leads to about 0.29 percent increase in trade, while column 2 suggests that a one percent increase will lead to about 0.54% increase in trade. GDP of importer turns out to be statistically not significant in columns 2 and 3 with this slice of data, which contrasts with most gravity equation applications.

The coefficients on other standard gravity variables such as colonial ties, common official language, and contiguity are positive and statistically significant in column 1 and column 2. In column 1, the model predicts that the average trade between any country-pair with past colonial ties leads to about  $22.38 \{ [e^{(0.202)} - 1] * 100 \}$  percent more in trade compared with country-pair without past colonial ties. Similarly, column 2 suggest that on average, trade between any country-pair with historical colonial ties leads to about  $14.34 \{ [e^{(0.134)} - 1] * 100 \}$  % more in trade than the country-pair without colonial ties. Both results are statistically significant at the 1% level. In the case of the common official language, the coefficient in column 1 predicts that on average, when two bilateral trade partners share the same official language, they trade about  $9.09 \{ [e^{(0.087)} - 1] * 100 \}$  percent more compared with a country pair who does not share the common official language. Again, column 2 shows a similar result, predicting that trade between two bilateral trade partners sharing same official language is about  $2.74 \{ [e^{(0.027)} - 1] * 100 \}$  percent more than a country pair who does not share the common official language. Results from both column1 and column 2 show that the existence of a contiguous border between any two trading partners promotes trade. The result indicates that on the average, trade flow between any two trading partners with contiguous border is about  $61.61 \{ [e^{(0.480)} - 1] * 100 \}$  percent higher than

trade flows of any country-pair without contiguous border (column 1). In column 2, the coefficient indicates that, on average, trade flow between any two trading partners with a contiguous border is about 60.64  $\{[e^{(0.474)} - 1] * 100\}$  percent higher than trade flows of any country-pair without a contiguous border.

The coefficients on RTA in columns 1 and 2 show a positive correlation between RTA and trade flows. Bilateral trading partners belonging to a common RTA, on average, are estimated to trade about 23.86  $\{[e^{(0.214)} - 1] * 100\}$  percent more than bilateral trading partners who does not belong to any RTA in model 1, while model 3 predicts about 28.02  $\{[e^{(0.247)} - 1] * 100\}$  percent more. Both results in model 1 and model 3 are statistically significant at the 1% level. These results are similar to other results such as Tinbergen (1962), Brada and Mendez (1985), Grant and Lambert (2008), and Sharma et al. (2019).

The coefficients on WTO membership in columns 1 and 2 take a negative sign when only the exporter or only importer of a bilateral trading pair is a WTO member. However, when both the exporter and the importer are in WTO, there is a positive sign on the coefficients. That is, when both trading partners are members of the WTO, there is an increase in trade flow between them, holding all other variables constant. On average, these partners trade about 93.67  $\{[e^{(0.661)} - 1] * 100\}$  percent more than bilateral partners who are not members of the WTO (column 1). The model predicts a lower impact of about 27.89  $\{[e^{(0.661)} - 1] * 100\}$  with the PPML estimator in column 2.

#### **4.2.2. The Global Impact of the Trade Dispute on the Agricultural Sector**

The estimation in table 4.5. includes  $\ln(1+\text{tariff}_{ijgt})$  and its interaction term with an indicator variable *tradewardummy*. This time dummy takes a value of 1 for the period between January 2018 to December 2019. Column 1 includes a full sample in the analysis, while column 2 and column 3

are sub-sample analyses for U.S and China, respectively. All three columns include theoretically consistent panel indicators importer-product, importer-time, and product-time dummies to control factors that vary along country-pair-product dimensions and country-time and product dimensions. For example, there was bumper production in the U.S. during the trade-war period because of the good weather conditions. There was also a swine fever outbreak in China, affecting hog production. Although these panel fixed effects cannot separately measure the impact of such country-time-product-specific factors, they control for them.

The coefficients on  $\ln(1+\text{tariff}_{ijgt})$  have the expected negative sign in all the models. Also, all the coefficients are statistically significant at the 1% significance level. In column 1 the coefficient on  $\ln(1+\text{tariff}_{ijgt})$  implies that, on the average, a 1% increase in tariff would decrease the global agricultural trade by about 0.49 percent if there were no trade war. The sub-sample analysis in Columns 2 and 3 indicate that, on average, a 1% increase in tariff would decrease U.S. agricultural exports by about 0.23%. and China's agricultural exports by about 0.06% if there were no trade war.

The coefficient on interaction term provides interesting results on the effect of the trade war. In column 1, the interaction term takes a positive sign and is statistically significant, suggesting that, on average, global agricultural trade increased during the trade war. However, the coefficients in columns 2 and 3 have negative signs. In column 2, on average, a 1% increase in retaliatory tariff decreased the U.S agricultural exports during the trade war period by about 8.6% compared to the periods preceding the trade war. In the case of China in column 3, a 1% increase in tariff decreased China's agricultural exports by 16.9% percent during the trade war than before the trade war. The result on the impact of retaliatory tariffs on U.S agricultural exports is comparable with the estimates of Fajgelbaum et al. (2020). Fajgelbaum et al. (2020) find that



retaliatory tariffs caused a 9.9% decline in total U.S exports. In addition, the results show China also experienced a negative impact on its agricultural trade, which is higher than the U.S. Despite the negative implications for both the U.S and China's agricultural trade, global agricultural trade increased during the trade war.

To test for the presence of anticipatory and delayed trade effects of tariffs and retaliatory tariff increase, up to three lags and six leads of the tariff variable are allowed in the model. The results are presented in the appendix table A3. The regression includes country pair-product specific fixed effects and robust standard errors are reported. The coefficient on all the lag and lead terms are statistically insignificant. This means that there is no evidence of anticipatory or delayed effects of the trade war tariffs on agricultural exports.

Table 4.5. Impact of the Trade War Tariffs on Agricultural Exports

Variables	(1) (Full sample)	(2) (U.S)	(3) (China)
$\ln(1+\text{tariff}_{ijgt})$	-0.491 *** (0.0245)	-0.228*** (0.0449)	-0.060*** (0.0312)
$\ln(\text{tariff}+1)*\text{tradewarperiod}$	0.324*** (0.0712)	-0.086* (0.0462)	-0.169*** (0.468)
_Cons	0.5538*** (0.0030)	2.893*** (0.0043)	1.164 (0.0023)
Observations	24757076	1133656	869196
Pseudo R <sup>2</sup>	0.46	0.87	0.72
Importer-Product FE	Yes	Yes	Yes
Importer-time FE	Yes	Yes	Yes
Product-time FE	Yes	Yes	Yes

Notes: \*\*\*, \*\*, \* denote 1%, 5% and 10% significance levels, respectively  
Robust standard errors are reported in parenthesis

### **4.2.3. Evaluating the Tariff Effect During the Trade War While Considering the Competing Suppliers' Effect**

The econometric results examining the impact of the trade war by considering the U.S. competing suppliers and China's competing suppliers are presented in table 4.6. The binary variable *Competingsuppliers\_US* captures all other exporters, excluding China, that trade with the U.S in a particular commodity in a given year and month during the trade war period. Similarly, *Competingsuppliers\_China* is assigned 1 for all exporters to China, except the U.S. Note that these two dummy variables capture the non-tariff effect of the trade war. On the other hand, the interaction terms provide the tariff effect of the trade war for the competing suppliers. The binary variable and the interaction term combinedly capture the competing suppliers' effect of the trade war. Therefore, our main variables of interest are the interaction terms in each column. Columns 1 and 2 contain exporter-product, importer-product, and time fixed effects (FE), and columns 3 and 4 include exporter-time, importer-time, and product fixed effects. Separate Time FE and product FE are intended to control unobserved global macroeconomic trends and product-specific variations.

Table 4.6. Effect of Trade War Tariffs on U.S and China’s Competing Suppliers

Variables	(1) (trade)	(2) (trade)	(3) (trade)	(4) (trade)
ln(1+tariff <sub>ijgt</sub> )	-1.416 ***	-1.390***	-1.342 ***	-1.279***
Competingsuppliers_US	(0.0323) -0.058***	(0.0319)	(0.0320) -0.223*	(0.0317)
ln(tariff+1) * compsuppliers_US	(0.0117) 1.248***		(0.1294) 1.821***	
Competingsuppliers_China	(0.0786)	-0.062***	(0.0728)	-0.052
ln(tariff + 1) * compsuppliers_China		(0.0102) 0.955***		(0.0409) 1.459***
_Cons	(0.0829) 1.237***	(0.0023) 1.236***	(0.0044) 0.268***	(0.0035) 0.262***
Observations	24755005	24755005	24783676	24783676
Pseudo R <sup>2</sup>	0.64	0.64	0.36	0.36
Exporter-Product FE	Yes	Yes	No	No
Importer-Product FE	Yes	Yes	No	No
Time FE	Yes	Yes	No	No
Exporter-Time FE	No	No	Yes	Yes
Importer-Time FE	No	No	Yes	Yes
Product FE	No	NO	Yes	Yes

Notes: \*\*\*, \*\*, \* denote 1%, 5% and 10% significance levels, respectively  
 Robust standard errors are reported in parenthesis

The coefficient on the interaction term indicates that an increase in china’s retaliatory tariff by 1% increased its’ competing suppliers’ exports to the United States by about 1.25%. A similar effect is found in column 3 when controlled for unobserved country-time specific and product factors rather than country-product specific and time factors as in column 1. The result shows that when china’s retaliatory tariff increased by 1%, its competing suppliers’ exports to the united states increased by about 1.82%. In column 2, the coefficient on the interaction term indicates that an increase in the U.S. tariff by 1% increased U.S. competing suppliers’ exports to China by about 0.95%. Changing the set of panel fixed effects does not change the result much. For example, with the inclusion of unobserved country-time specific and product factors instead of country-product specific and time factors in column 2, the result shows that when the U.S. tariff increased by 1%,

its competing suppliers' exports to China increased 1.46%. Though other factors such as good weather conditions in the U.S and bad weather conditions in other countries might have affected trade and production, the extent of this kind of impact remain poorly understood. Thus, panel fixed effects were used to control for these impacts.

In columns 1 and 3, the coefficients on *Competingsuppliers\_US* are negative and statistically significant, indicating that the trade war has affected China's competing suppliers' exports to the United States through non-tariff measures as well. For example, the coefficient in column 1 shows that, on average, China's competing suppliers exported 5.63  $\{[e^{(-0.058)} - 1] * 100\}$  percent less in agricultural products to the United States during the trade war period between January 2018 to December 2019 ceteris paribus. The magnitude of this effect is higher in column 3, where competing suppliers exported about 19.98  $\{[e^{(-0.223)} - 1] * 100\}$  percent less to the U.S. compared to China. This indicates that country-product level differences might be more important than the product level differences alone. Thus, specification 1 is more preferred in this case.

The coefficient on *Competingsuppliers\_China* in column 2 suggests that, on average, U.S competing suppliers' exports to China is about 6  $\{[e^{(-0.062)} - 1] * 100\}$  percent less in agricultural products compared to the U.S. during the trade war period, ceteris paribus. With a different set of panel-FEs in column 4, there is a slight variation in the magnitude of the effect: U.S. competing suppliers' exports to China is 5.1 percent lesser compared to the U.S exports. Note that this dummy variable captures the non-tariff effect of the trade war. In contrast to the tariff effect, the non-tariff measures have negatively affected the U.S. competing suppliers' exports to China.

## CHAPTER FIVE. SUMMARY AND CONCLUSIONS

This chapter presents a summary of the findings of the study. The chapter also includes conclusions and policy implications of the trade war based on the results from the study.

The thesis examined the impact of the U.S-China trade war on the global, U.S, and China's agricultural exports while considering the competing suppliers' effect using a highly disaggregated HS 6-digit trade flow data in the structural gravity model.

The study used a monthly agricultural trade data obtained from the UN COMTRADE database. The tariff data was compiled and constructed with data from WITS and other official government websites. The trade and tariff data were matched with data on GDP and other standard gravity variables from CEPII. The sample covered a period between January, 2013 to December, 2019 and included about 24,784,218 observations.

In estimating the gravity models, fixed effect Ordinary Least Square (OLS) and Poisson Pseudo-Maximum Likelihood (PPML) were used. These two methods allowed the inclusion of multi-dimensional fixed effects into the models.

Descriptive statistics showed that U.S average Agricultural exports to retaliatory countries decreased from about \$82.44 billion between 2013 to 2017 to about \$73.06 billion between 2018 to 2019. In contrast, U.S agricultural and food exports to non-retaliatory countries increased during the trade war. The average value of U.S agricultural and food exports increased from \$67.88 billion between 2013-2017 to about \$76.39 billion between 2018-2019. During the trade war period, the EU and China's share of the U.S agricultural import market declined by about 0.51% and 6.6%, respectively.

In our econometric results, the coefficient on the primary variable of interest  $\ln(1+\text{tariff}_{ijgt})$ , has the expected negative sign in all the models consistent with empirical trade literature. The

negative sign indicates that all other variables being constant, an increase in tariff between any two bilateral trading partners reduced trade between those two countries. In assessing the effect of the trade war on trade, the study exploited the interaction between tariff and a dummy variable that captured trade war period. The coefficient on interaction term provides interesting results on the effect of the trade war on global, U.S., and China's agricultural trade. The result suggests that, on average, global agricultural trade increased during the trade war. However, a 1% increase in retaliatory tariffs decreased the U.S agricultural exports during the trade war period by about 8.6 percent compared to the periods preceding the trade war. In the case of China, a 1% increase in U.S tariff decreased China's agricultural exports by 16.9% during the trade war than before the trade war.

The study concludes with evaluation of tariffs' impact on the U.S. and China's competing suppliers. In this section, a competing suppliers dummy-variables were created and embedded in the models. In addition, the dummy variables were interacted with tariff. The coefficient on U.S competing suppliers dummies indicates that on the average, China's competing suppliers exported 5.63-19 percent less in agricultural products to the United States during the trade war period between January 2018 to December 2019 *ceteris paribus*. The coefficient on China's competing suppliers' dummies suggest that on the average, U.S competing suppliers' exports to China is between 5.1-6 percent less in agricultural products compared to the U.S. during the trade war period, *ceteris paribus*. These results indicate that the trade war has affected the U.S. and China's competing suppliers' exports through non-tariff measures as well.

The interaction between tariff and competing suppliers dummy is used to assess tariff impact on U.S and China's competing suppliers. The interaction between tariff and competing suppliers dummy is used to assess tariff impact on U.S and China's competing suppliers. The

coefficient on the interaction terms in column 1 and column 3 indicate that an increase in china's retaliatory tariff by 1% increased its' competing suppliers' exports to the United States by about 1.25% and 1.82%. Similarly, the coefficients on the interaction terms in column 2 and column 3 indicate that an increase in the U.S. tariff by 1% increased U.S. competing suppliers' exports to China by about 0.95% and 1.46%.

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## APPENDIX

Table A1. Summary Statistics of Variables

Variable		Mean	Std. Dev.	Min	Max	Observations
<i>Tradeflow</i>	overall	339910.8	5404553	0	4.53E+09	N =24784218
	between		2119691	0	1.69E+09	n = 1396031 T-bar =
	within		3144310	-1.59E+09	2.84E+09	17.7533
<i>Tariff<sub>ij,t</sub></i>	overall	0.041756	0.249634	0	30	N =24784218
	between		0.232842	0	30	n = 1396031 T-bar =
	within		0.165226	-26.37205	28.90635	17.7533
<i>GDPPC_EXP</i>	overall	2.40E+09	4.45E+09	32673.28	2.14E+10	N =22865643
	between		4.14E+09	32673.28	2.14E+10	n = 1274073 T-bar =
	within		4.41E+08	-2.27E+09	7.04E+09	17.9469
<i>GDPPC_IMP</i>	overall	29.93296	20.49564	0.226	119.173	N =22865643
	between		21.30739	0.226	119.173	n = 1274073 T-bar =
	within		2.375058	3.132951	58.09491	17.9469
<i>RTA<sub>ij,t</sub></i>	overall	0.641999	0.479413	0	1	N =22975116
	between		0.492253	0	1	n = 1286952 T-bar =
	within		0.110788	0.3430756	1.627506	17.8523
<i>DIST<sub>ij</sub></i>	overall	4377.724	4351.89	1.880632	19888.66	N =23612173
	between		4442.579	1.880632	19888.66	n = 1314727 T-bar =
	within		0	4377.724	4377.724	17.959

Table A2. Profile of the Trade War Tariffs

<b>Retaliating Country</b>	<b>Approximate No. of HTS Codes Targeted</b>	<b>Retaliatory Tariff Range</b>	<b>Effective Date</b>	<b>Products Description</b>
China	90 510 360	15% or 25% 25% 5%, 10%, 15%, 25%	04/02/2018 06/06/2018 07/01/2018	All Agricultural products
Canada	24	10%	07/01/2018	Roasted coffee, prepared meats and poultry, sugar products, prepared fruits and vegetables, miscellaneous prepared foods, whiskey
Mexico	16	15% - 25%	06/05/2018	Pork, cheese, apples, prepared fruits and vegetables, whiskey
EU	40	25%	06/22/2018	Prepared vegetables and legumes, grains, fruit juice, peanut butter, whiskey
Turkey	40	20% - 140%	06/21/2018	Tree nuts, rice, miscellaneous prepared foods, whiskey, tobacco
India	7	10% - 25%		Legumes, tree nuts, apples

Source: U.S Congressional Research Service report, 2018.



Table A3. Anticipatory and Delayed Effects of Trade War Tariffs and Retaliatory Tariffs

<i>m_trade</i>	<i>Coef.</i>	<i>Robust Std. Err.</i>	<i>z.</i>	<i>P&gt;z</i>	<i>[95% Conf.</i>	<i>Interval]</i>
<i>ln(1+tariff)</i>	-0.228	0.079	-2.89	0.004	-0.383	-0.074
<i>lag_1</i>	0.023	0.092	0.25	0.8	-0.158	0.204
<i>lag_2</i>	-0.015	0.075	-0.21	0.837	-0.163	0.132
<i>lag_3</i>	-0.026	0.072	-0.37	0.715	-0.168	0.115
<i>lead_1</i>	-0.096	0.097	-0.99	0.321	-0.286	0.094
<i>lead_2</i>	-0.083	0.091	-0.92	0.358	-0.261	0.094
<i>lead_3</i>	0.022	0.064	0.35	0.728	-0.103	0.148
<i>lead_4</i>	-0.003	0.0904	-0.03	0.978	-0.180	0.175
<i>lead_5</i>	-0.015	0.069	-0.22	0.823	-0.150	0.119
<i>lead_6</i>	0.046	0.075	0.61	0.541	-0.102	0.194
<i>_cons</i>	15.572	0.0049	3153.62	0	15.563	15.582

Pseudo R<sup>2</sup> = 0.94      Observation = 6588778, log pseudolikelihood = -4.01867e+11  
 Note: PPMLHDFE regression with country-pair-product effect were included. The sample spans 2018m1 to 2019m12.