

The US-China trade war: The effects on the soybean industry

By

Xijian Hao

B.S., Kansas State University, 2017

A THESIS

submitted in partial fulfillment of the requirements for the degree

MASTER OF SCIENCE

Department of Agricultural Economics

College of Agriculture

Kansas State University

Manhattan, Kansas

2019

Approved by:
Major Professor
Tian Xia

Copyright

© Xijian Hao 2019

Abstract

The growing industry of soybean has been affected as never before due to the global economic slowdown, especially under the threat of the trade war between the U.S. and China that began in 2018. As the largest buyer of soybeans in the international market, China relies heavily on imports of foreign soybeans to meet the growing domestic production of meat and poultry. The U.S. is one of the world's largest soybean exporters, and China used to buy 60% of U.S. soybean exports, but now the number was dropped to 20-25%. This article will analyze the ongoing trade war between China and the U.S., as China already increased tariffs on U.S. soybean export, how it would affect the soybean industry. The regression analysis of supply and demand model was used to explain which factors affect the soybean supply and demand of the two countries.

Table of Contents

List of Figures.....	vi
List of Tables.....	vii
Acknowledgements.....	viii
1 Introduction.....	1
1.1 Background	1
1.2 Problem Statement.....	2
1.3 Objectives of study	3
2 Literature Review.....	4
2.1 Soybean Farming	4
2.2 Soybean Industry in China.....	4
2.3 Soybean Industry in USA	5
2.4 Historical Soybean Trade Between the USA and China	7
2.5 US-China Trade War	7
2.6 WTO Regulations on International Trade.....	8
2.6.1 Most Favored Nation (MFN) Treatment	
2.6.2 The Coffee Case; Spain and Brazil	
3 The Model.....	11
3.1 U.S. Soybean Production Model.....	13
3.2 China's Demand for U.S. Soybeans	15
3.3 U.S. Domestic Demand for Soybeans.....	16
4. Results.....	17
5. Conclusions.....	21
References.....	24

List of Figures

Figure 1 Demand of U.S. Soybean in China, and the Correlation with Importing Price.....	12
Figure 2 China’s Demand of U.S. Soybean	13
Figure 3. China’s Demand of U.S. Soybeans from Jan. 2016 to Sep. 2019.....	21
Figure 4. Demand for U.S. soybeans in China (1000 metric tons) and pork production in China (million heads) from Jan. 2016 to Sep. 2019.....	22

List of Tables

Table 1 Summary Statistics of Soybean data (2001.1 to 2019.9).....	11
Table 2 Estimation Results of U.S. Soybean Production.....	17
Table 3 Estimation Results of China’s Demand for U.S. Soybeans	18
Table 4 Estimation Results of U.S. Domestic Demand for Soybeans.....	19

Acknowledgements

It has been a long journey; the postgraduate study is about to meet the end. I would like to take this opportunity to thank all the professors, classmates, friends who supported me, and most importantly, my family.

Thanks to my major professor Tian Xia for the kind support, ever since undergraduate all the way to graduate program, you have always been helping me and saving me from all my troubles.

Thanks to all my committee members: Dr. Andrew Barkley and Dr. Brain Coffey, you have always been patient with me and thank you for being my committee members, I'm lucky to have you helping me with my thesis, and I learned a lot from your classes as well, it's has been a great time.

Thanks to all my classmates, friends, and my buddy Gabe and Chris, as an international student, I can never finish my study without you, your friendship has always been my most precious treasure and I can never forget.

At last, thanks to my family, my parents, and my grandparents, sorry I spend such a long-time study aboard, I missed so many family events that I even lost my counts. You have always inspired and encouraged me, supported me as much as you can, I'm thankful to have such a family.

1. Introduction

1.1 Background

As one of the campaign promises that the 45th U.S. President Donald Trump made, he gave the directive that he will cut back on unfair trade practices that were being promoted by the Chinese government (Zheng 2019). As of 2016, there was a trade deficit of over 300 billion U.S. dollars and President Trump promised to make adjustments on the figure with the institution of supporting trade practices and tariffs. In March of 2018, the United States put in place tariffs that saw the increased amount of steel and aluminium imports from China. The U.S. government further put in place further tariffs meant to limit the trade malpractices practised by China and in response, the Chinese government also put in place tariffs to meet the ones proposed by the U.S. government (Finbarr 2019). Despite efforts by both governments to reverse the implications of the sanctions, the implementation of the proposed tariffs has caused serious consequences for the two economies.

China is the world's largest consumer of soybeans with the majority of the beans being imported. China imports over 88 million tons on average every year with the majority of the imports coming from the U.S. and Brazil. In July 2018, China imposed a 25% punitive tax on the imports of soybeans from the U.S. resulting in a decrease in the overall quantity of imported soybeans by half. The increase in tariffs for soybeans has presented unique challenges for the U.S. and China with both markets seeing significant challenges and risks (Daniel 2019).

China has been looking for a different long-term supplier in place of the U.S. with Russia and Brazil being seen as possible replacements. They are however not able to meet China's demand because Russia is not able to support its demand while Brazil is not able to meet the gap left by the U.S. Without alternatives to meet the gap left by the U.S., China is left with a crisis to

source for sustainable supply of soybeans (Zhang 2019). With projected soybean production levels in Russia expected to remain constant, no foreseen supplier will fill the gap left by the U.S. and meet the domestic demand in China. The Director-General Moscow-based Institute for Agricultural Market Studies stated that Russia still needs to import soybeans to meet its own demand hence it cannot offer sustainable exports to China to meet China's demand (Zhang 2019).

Soybeans are used as a major protein source for edible oils and animal feeds in China. However, the trade war causes immense challenges to the trade and this will have an overall impact on the economies concerned. While they offer opportunities for third party trade partner, they pose challenges to both the U.S. and China market and have possible detrimental implications on the rate of economic growth. The barriers and tariffs adopted by China and the U.S. are harming their own economies as opposed to protecting them. This thesis will show that the trade war has had detrimental implications for the soybean trade, production and consumption in the two countries.

1.2 Problem Statement

The United States and China are the first and second largest economies of the world. Since President Trump took his office, there has been more trade conflicts between the two countries. These have been characterised by increases in tariffs and imposition of trade barriers between the two nations leading to an overall increase in economic hostility between the two nations. The U.S. had accused China of unfair trade practices and as a measure of harmonizing trade, it put in place measures and barriers to restrict the freedom of trade China enjoyed. In retaliation, China also imposed bans which affected the U.S. mainly in agriculture.

The trade war has particularly affected the soybean industry having an overall impact on farmers in the U.S. and consumers in China. The emergence of the trade war between China and the U.S. has seen a drastic fall in the overall import of soybeans from the U.S. leading to increased demand from other markets. Brazil has been the biggest beneficiary from the trade war seeing an increase in the overall soybean exports in 2018 to 66.1 million tons. This was a 30% increase from 2017 signalling the demand to fill the void left by the U.S. This has however not been sufficient to meet China's demand for soybeans with the market looking towards Russia as an alternative supplier. The institution of trade barriers will have negative implications of the Chinese and U.S. markets with consumers and farmers in the respective market facing possible losses and increased expenditure.

1.3 Objectives of the study

The following are the objectives of the study:

1. How the rise of trade barriers and other factors have affected the soybean trade in both U.S. and China, and soybean production and consumption.
2. The implications of the reduced soybean trade in U.S. and China.

2 Literature Review

2.1 Soybean Farming

Soybean or Soya bean is a legume which has been traditionally used by Asians over the years and is widely known for its nutritious benefits together with its large use as an ingredient in processed foods (Groves 2018). In global markets, agricultural products are made up of staple crops and animals and they are elaborated under “Annex 1 of the WTO Agreement on Agriculture” which can be traded among contracting parties (Antkiewicz and Whalley 2011). The soybean is considered to be one of the most versatile crop plants globally and is considered a staple food in Asia where they are used as a vegetable (Hartman, Ellen and Theresa 2011).

Globally, there is a huge demand for the soybean as its well known as “King of Beans”. It is grown in regions which exhibit both temperate and tropical climates (World Wildlife Fund 2019). Three major producing countries produce over 80% of the world’s soybeans in total. These three countries are the U.S., Brazil and Argentina. China imports more soybeans than any other nation (World Wildlife Fund 2019).

Soybean is used widely in livestock feed, food, fuel and industrial products. It is a leading oilseed crop amounting to 34% of production occurring in the U.S. (Wiggins *et al.* 2019). Soybean is not only used in the common purposes stated above but also, its combination with yeast extract is processed to achieve a solution used to treat and/or damage DNA of skin cells associated with ageing. This has been scientifically demonstrated in which it limits cells senescence and action of oxidative stress on DNA (Botto and Frederique 2015).

2.2 Soybean Industry in China

Soybeans are mostly consumed in Asia where demand for the product is the highest. Due to the nature of the market, soybeans are not grown in the market but rather imported from other

producing countries and markets. Following the food insecurity in the region, uncertainty, and scarcity of the legumes, the Chinese government tried to improve domestic soybean production (Liu, et al. 2019). China has not had considerable progress in soybean production with its government going as far as putting in place policies and measures that would inspire investment in agriculture (Liu, et al. 2019). Chinese farmers used genetic diversity to find an improved soybean species as compared to the original wild soybean. The genetically produced soybean in China is referred to as *Glycine max* and is locally used to produce foods such as tofu, soybean milk, nutritional supplements and soy sauce (Gale, Valdes and Ash 2019; Sneller, Randall and Nelson 2005). China accounts for about 60% of global soybean imports (Gale, Valdes and Ash 2019). In the 1970s, Europe was the major importer of soybeans from the U.S. and Brazil. This has however changed in the 21st century when China increased its imports of soybeans and its imports surpassed the European import volume, amounting to about 65% of all soybeans imports in 2016/17 (Gale, Valdes and Ash 2019).

The import of soybean meets China's demand for edible oils and animal feed. They are used to produce high-protein meals that are consumed by Chinese livestock and as oil. Approximately every 1000 kilogram (kg) of imported soybeans yields about 800 kg of the meal and 180 kg of oil and thereafter, the profitability of the imports is determined by weighing the value of meal and oil against the cost of soybeans (Gale, Valdes and Ash 2019).

2.3 Soybean Industry in the U.S.

Soybean began as a small-scale crop and gradually became a significant crop during World War II (Hartman, Ellen and Theresa 2011). Production of soybean grew in magnitude and gained dominance in the world markets and the production exceeded 75 million metric tons for the first time in the 21st Century (Hartman, Ellen and Theresa 2011). Due to the availability of vast

agricultural land and manpower, the U.S. has managed to become the highest producer of soybeans globally with over 117 million tons of grain being harvested as of 2016. Other than direct consumption, the beans are used to produce biodiesel, tofu, livestock feed, vegetable oil and in many other applications including lubricants (Wiggins *et al.* 2019). Due to the high demand levels of the soybeans in other countries, the overall acreage of soybeans took a sharp increase over the past four decades. The distribution of soybean in the U.S. grew by 25% between 1970 and 1980 signifying the importance of the legumes to the globe (Ramirez, Sukant and James 2003). The U.S. and Brazil account for about 80% cumulative supply of global exports of soybeans (Gale, Valdes and Ash 2019).

The top soybean producing state in the U.S. during the 21th century is Iowa, followed by Illinois and Minnesota. Iowa and Illinois produced over 500 million bushels of soybeans in 2015. Illinois on an average yielded about 41.7 bushels per acre from 2013 to 2017 (Purdy and Langemeier 2019). The U.S. encouraged their farmers to venture into the growth of soybeans anticipating huge returns, by offering incentives that include replacing legislation of subsidy payments tied to corn and wheat base acres that gave US farmers more flexibility to make planting decisions on market prices (Gale, Valdes and Ash 2019). The growth of soybean production in the U.S. is attributed to shifting land from crops such as wheat and corn to soybeans (Gale, Valdes and Ash 2019). In 2018/19, soybean harvest was recorded at 35.6 million hectares, despite the increase of Chinese tariffs against U.S. soybeans. U.S. farmers received trade mitigation payments in a bid to offset losses that resulted from the U.S.-China trade war. (Gale, Valdes and Ash 2019)

2.4 Historical Soybean Trade between the U.S. and China

The United States and China have been some of the most dominant characters in soybean trade over the past two decades as compared to other players in the industry (Li, Ker and Rude 2019). According to a cointegration analysis done between 2004-2016 to estimate China's per capita consumption spending on imported soybeans from the U.S., it was discovered that importing soybeans from the U.S. was economically feasible for China (Qi and Qi 2018). China has been the largest importer of soybeans in the world with the product being used in different sectors of the economy. China imported approximately 93.5 metric tons of soybeans in 2016, which accounted for 65% of the world total soybean imports (Farzad and Wallace 2018). China's soybean imports are from two major countries, Brazil and the U.S., which account for 44% and 42%, respectively, of China's soybean imports (Farzad and Wallace 2018). During 2017, China was the top destination of U.S. soybean exports. Soybean exports were valued at \$12.3 billion reflecting 63% of US agricultural exports to China (Gale, Valdes and Ash 2019). Due to its huge amount, soybean imports has a major impact on China's economy (Qi and Qi 2018). This means that a slight change in the buying price of soybeans could significantly affect China's economy.

2.5 U.S.-China Trade War

The trade war between the United States and China began at the beginning of 2018 when the U.S. imposed tariffs on imported solar panels and other products imported from China, which led to a retaliation from China, which initiated an anti-dumping investigation into US sorghum exports (Li, Zhang and Chad 2018). The U.S. accused China of violating the multilateral trade agreements under the WTO (Carvalho, André and Angélica 2019). The tariff imposition took an unexpected turn after China retaliated by imposing tariffs on about 128 U.S. products effective in April 2018. As a retaliatory action, the U.S. also put in place a 25% tariff on Chinese products

coming to the U.S. valued at \$50 billion, alongside investment restrictions and submission of a case against China to the WTO (Li, Zhang and Chad 2018). One of the biggest traded items between the two nations was soybeans and China put a 25% tariff on all US exports to China (Carvalho, André and Angélica 2019). China used to import about 30 million metric tons of soybeans from the U.S. and last year, they just bought 8.3 million metric tons of the crop, this is a devastatingly huge drop in the number of soybeans imported by China from the U.S. (Tan 2019).

China opted to impose the 25% tariff because they noted that pricing was not only the issue that they had to deal with but also the fact that they had another supplier which is Brazil, they felt less affected by imposing such a tariff on soybeans imported from the U.S. (Choe, Hammer and Montgomery 2019). China gradually increased its importation of soybeans from Brazil and has amounted to a considerable 75% of soybean coming from Brazil which is a new record. This is a clear indication that China reduced its imports from the U.S. and substituted the majority of imports with soybeans from Brazil (Fuchs 2019). China has also considered importing soybeans from Argentina, in a bid to counter the tariff imposed by the U.S. (Byrne 2019).

2.6 WTO Regulations on International Trade

The WTO was set up to ensure trade is done fairly and by internationally accepted rules. In this regard, the trade between the U.S. and China is ideally supposed to adhere to be consistent with the WTO regulations. In accordance to WTO regulations, contracting parties in the WTO are required to accord each other similar treatment with no less favorable terms (Bartels and Christian 2010). With regards to this provision, the U.S. and China violated the requirement and put harsh treatment to each other in a bid to shake up trade which negatively affected the global

market in which they have been large beneficiaries. The imposition of tariffs against each other was inconsistent with the provision that stipulates imposition of equivalent internal taxes or any other levies or tariffs being commensurate with the cost of services rendered (Bartels and Christian 2010).

2.6.1 Most Favored Nation (MFN) Treatment

One of the other rulings that also relates to the case of China-US trade war can be borrowed from the regulations provided for by the WTO under Article I of GATT 1994. The regulation states that

“With respect to customs duties and charges of any kind imposed on or in connection with importation or exportation or imposed on the international transfer of payments for imports or exports, and with respect to the method of levying such duties and charges, and with respect to all rules and formalities in connection with importation and exportation, and with respect to all matters referred to in paragraphs 2 and 4 of Article III, any advantage, favour, privilege or immunity granted by any contracting party to any product originating in or destined for any other country shall be accorded immediately and unconditionally to the like product originating in or destined for the territories of all other contracting parties.”.*

By WTO Regulations on trade, the principle of MFN is highly regarded as a fundamental tool in the promotion of efficiency and development in trade. The basic rule of MFN requires that contracting parties are obliged to unconditionally and immediately treat other members of the WTO with similar treatment with regards to rules and tariffs for like products (Hoekman 2002).

2.6.2 The Coffee Case - Spain and Brazil

Brazil was informed that Spain had made amendments to the tariffs applied to the importation of unroasted coffee. The two main variants of imported coffee namely unwashed Arabica and Robusta were subject to harsh tariffs titled (tariff No. 09.01A), as opposed to "mild coffee" which received favorable terms. The 7% tariff rate on unwashed Arabica and Robusta was not applied to mild coffee and it led to increased tension between the two trading partners. Before this tariff alteration, there were no predetermined ranges of tariff rates applied by Spain for the importation of unroasted coffee, and as the major exporter of coffee to Spain, Brazil was highly disturbed and felt discriminated upon with the new tariff. This motivated Brazil to seek the consultation of Article XXII:1 (WTO 1981).

Spain, however, argued that it was not a mandatory restraint on its tariff structure and that it was not binding on imports and referenced the Brussels nomenclature adopted by Spain and interpreted it stating that each country had the liberty of establishing it (Spain-Tariff Treatment of Unroasted Coffee). In its ruling, a WTO panel for arbitration determined that the tariff imposed by Spain in the form of a royal decree 1764/79 on Brazil for importation of coffee was contrary to the provision of Article I:1, and it concluded further that it amounted *prima facie* a case of unfair treatment for the settlements ensuing to Brazil as provided for by article XXIII (WTO 1981).

Similar to the above case on inconsistent tariff imposition, the United States and China both arbitrarily imposed tariffs on each other and those tariffs were less favorable than those for other trading partners. Because the United States and China contribute tremendously to the global markets, their impositions of those tariffs significantly distorted the international trade of many products.

3 The Model

Three econometric models are specified and estimated to analyze how various factors affect U.S. soybean production, China's demand for U.S. soybeans, and U.S. domestic soybean demand. In the econometric analysis, the data covered the time period from January 2001 to September 2019. The reason for choosing 2001 as the starting point is because China became a member of the World Trade Organization (WTO) on December 11, 2001. After the accession to the WTO, the economic development in China has significantly accelerated. The number and value of imported commodities of China have also increased tremendously, especially for the imports of U.S. soybeans, due to the increasing China's demand for soybean oil and meat products including pork and poultry.

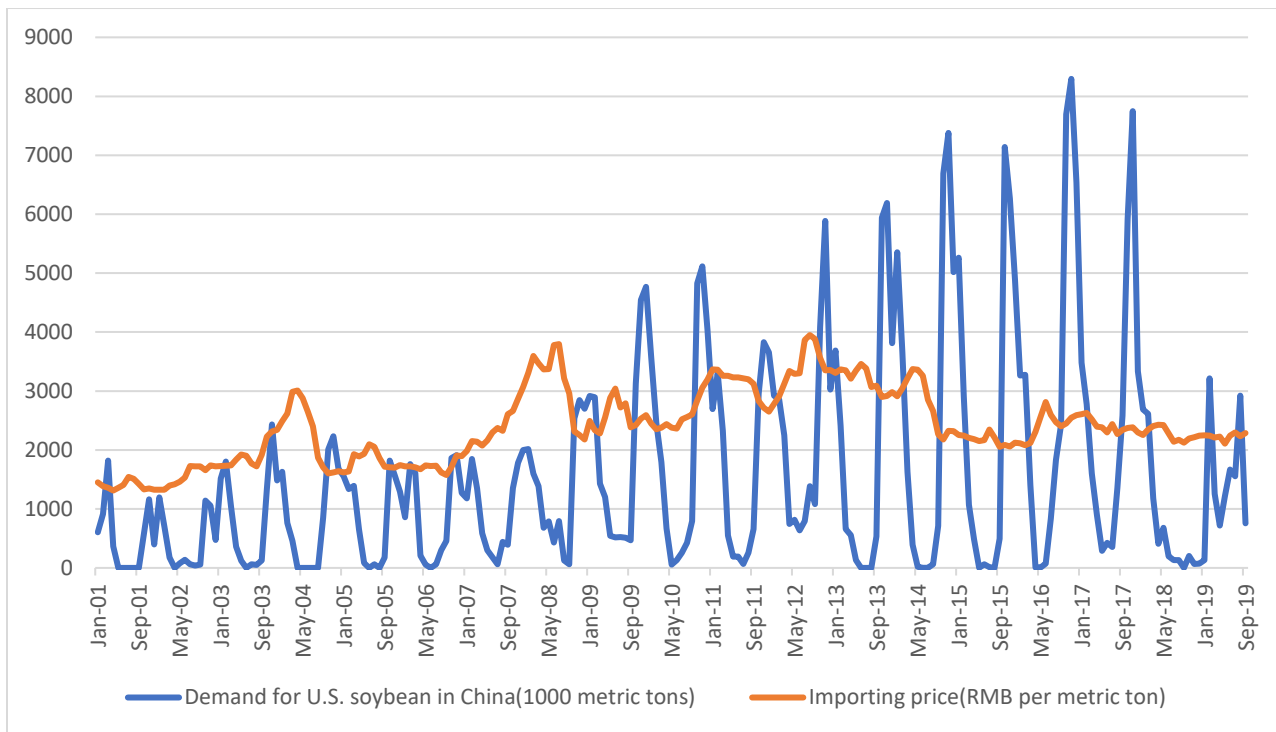
Table 1 below provides the variable names and the summary statistics of the data used in the econometric analysis for the time period from January 2001 to September 2019.

Table 1. Summary Statistics of the Data (January 2001 – September 2019)

Variables	Mean	Std.Dev	Min	Max
U.S. soybean production (1,000 metric tons)	7,640.75	1,332.58	5,557.15	1,0297.5
Soybean price (\$ per metric ton)	344.6756	115.0711	157.6305	637.8706
China's Tariff (Percentage)	4.375	5.337	3	25
Soybean subsidies(million \$)	171.5504	103.5521	79.42	513.17
Soybean cost (\$ per metric ton)	317.1047	67.88	221.5645	408.9574
Corn supply (million metric tons)	29.57	4.045	22.391	35.863
Exporting price (\$ per metric ton)	346.4135	115.5353	158.61	622.91
Demand for U.S. soybean in China (1,000 metric tons)	1,533.76	1,796.404	0	8,295.38
Importing price (RMB per ton)	2,395.60	620.753	1,312.85	3,948.88
Pork production (million heads)	53.204	5.5	40.83	60.95
Soybean oil consumption (1,000 metric tons)	933.929	311.562	344.75	1375
China GDP per capita (\$)	405.612	259.686	8.277	841.58
Demand of U.S. soybean (1,000 metric tons)	4,343.42	358.451	3,716.93	5,099.35
Domestic soybean price (\$ per metric ton)	391.546	120.646	184	684
Soybean Oil (1,000 metric tons)	854.8049	82.309	711.5	1024
US GDP per capita (\$)	4,298.29	252.509	3,864.83	4,816.17

To estimate the model system, the data was collected from various databases such as USDA and other government agencies. The excel sheet is showing per capita GDP for China, the currency exchange between the two countries the U.S. dollars and the Chinese Yuan. The disappearance of the soybean supply in China is shown in the regression analysis. The graph (Figure 1) below shows the demand for the U.S. Soybean in China and the import price. It shows that if there is no imposition of tariffs on the trade, the demand for U.S. soybeans in China is likely to increase.

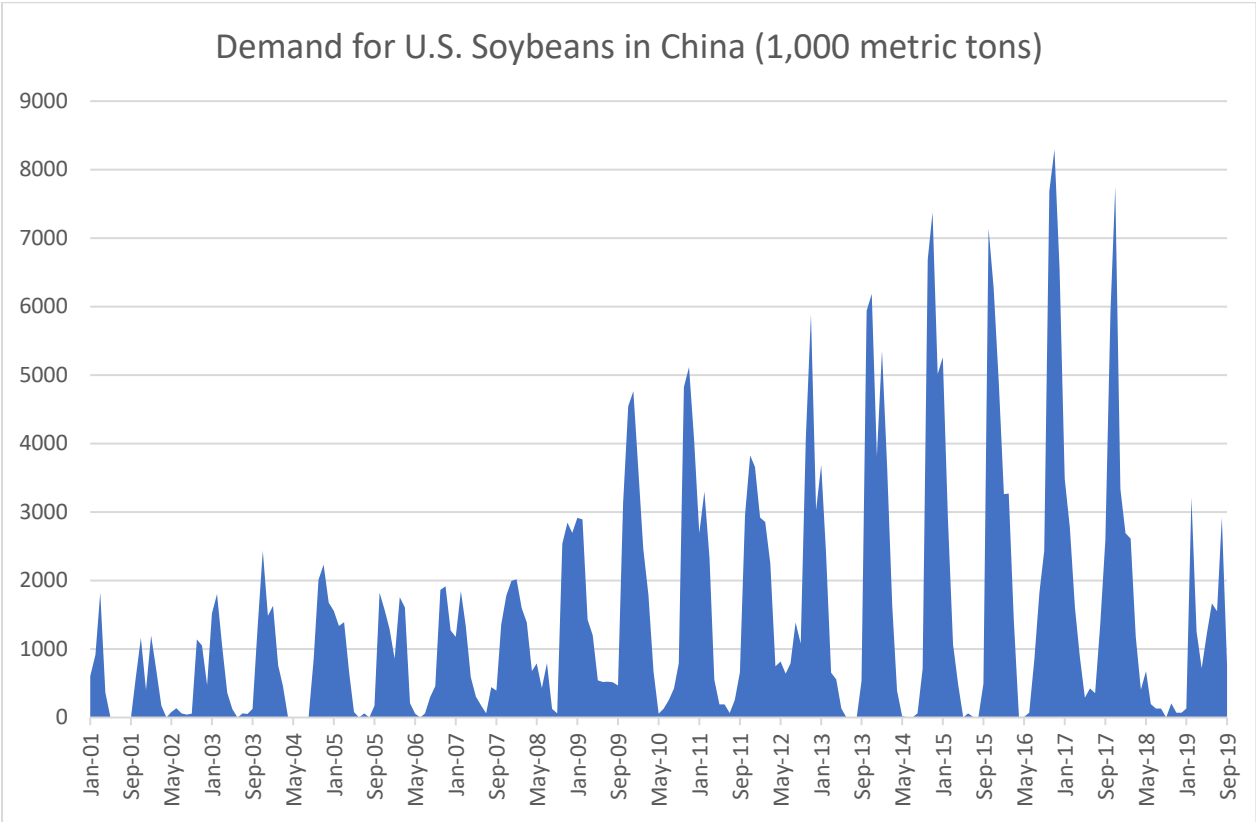
Figure 1. Demand for U.S. Soybeans in China, and the Correlation with Importing Price



The data set can also show the trend line for the U.S. Soybean demand in China, and help us analyze how factors such as import prices, tariffs, GDP as well as exchange rate affect the demand and consumption of soybeans in China. From the graph in Figure 2 we can see that the trend line for China’s demand for U.S. soybeans has been increasing. There were a few trade conflicts between the two countries, but as the conflict intensified, the demand for US soybean

declined further. It can be clearly seen from Figure 2 that, before the trade war happened in 2018, the amount of soybeans imported from the U.S. has constantly increased since the beginning of the 21st century. Due to the impact of the trade war, China quickly reduced the amount of soybean imports from the U.S.

Figure 2. China’s Demand of U.S. Soybeans



3.1 U.S. Soybean Production Model

The econometric model for the soybean production of the United States is specified as:

$$Ss_t = \alpha + \beta_1 Ps_{t-1} + \beta_2 TF_{t-1} + \beta_3 Sub_{t-1} + \beta_4 Ct_{-1} + \beta_5 Sc_t + \beta_6 Pe_{t-1} + \beta_7 S2_t + \beta_8 S3_t + \beta_9 S4_t + \beta_{10} T_t + \delta_t,$$

where the dependent variable is the quantity of U.S. soybean production (S_t), representing the monthly US soybean production in 1000 metric tons. Lagged soybean price (PS_{t-1}) and lagged China's tariff rate on US soybeans (TF_{t-1}) are the most important explanatory variables in this model. The lagged values of these two variables were used based on the fact that the production decision usually relies relatively more on the price and tariff rates from a previous period. The coefficient estimates will show the effects of soybean price and China's tariff rate on the production of U.S. soybean.

The variable, Soybean subsidies (Sub_{t-1}), represents the value of soybean subsidies in million dollars, and the coefficient shows the effect of soybean subsidies on U.S. production of soybeans.

Soybean cost (C_{t-1}) is the lagged monthly production cost of U.S. soybeans in dollar per metric ton. The coefficient indicates the effect of soybean cost level on the production quantity of soybeans. Total corn supply (Sc_t) represents the monthly corn supply in million metric tons, and its coefficient shows the effect of monthly corn supply on U.S. production of soybeans.

Exporting price (Pe_{t-1}) represents the lagged monthly price for exported soybeans in dollar per metric ton. Its coefficient measures the effect of the exporting price on the production of soybeans of the U.S.

Season dummies ($S2_t, S3_t, S4_t$) represents summer, fall and winter. The coefficient estimates will measure the difference in soybean production between the three seasons and spring. Time trend (Tt_{ij}) is included to take the effects of possible long-term trends, which are not represented by other explanatory variables, into account.

3.2 China's Demand for U.S. Soybeans (Import System)

The second econometric model is for the analysis on China's demand for U.S. soybeans. It is specified as:

$$DC_t = \alpha + \beta_1 Pi_{t-1} + \beta_2 T_{t-1} + \beta_3 Sp_{t-1} + \beta_4 CSO_{t-1} + \beta_5 GDP_{Ct} + \beta_6 S2_t + \beta_7 S3_t + \beta_8 S4_t + \beta_9 T_t + \delta_t,$$

where the dependent variable is the quantity of China's demand for U.S. soybeans (DC_t). Its value is the monthly China's imports of U.S. soybeans in 1000 metric tons.

Lagged Importing price (Pi_{t-1}), lagged China's tariff rate on US soybeans (TF_{t-1}), and GDP per capita (GDP_{Cij}) of China are the three most important variables we focus on in this model. The coefficients of these three variables can show how the importing price, China's tariff rate, and the per capita GDP in China affect China's soybean imports from the United States, respectively.

Pork production (Sp_t) represents the monthly pig production in million heads in China. Its coefficient measures the effect of pork production on China's demand of U.S. soybeans. The consumption of soybean oil (CSO_t) is China's monthly consumption of soybean oil in 1000 metric tons, and the coefficient indicates the effect of consumption of soybean oil on China's demand for U.S. soybeans.

Season dummies ($S2_t, S3_t, S4_t$) represents summer, fall and winter. The corresponding three coefficient estimates will measure the difference in China's demand for U.S. soybeans between the three seasons and spring. The coefficient of Time trend (T_{ij}) will measure the effects of possible long-term trends on China's imports of U.S. soybeans.

3.3 U.S. Domestic Demand for Soybeans

The third econometric model is estimated to analyze how factors affect U.S. domestic demand for soybeans. This econometric model is specified as:

$$Dus_t = \alpha + \beta_1 Pds_{t-1} + \beta_2 Sso_{t-1} + \beta_3 GDP_{us} + \beta_4 S2_t + \beta_5 S3_t + \beta_6 S4_t + \beta_7 T_t + \delta_t,$$

where the dependent variable in this model is U.S. domestic demand for soybeans (Dus_t).

Its value is the monthly quantity of U.S. domestic demand for soybeans in 1000 metric tons.

U.S. domestic soybean price (Pds_{t-1}) and GDP per capita (GDP_c) in the United States are the two most important explanatory variables in this model. Their coefficients measure how the soybean price and GDP per capita affect the domestic demand for soybeans in the United States.

U.S. soybean oil production (Sso_{t-1}) represents the monthly soybean oil production in 1000 metric tons. The corresponding coefficient indicates how soybean oil production affects the domestic demand for soybeans in the U.S.

Season dummies ($S2_t, S3_t, S4_t$) represents summer, fall and winter. Their coefficient estimates will show whether and how much the seasons affect U.S. domestic demand for soybeans. Time trend (T_t) is included to capture the effects of possible long-term trends, which are not explicitly modeled.

4 Results

The estimation results of U.S. soybean production model are included in table 2. We focus on two important effects in the model, the effects of soybean price and China's tariff rate on U.S. soybean production. The coefficient estimate of lagged soybean price is positive as what we expected, showing that lagged soybean price is positively related to U.S. soybean production. The coefficient estimate is 2.181, which means that, if the soybean price increases by \$1, U.S. soybean production will increase by 2.181 thousand metric tons. China's tariff rate is negatively related to U.S. soybean production as what we expected, meaning that rising China's tariff on U.S. soybeans reduces the production of US soybeans, as Chinese importers would prefer purchasing soybeans from other countries like Brazil and Argentina. The coefficient estimate of lagged China's tariff rate on U.S. soybean production is negative at -56.629 and statistically significant, showing that a one-percent increase in China's tariff rate would reduce U.S. soybean production by 56.629 thousand metric tons.¹

Table 2. Estimation Results of U.S. Soybean Production.

	<i>Unit</i>	<i>Coefficients</i>	<i>Standard Error</i>
Intercept	-	2699.452***	534.5531
Ps(t-1)	\$ per metric ton	2.180651	2.839637
T(t-1)	percentage	-56.6287***	8.206116
Sub(t-1)	million \$	2.316819***	0.329359
C(t-1)	\$ per metric ton	3.500526**	1.118504
Sc	million metric tons	127.6429***	17.45405
Pe(t-1)	\$ per metric ton	-6.5162*	2.853792
S2	-	41.8488	86.39499
S3	-	-35.8959	87.68458
S4	-	-30.6838	86.76504
Tt	-	12.54516	1.757593

Note: Dependent variable: U.S. soybean production

*p<0.05

**p<0.01

***p<0.001

¹ We also tried to run the U.S. production regression using annual data, but for the prices and tariff, annual data cannot be effectively shown the monthly fluctuations of the variables and adequately explain their effects.

The coefficient estimate of the soybean subsidies is positive and statically significant. So when the value of soybean subsidies increases, U.S. soybean production will also increase. From analysis we know that production of U.S. soybean is also affected by other variables such as soybean cost, corn supply, exporting price, and seasons of the year. In the results, most of those effects are statistically significant.

Table 3 shows the estimation results of the model for China's demand for U.S. soybeans. The three most important effects are those of importing soybean price, China's tariff rates, and per capita GDP of China on China's imports of U.S. soybeans. The coefficient estimate of importing soybean price on China's demand of U.S soybeans is statistically significant and negative as what we expected at -0.0049. So, if the importing soybean price increases by 1 RMB, China's demand for U.S. soybeans will decrease by 4.9 metric tons.

Table 3. Estimation Results of China's Demand for U.S. Soybeans

	<i>Unit</i>	<i>Coefficients</i>	<i>Standard Error</i>
Intercept	-	-62.53366761*	24.97928
Pi(t-1)	RMB per metric ton	-0.004921291*	0.002464
T(t-1)	percentage	-2.407015601***	0.426941
Sp(t-1)	million head	1.784386373***	0.461184
Cso(t-1)	1000 metric ton	0.054348902*	0.029751
GDPc	dollars	0.04674354	0.027666
S2	-	6.140260136	3.365882
S3	-	-52.56365216***	3.539653
S4	-	-22.05599176***	3.352912
Tt	-	-0.069730846	0.204406

Note: Dependent variable: Demand for U.S. soybean in China

*p<0.05

**p<0.01

***p<0.001

The coefficient estimate of China's tariff on its demand for U.S soybeans is negative as what we expected at -2.407, showing that a one-percent increase in China's tariff rate would lead

to a reduction of 2.407 thousand metric tons in China’s imports of U.S. soybeans. The estimation results show that China’s per capita GDP has a positive and statistically significant effect on China’s demand for U.S. soybeans. The coefficient estimate is 0.0467, meaning if one-dollar increase in China’s per capita GDP, China’s total demand for U.S. soybeans will increase by 46.7 metric tons, the percentage increase is 0.003%.

Due to the increasing demand for pork and soybean oil, the coefficient estimates of pork production in China and China’s consumption for soybean oil are both statistically significant and positive as expected. Soybean is one of the main sources of protein of animal feeds in China. As income of Chinese consumers grows higher, the demand for meat in China will increase, thus the demand for soybeans will also rise.

Estimation results of the third model, U.S. domestic demand for soybeans, are shown in Table 4. The variables of interest are domestic soybean price and U.S. per capita GDP. The effects of these two variables on U.S. domestic demand for soybeans are the focus for this model. the coefficient estimate for lagged U.S. domestic soybean price on domestic demand for U.S soybeans is negative as what we expected at -1.18602 and statistically significant at the one percent level. That means a one-dollar increase in U.S. soybean price will result in a reduction of 1.18602 thousand metric tons in U.S. domestic demand for soybeans.

Table 4. Estimation Results of U.S. Domestic Demand for Soybeans

	<i>unit</i>	<i>Coefficients</i>	<i>Standard Error</i>
Intercept	-	-122.071	458.7842
Pds(t-1)	\$ per metric ton	-1.18602***	0.102875
Sso(t-1)	1000 metric tons	0.882104***	0.163562
GDPus	\$	0.954349***	0.124148
S2	-	-7.74576	25.92696
S3	-	-29.0765	26.18088

S4	-	8.224575	26.21991
Tt	-	0.736911	0.487258

Note: Dependent variable: Demand of U.S. soybean

*p<0.05

**p<0.01

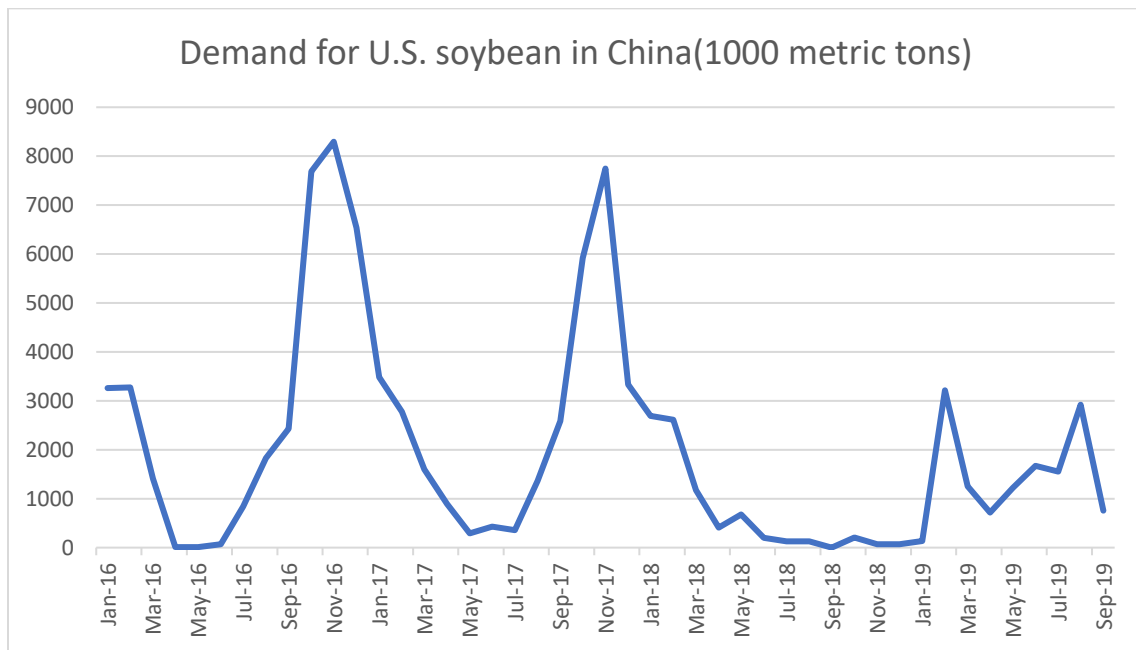
***p<0.001

The coefficient estimate of the U.S. GDP per capita is also statistically significant and positive as what we expected at 0.954349. Thus, U.S. GDP per capita has a positive and significant on U.S domestic demand for soybeans. The estimation results show that other factors may also affect U.S. domestic demand for soybeans such as U.S. soybean oil consumption, the coefficient is 0.882 and significant, means it has a positive and significant on U.S. domestic demand for soybeans.

5 Conclusion

According to the model estimation results in our analysis, the tariff rate of China on soybean imports is shown to have severely affected the soybean trade and production between the United States and China. China's 25% tariff imposed on the soybean imports from the U.S. is the result of escalating trade sanctions. Its impact on the soybean trade between the United States and China starting from July 2018 is shown in Figure 3:

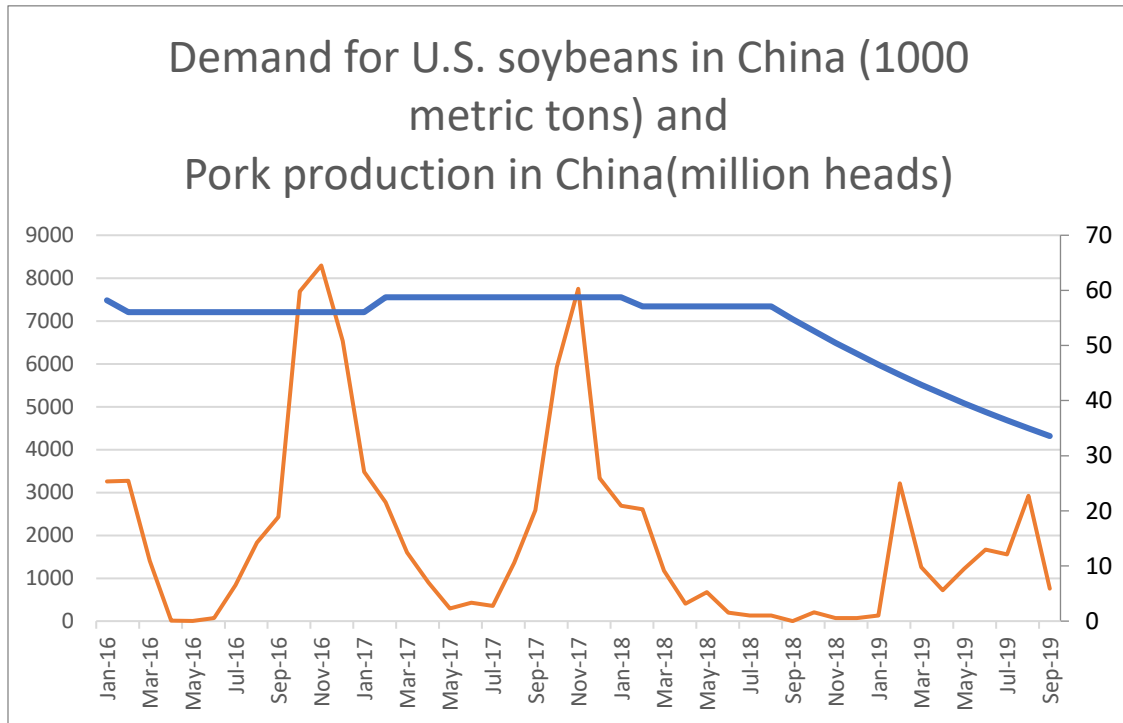
Figure 3. China's Demand of U.S. Soybeans from Jan. 2016 to Sep. 2019



As illustrated in the above graph, after the tariff imposition in July 2018, Chinese demand for U.S. soybeans immediately dropped to zero and gradually came back, but was still more than 50% lower than the level in the previous year. Prices and tariffs aren't the only factors that affect the demand for U.S. soybeans. Chinese government policies also affect the purchasing decisions of the majority of state-owned companies.

The graph below shows the correlation between China’s pork production and its demand for U.S. soybeans:

Figure 4. China’s Demand for U.S. Soybeans (1000 metric tons) and China’s Pork Production (million heads) from Jan. 2016 to Sep. 2019



As shown in our regression results, Chinese swine supply positively impacted the demand for U.S. soybeans in China. However, in 2019, China reported the African swine fever outbreak resulting in the death of over 15- 40 million swine in comparison to the previous year. Due to decreased swine production, the demand for U.S. soybeans was decreased.

Prior to U.S.-China trade war, China was increasing its consumption of U.S. soybeans. As a short-term result of the U.S.-China trade war, in 2019 China has purchased less U.S. soybeans to exert pressure on the U.S government. Because China is the most important soybean

importer, the reduction of Chinese imports of U.S. soybeans not only greatly increased the U.S. soybean inventory, but also reduced the soybean production in the United States. Since market confidence has been compromised due to the decreasing Chinese purchase, U.S. farmers are likely to switch to other crops such as wheat and corn.

In the long-term, the negative impact of the U.S.-China trade war on the U.S. soybean industry will be mitigated by the increasing demand for U.S. soybeans of other importing countries. However, if trade agreements cannot be reached between the U.S. and China, the soybean industry will continue to face a very difficult time in the future.

References

- Angela, B. *Project timelines: Why they're so important*. 2016. 17 August 2019.
- Antkiewicz, A. and J. Whalley. "China's new regional trade agreements." *China's Integration Into The World Economy* (2011): 99-121.
<https://www.wto.org/english/tratop_e/agric_e/symposium_ag_policy_landscape_e/s2_o_molo.pdf>.
- Bartels, L. and C. Häberli. "Binding tariff preferences for developing countries under article II GATT." *Journal of international economic law* 13.4 (2010): 969-995.
- Biesta, G. "Pragmatism and the philosophical foundations of mixed methods research." *Sage handbook of mixed methods in social and behavioural research* (2010): 95-118.
- Botto, J.-M., D. Nouha, and F. Portolan. "Cosmetic composition comprising a synergistic TRF2 protein activation system consisting of a combination of a peptidic soybean and yeast extract and the U.S.es thereof." *US Patent 974728B2*. New York, 22 May 2015.
<<https://patents.google.com/patent/US9974728B2/en>>.
- Bunniss, S. and D. Kelly. "Research paradigms in medical education research." *Medical Education* 44.4 (2010): 358-366.
- Byrne, J. "Boost for Argentina Crushers as China Opens its Market to Soybean meal from the South America Country." *Feed Navigator* 11 September 2019: 1.
<https://www.feednavigator.com/Article/2019/09/11/Boost-for-Argentinian-crushers-as-China-opens-its-market-to-soybean-meal-from-the-South-America-country?utm_source=copyright&utm_medium=OnSite&utm_campaign=copyright>.

- Carvalho, M., A. Azevedo and A. Massuquetti. "Emerging Countries and the Effects of the Trade War between the U.S. and China." *Economies* 7.2 (2019): 45. 1 May 2019. <<https://www.mdpi.com/2227-7099/7/2/45>>.
- China Law Insight. *Impact of China Removal of Foreign Ownership Restrictions in Auto Sector*. 18 July 2018. 17 September 2019.
- Choe, J., A. Hammer and C. Montgomery. "U.S. Soybean Exports to China Crushed Amid Rising Trade Tensions." *Executive Briefings on Trade (EBOTs)* (2019): 16-50. <<https://ssrn.com/abstract=3443445>>.
- Cooper, D., P. Schindler and J. Sun. *Business research methods*. New York: McGraw-Hill, 2006.
- Cottier, T. "The implications of EC–Seal Products for the protection of core labour standards in WTO law." *Labour Standards in International Economic Law* (2018): 69-92.
- Crossan, F. "Research philosophy: towards an understanding." *Nurse Researcher* 11.1 (2013): 46.
- Daniel, R. *The U.S.-China trade war has been a boon for Brazil's soybean farmers. But can they keep up with Chinese demand?* 11 September 2019.
- Davidson, P. *Low prices, floods and trade wars plague American farmers, putting their survival at risk*. 6 June 2019. 17 September 2019.
- Doug, P. *U.S. trade gap with China reaches all-time high under Trump*. 3 June 2019. 17 September 2019.
- EC SEAL Products. No. DS400. WTO Dispute Settlement Board. 22 May 2014. <https://www.wto.org/english/tratop_e/dispu_e/cases_e/ds400_e.htm>.
- Eugenio, C., G. Gita and M. Adil. *The Impact of US-China Trade Tensions*. 23 May 2019. 23 September 2019.

Farzad, T. and E. Wallace. "Impacts of Possible Chinese 25% Tariff on U.S. Soybeans and Other Agricultural Commodities." *Choices* 33.2 (2018): 1-7.

<https://www.jstor.org/stable/26487444?seq=1#page_scan_tab_contents>.

Finbarr, B. and A. Behsudi. *Donald Trump's trade war tariffs on car industry sending shock waves through the global supply chain*. 17 April 2019. 17 September 2019.

Finbarr, B. *US trade deficit with China narrows, as effects of trade war-induced export front-loading begin to fade*. 7 February 2019. 17 September 2019.

Fuchs, R. "Why the U.S.-China trade war spells disaster for the Amazon." *Nature* (2019): 451-454. <<https://www.nature.com/articles/d41586-019-00896-2>>.

FXCM. *How Would A U.S.-China Trade War Impact The U.S.D?* 17 September 2019. 17 September 2019.

Gale, F., C. Valdes and M. Ash. *The interdependence of China, the United States, and Brazil in Soybean Trade*. Research Paper. New York: United States Department of Agriculture, 2019. <<https://www.ers.usda.gov/webdocs/publications/93390/ocs-19f-01.pdf?v=3881>>.

George, A. *Case studies and theory development: The method of structured, focused comparison*. In *Alexander L. George: A Pioneer in Political and Social Sciences*. Cham: Springer, 2019.

Groves, M. *Is Soy Good or Bad for your Health*. 22 November 2018. <<https://www.healthline.com/nutrition/soy-good-or-bad>>.

Hartman, G, E. West and T. Herman. "Crops that feed the World 2. Soybean—worldwide production, use, and constraints caused by pathogens and pests." *Food Security* 3.1 (2011): 5-17.

<https://www.academia.edu/28592301/Soybean_Cultivation_and_BBF_in_China>.

- He, R., et al. "How the trade barrier changes environmental costs of agricultural production: An implication derived from China's demand for soybean caused by the U.S.-China trade war." *Journal of Cleaner Production; Science Direct.* (2019): 578-588.
- . "How the trade barrier changes environmental costs of agricultural production: An implication derived from China's demand for soybean caused by the U.S.-China trade war." *Journal of Cleaner Production* 227 (2019): 578-588.
- Hoekman, B. "The WTO: functions and basic principles." *Development, Trade, and the WTO: A Handbook.* *World Bank* (2002): 41-50.
- Hubbs, T. "Soybean Exports since the Onset of Tariffs." *farmdoc Daily* 8.16 B (2018): 8.
- Johnson, B. and L. Turner. "Data collection strategies in mixed methods research." *Handbook of mixed methods in social and behavioural research* (2003): 297-319.
- Karl, P. *On the front lines: Trade war sinks North Dakota soybean farmers.* 22 August 2019. 17 September 2019.
- Layne, R. *Trump trade war with China has cost 300,000 U.S. jobs, Moody's estimates.* 12 September 2019. 17 September 2019.
- Li, M., W. Zhang, and C. Hart. "Lessons from Previous US-China Trade Disputes." *Agricultural Policy Review* 1.2 (2018): 1.
- Li, N., A. Ker, and J. Rude. *Modelling Regime-Dependent Price Volatility Transmissions Between China and US Agricultural Markets: A Normal Mixture Bivariate GARCH Approach.* Thesis. Ontario: Institute for the Advanced Study of Food and Agricultural Policy University of Guelph, 2019. <<https://ageconsearch.umn.edu/record/290307/>>.
- Li, Y. *China will retaliate with tariffs on \$75 billion more of US goods and resume auto tariffs.* 23 August 2019. 17 September 2019.

- Liu, S., P. Zhang, B. Marley, and W. Liu. "The Factors Affecting Farmers' Soybean Planting Behavior in Heilongjiang Province, China" *Agriculture*, MDPI, Open Access Journal, September 2019.
- Lui, S., et al. "The Factors Affecting Farmers' Soybean Planting Behavior in Heilongjiang Province, China." *Agriculture* 9.9 (2019): 188.
- Marceau, G and J. Trachtman. "The Technical Barriers to Trade Agreement, the Sanitary and Phytosanitary Measures Agreement, and the General Agreement on Tariffs and Trade A Map of the World Trade Organization Law of Domestic Regulation of Goods." *Journal of World Trade* 36.5 (2002): 811-881.
<https://www.wto.org/english/tratop_e/tbt_e/tbt_e.htm>.
- Petty, N., O. Thomson and G. Stew. "Ready for a paradigm shift? Part 2: Introducing qualitative research methodologies and methods." *Manual therapy* 17.5 (2012): 378-384.
- Ponterotto, J. "Qualitative research in counselling psychology: A primer on research paradigms and philosophy of science." *Journal of counselling psychology* 52.2 (2005): 126.
- Purdy, R. and M. Langemeier. *International Benchmarks for Soybean Production*. 22 May 2019. 17 September 2019.
- Qi, Y. and Q. Qi. "The Effect of Soybean Trade between China and the United States on Chinese Residents' Consumption Expenditure—Based on 2004-2016 Trade Data." *Modern Economy* 9.6 (2018): 1045. <https://file.scirp.org/pdf/ME_2018060414091370.pdf>.
- Ramirez, O., S. Misra and J. Field. "Crop-yield distributions revisited." *American Journal of Agricultural Economics* 85.1 (2003): 108-120.
- Reuters. *Factbox: From phone makers to farmers, the toll of Trump's trade wars*. 24 August 2019. 17 September 2019.

- Saunders, M., L. Philip, and T. Adrian. *Research methods: Business Students*. Harlow: Pearson Education Limited, 2007.
- Sneller, C., et al. "Genetic diversity in crop improvement: The soybean experience." *Journal of crop improvement* 14.1-2 (2005): 103-144.
- Spain-Tariff Treatment of Unroasted Coffee. No. L/5135-28S/102. WTO Dispute Settlement Board. 11 June 1981. Arbitration.
<https://www.wto.org/english/tratop_e/dispu_e/gatt_e/80coffee.pdf>.
- Steinberg, R. and T. Josling. "When the peace ends: the vulnerability of EC and US agricultural subsidies to WTO legal challenge." *Journal of International Economic Law* 6.2 (2003): 369-417.
- Stephanie, K. *UPDATE 11-Oil prices slide as U.S.-China trade war escalates*. 23 August 2019. 17 September 2019.
- Sundberg, D. and E. Vermulst. "The EC Trade Barriers Regulation—An Obstacle to Trade?" *Journal of World Trade* (2001): 989-1013.
- Tan, H. *US soybean farmers are working new markets now that exports to China have tanked*. 7 August 2019. 17 September 2019. <<https://www.cnbc.com/2019/08/08/us-china-trade-war-soybean-farmers-are-working-new-markets.html>>.
- Wahyuni, D. "The research design maze: Understanding paradigms, cases, methods and methodologies." *Journal of applied management accounting research* 10.1 (2012): 69-80.
- Wang, O. *US trade war dominates agenda at China's premier soybean conference as American imports plummet*. 20 August 2019. 17 September 2019.

- Wiggins, B., et al. "Genetic Gain for Soybean Seed Protein, Oil, and Yield in a Recombinant Inbred Line Population." *Journal of the American Oil Chemists Society* 96.1 (2019): 43-50. <<https://aocs.onlinelibrary.wiley.com/doi/full/10.1002/aocs.12166>>.
- World Wildlife Fund. *Sustainable Agriculture: Soy*. 17 September 2019. <<https://www.worldwildlife.org/industries/soy>>.
- WTO Analytical Index DSU. *Article 11: 1.4.1.1.4.3*. 1981 <https://www.wto.org/english/res_e/publications_e/ai17_e/dsu_art11_jur.pdf>.
- Yilmaz, K. "Comparison of quantitative and qualitative research traditions: Epistemological, theoretical, and methodological differences." *European Journal of Education* 48.2 (2013): 311-325.
- Zhang, P. *Beijing warns US farmers may lose China market for good, but plays down tariffs impact at home*. 5 June 2019. 17 September 2019.
- Zheng, S. *Donald Trump says the trade deal must force 'structural change' to end China's 'theft of US jobs'*. 6 February 2019. 17 September 2019.
- Zhou, Y. *The U.S.-China trade war is creating winners out of Brazil, Australia, Mexico, and Canada*. 9 August 2019. 17 September 2019.

