The Impact of the Sino-US Trade War on International Soybean Trade

Chenyu Pan and Yingzhi Wang

Purdue University

ABSTRACT

The Sino-U.S. trade war from the 2018-2021 years disrupted international agricultural trade. This study aims to understand how these trade tensions have affected soybean trade, especially China's response strategies and the resulting price changes. The research is motivated by the trade conflicts between the world's largest economies, the United States and China. Tariffs were applied on agricultural goods, including soybeans, causing disruptions in established trade routes and market dynamics. In response, China also applied tariffs on U.S. products, and sought alternative suppliers to cushion the impact of the tariffs. This strategic shift in procurement helped stabilize domestic soybean prices, countering the expected price fluctuations during the trade war. The study uses a series of regression models to analyze how the prices of soybean substitutes change in response to changes in trade patterns caused by the trade war. By studying the relationship between the prices of substitutes goods and market changes, we gain insight into how changes in trade policy affect commodity prices. We find limited significance in price changes for these soybean substitutes due to trade policies, suggesting the Chinese government's swift response was able to combat potential disruptions.

1 Introduction

1.1 The Trade War Between China and the United States

After China's 2001 accession to the World Trade Organization (WTO), it swiftly became a major trading partner of the United States, significantly contributing to the U.S. import market from China's manufacturing centers. This trade relationship thrived on the exchange of goods, technology, and services, benefitting both nations through global supply chains. U.S. companies often outsource production to China due to cost advantages, while China's export-focused economy relies on the vast U.S. consumer market (Anshu, 2023).

While these strong economic ties fostered growth and prosperity, the outbreak of a trade war severely strained their long-term relationship. Beginning in 2018, a series of tariff disputes, rooted in allegations of unfair trade practices like intellectual property theft and technology transfers, triggered a protracted trade conflict during the Trump administration (Linda, 2022).

By the end of 2019, an attempt to alleviate tensions resulted in a phase one trade agreement between the two nations. China committed to increasing purchases of U.S. agricultural products and enhancing intellectual property protection, with the U.S. agreeing to reduce tariffs. However, persisting tensions, amplified by the COVID-19 pandemic and geopolitical factors, complicated the situation. The Biden administration, recognizing the global impact of the trade war, shifted its approach towards a more strategic, multilateral framework to manage the intricate U.S.-China relationship.

1.2 Brief Introduction on the Impact of the Trade War on Soybean Trade

On May 29, 2018, President Trump announced that he would impose additional tariffs on approximately $50 billion worth of Chinese imports, covering important technologies related to China's "Made in China 2025" industrial policy (USTR, 2018). Subsequently, China announced an additional 25% tariff on 659 items of approximately $50 billion in imported goods originating in the United States, and the two countries began imposing tariffs on July 6, 2018 (MOFCOM, 2018).

A large portion of these tariffs are imposed on agricultural products. China has always been the largest importer of soybeans, and the trade war has had a significant impact on most trade. As the main importer of U.S. soybeans, China imposed high tariffs on U.S. soybeans, resulting in a sharp reduction in soybean exports, falling prices, and accumulation of inventories. This created serious difficulties for U.S. soybean farmers and exporters. At the same time, the global soybean market became less stable due to the uncertainty caused by the trade war, resulting in price fluctuations and supply chain adjustments.

Throughout this period, China adopted a diversification strategy and sought to import soybeans from other countries, thereby changing the global soybean trade pattern. In particular, China increased imports of Brazilian soybeans, and has become one of the major buyers of Brazilian soybeans, helping to diversify its supply channels and reduce its dependence on U.S. soybeans. In addition to Brazil, China is also actively cooperating with other South American countries, such as Argentina, to increase its sources of soybean imports. Another strategy is to increase domestic soybean production, which can reduce import dependence. The goal of these strategies is to reduce China's risks in the global soybean market and ensure adequate soybean supply.

The goal of this study is to analyze the impact of the trade war on soybean trade and its impact on soybean substitutes.

1.3 Analysis of Soybean Price Changes in China

As the main imported agricultural product, soybeans are obviously one of the crops most severely affected by the trade war. We can get a first glance at the potential impacts of the trade war on soybean prices in China through a first-look at the data. The following tables and pictures are the nominal price and real price of Chinese soybeans from 2013 to 2021 respectively.

Table 1. Real Prices of Soybeans in China from 2013 to 2021

Time	Soybean	Real Price of Soybean
2013	6.23	6.23
2014	6.30	6.18
2015	6.19	5.99
2016	6.02	5.71
2017	6.03	5.63
2018	5.99	5.48
2019	6.02	5.35
2020	6.57	5.70
2021	7.28	6.26

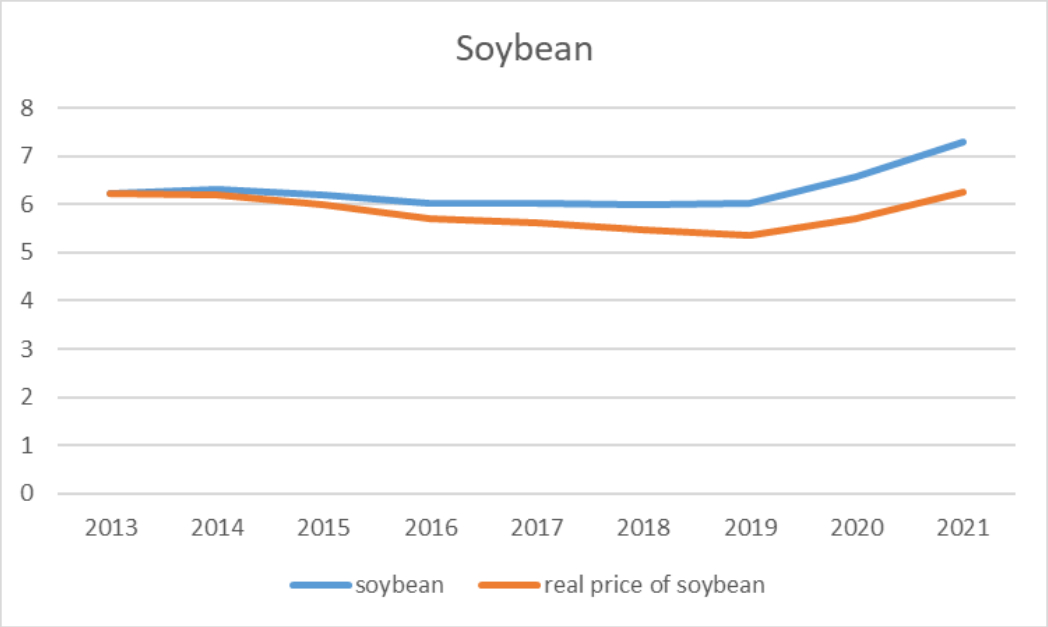

Figure 1. Trend in the Real Price of Soybeans in China from 2013 to 2021

It is not difficult to find from the above data that, contrary to expectations, both the nominal price and the real price of soybeans declined in 2018 and 2019, the two years when the trade war was the most severe. This does not seem reasonable since the trade war resulted in China having fewer soybean imports from the United States. Because there is less soybean supply in China and soybean demand remains the same, this will certainly cause soybean prices to rise. Why, then, do we see that the price of soybeans has not changed significantly, and has even dropped a little?

The reason for this outcome is most likely the government's quick response. After the trade war began, China quickly changed the country of origin of soybean imports, ensuring that China's soybean supply might remain stable. Data on the source countries of China's soybean imports can be found on the oec.world website.

According to data on oec.world, in 2016, before the trade war, 43.7% of the soybeans imported by China came from the United States. This is a very large number. Another 44.6% are from Brazil and 8.65% are from Argentina. In 2018, only 9.99% of China's imported soybeans came from the United States, while 80.8% of imported soybeans came from Brazil. This approach not only avoids a supply shortage of soybeans in China, but also prevents the price of soybeans from becoming higher due to increased tariffs.

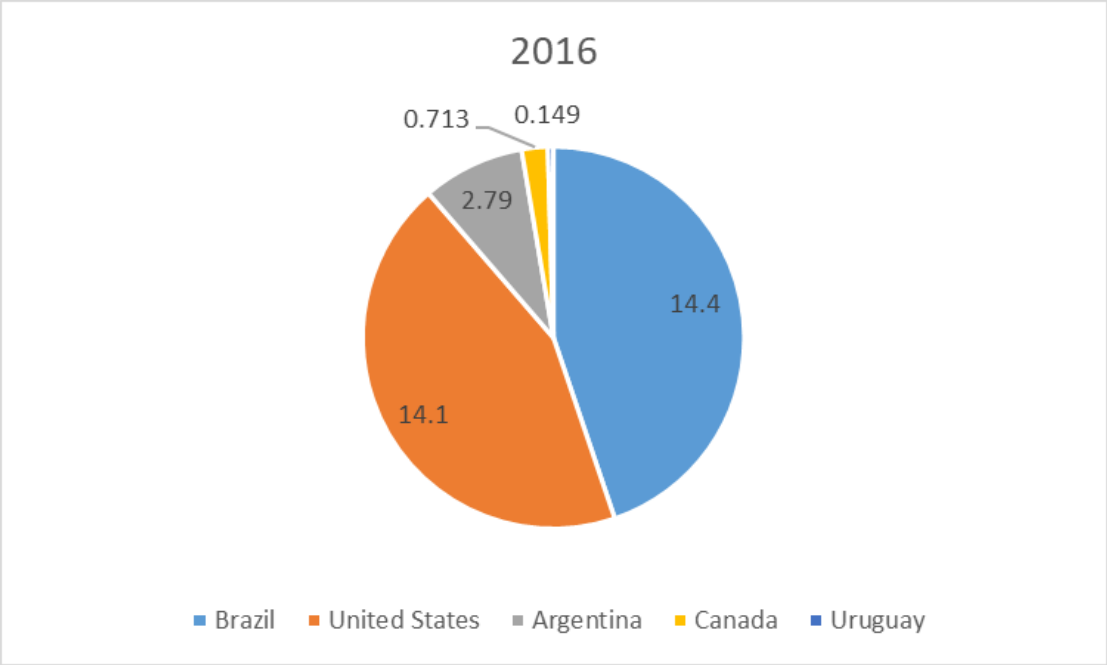

Figure 2. Distribution of China's Soybean Imports in 2016（Unit: Billion dollars)

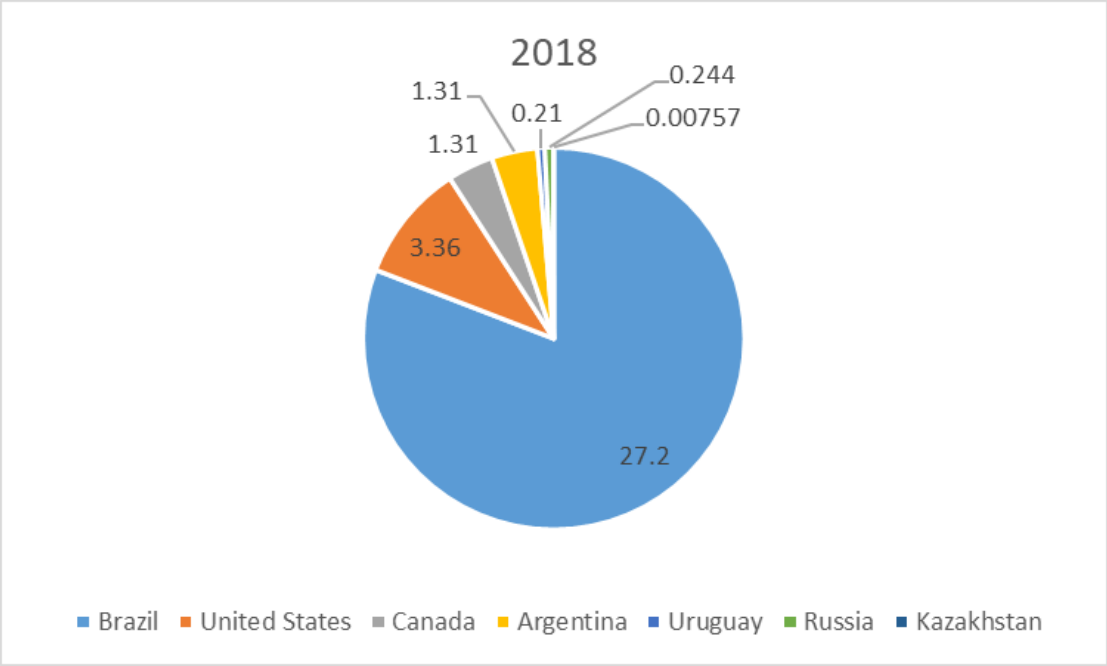

Figure 3. Distribution of China's Soybean Imports in 2018（Unit: Billion dollars)

In addition, according to this website the total value of China's soybean imports in different years is as follows: China imported a total of $36.5B in 2017, $33.7B in 2018, and $31.9B in 2019. Obviously, the trade war has caused some decline in China's soybean imports, but it is not significant. In 2020, after the trade war turmoil gradually subsided, this number returned to $37.4B. The graph below shows the change of soybean quantity in kilograms from 2013 to 2020.

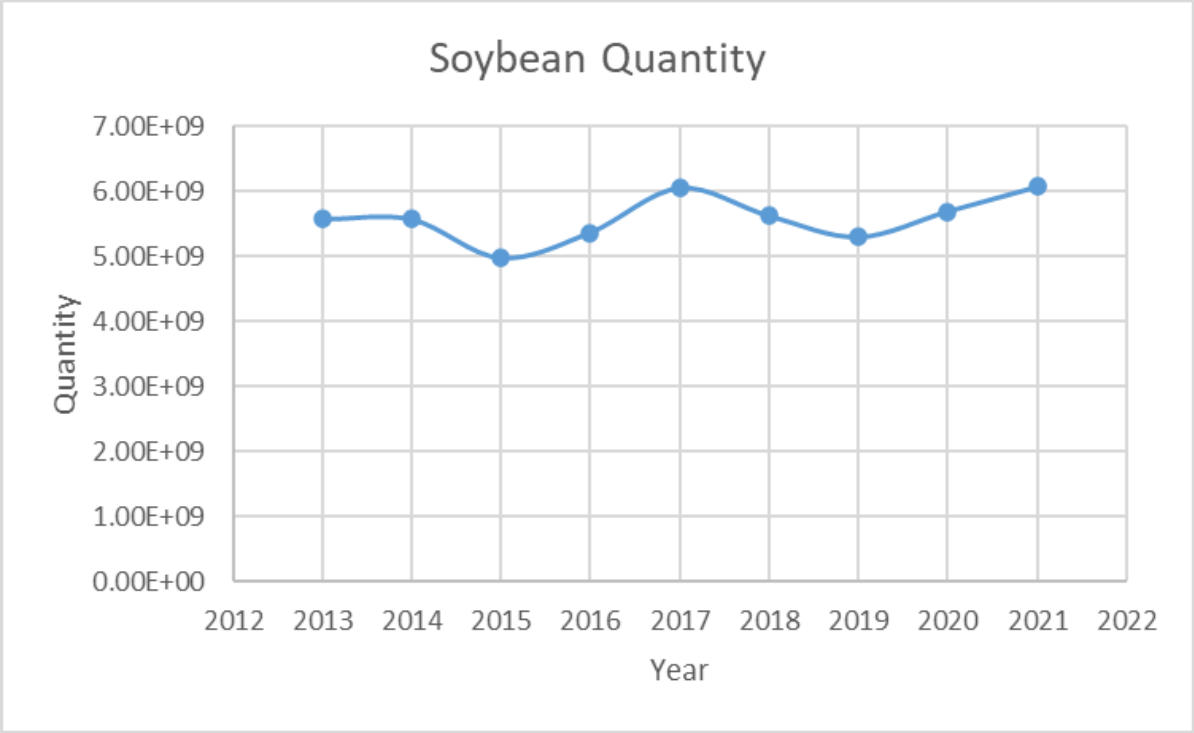

Figure 4. Change of Soybean Quantity in China from 2013 to 2021

In summary, the analysis of China's soybean prices during the intense period of the trade war in 2018 and 2019 reveals a counterintuitive trend. Despite the expected impact of reduced soybean imports from the United States, both nominal and real prices experienced a decline. This unexpected outcome can be attributed to the prompt response of the Chinese government, which swiftly adjusted the country of origin for soybean imports. This strategic move not only ensured a stable supply of soybeans in China but also prevented the anticipated price hike resulting from increased tariffs. By diversifying sources, China effectively navigated the challenges posed by the trade war, highlighting the significance of proactive governmental interventions in managing economic repercussions.

2 Data

2.1 Variables for Regression

The primary objective of this study is to investigate the impact of the trade war on the soybean market. Consequently, the real price of soybeans is chosen as the dependent variable. An explanatory variable in the form of a dummy variable is introduced to analyze the changes in the real price of soybeans in China before and after the trade war. Acknowledging that the real prices of soybean substitutes and complements may influence soybean prices, six additional explanatory variables are incorporated: the real prices of corn, peanuts, pork, fish, poultry, and beef. Although other variables such as the real prices of tofu, soy sauce, and sprouts were initially considered, they were omitted from the model due to data limitations.

y : the real price of soybean
The focus of this research is on soybeans. Taking the real price of soybeans as the y variable helps to observe changes in soybean trade. The reasons for the decline in soybean prices during the trade war were mentioned above.

X_1 : the real price of corn
Corn is one of the leading alternatives to soybeans. The price of corn is used as an x variable because its price is likely to affect the price of soybeans. From 2013 to 2021, corn prices were relatively stable.

X_2 : the real price of peanuts
Peanuts are one of the leading alternatives to soybeans. The price of peanuts is used as an x variable because its price is likely to affect the price of soybeans. From 2013 to 2021, corn prices will be relatively stable.

X_3 : the real price of pork
Soybeans are one of the main feeds for pigs. Pigs are also an important protein substitute for soybeans. Therefore, it is necessary to study the price of pork. There is a surge in pork prices around 2020. However, this is not because of the impact of the trade war on soybeans. In fact, the reason was that China suffered an outbreak of African Swine Fever, which led to gross domestic product and economic losses. The swine fever killed a large number of pigs, thus causing pork prices to rise. It was not directly related to the trade war.

X_4 : the real price of fish
Fish is an important source of protein, so it could be a possible substitute for soy. Therefore, it is necessary to set it as an x variable.

X_5 : the real price of poultry
Poultry is an important source of protein, so it could be a possible substitute for soy. Therefore, it is necessary to set it as an x variable. Chicken prices varied significantly over the 2016-2020 period. However, research has shown that such price changes are not caused by the trade war between China and the United States. According to two USDA articles, the price changes in 2017 were due to avian influenza (Abraham, 2017). The price changes in 2019 were due to swine fever (Abraham, 2019). Because chicken is an important pork substitute.

X_6 : the real price of beef
Beef is an important source of protein, so it could be a possible substitute for soy. Therefore, it is necessary to set it as an x variable.

T: a dummy variable, taking the values 1 (indicating the presence of a trade war) or 0 (indicating the absence of a trade war).

Table 2. Descriptive Statistics for Each Variable

	Mean	Median	Minimum	Maximum	Standard Deviation (SD)
Real Price of Soybean	5.84	5.71	5.35	6.26	0.34
Real Price of Corn	2.10	1.98	1.77	2.55	0.30
Real Price of Peanut	11.96	11.83	10.93	13.32	0.73
Real Price of Pork	27.00	24.15	20.03	44.65	7.32
Real Price of Fish	15.26	15.13	14.10	17.70	1.14
Real Price of Poultry	17.78	17.81	16.87	18.91	0.63
Real Price of Beef	62.45	59.85	57.51	73.16	6.00

From the chart above, we can summarize the dependent variable and the independent variables. The real price of pork and the real price of beef stand out with a large range, spanning from 20.03 to 44.65 and from 57.51 to 73.16, respectively. Moreover, these two variables have large standard deviations (SD), indicating significant price

variability. In contrast, the real price of soybeans and the real price of corn demonstrate narrower ranges, from 5.35 to 6.26 and from 1.77 to 2.55, respectively, and they have very small SDs, suggesting a more stable price series. The standard deviation reflects the dispersion of data points around the mean, indicating the level of price fluctuation. Pork has the highest SD at 7.32, indicating substantial variability, while corn has the lowest at 0.30, suggesting greater price stability.

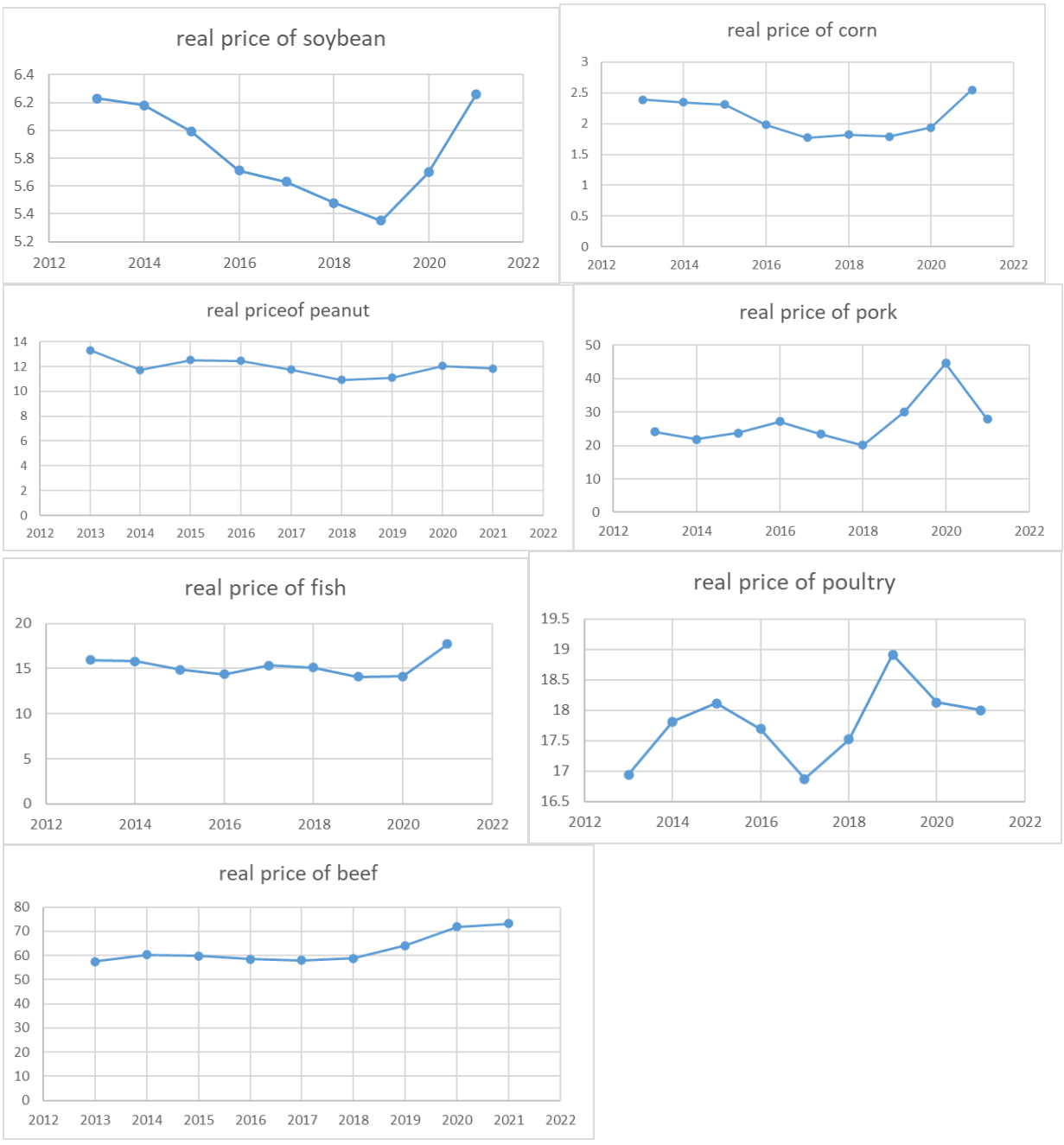

Figure 5. Chart of the Time Trends for Each Variable

Visually, it is evident in Figure 5 that the real prices of pork and beef exhibit wide fluctuations, whereas the real prices of soybeans and corn demonstrate more narrow ranges. Furthermore, the real price of pork shows significant variability, in contrast to the relatively stable real price of corn. This observation aligns with the data presented in the chart above.

3. Regression Analysis

3.1 Regression Equation

We propose to use a linear model with the soybean price on the left hand side and the given X variables on the right hand side:

$$y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 T + \varepsilon. \quad (1)$$

Formula (1) is the regression equation for the real price of soybean. The dependent variable y is the real price of soybeans during the 2013 - 2021 period; $X_1, X_2, X_3, X_4, X_5, X_6$ represent the real prices of corn, peanuts, pork, fish, poultry, and beef during 2012 - 2021, respectively; T is the dummy variable, taking the value one to indicate the presence of the trade war and zero otherwise; ε is the random error.

3.2 Regression Analysis Results

3.2.1 Full Model

The first model is a comprehensive model that aims to analyze the relationship between soybean prices and various factors, including the impact of trade wars, while accounting for other potentially influential variables. This model corresponds to the complete regression equation listed above.

Table 3: Regression Results for the Full Model

Variable Name	Estimated Coefficient	Std. Error	t value	P - value
(Intercept)	6.5180	0.4736	13.762	0.0462 *
Corn	1.2300	0.0467	26.319	0.0242 *
Peanut	-0.1415	0.0168	-8.447	0.0750 .
Pork	0.0256	0.0037	6.840	0.0924 .
Fish	0.0625	0.0206	3.034	0.2027
Poultry	-0.1123	0.0194	-5.780	0.1091
Beef	-0.0207	0.0053	-3.921	0.1590
Trade War	0.1346	0.0162	8.316	0.0762 .
Multiple R-squared	0.9999			
Adjusted R-squared	0.9989			

The variables that significantly impact soybean prices are the prices of corn, peanuts, and pork, and the trade war dummy variable, as indicated by the p-values of 0.0242, 0.0750, 0.0924, and 0.0762, respectively. That is, the corn price variable is significant at the 5 percent level, and the other three are significant at the 10 percent significance

level. The corn, pork, fish, and trade war variables have positive coefficients, suggesting that soybean prices increase with these factors, but the fish variable is not significant. The high multiple R-squared and adjusted R-squared values (both above 0.99) suggest that the model explains nearly all the variability of the response data around its mean. This shows, as one would expect, that the price of soybeans is very closely related to the prices of corn, peanuts, and pork, and the presence of trade war.

3.2.2 Regression Model with Only the Trade War Variable

Next, we focus on a reduced model that simplifies the analysis by including only the dependent variable (real price of soybeans) and the dummy variable, T, that represents the presence of a trade war. By excluding the other independent variables, the reduced model focuses solely on examining the direct impact of trade wars on soybean prices.

Table 4: Single Variable Regression of the Soybean Price on the Trade War Dummy

Variable Name	Estimated Coefficient	Std. Error	t value	P - value
(Intercept)	6.2050	0.2014	30.807	9.8e-09 ***
Trade_War (Soybean)	-0.4736	0.2284	-2.074	0.0768 .
Multiple R-squared	0.3805			
Adjusted R-squared	0.292			

The regression output (Table 4) shows us that the effect of the trade war is not highly significant; it is significant at the 10 percent level. The coefficient is -0.4736, this negative coefficient suggests that, during the trade war period, there was an estimated decrease in soybean prices compared to the periods not affected by the trade war. One reason for the tolerance of a higher significance threshold is that we have few degrees of freedom given the small sample.

Table 5: Single Variable Regression of the Corn Price on the Trade War Dummy

Variable Name	Estimated Coefficient	Std. Error	t value	P - value
(Intercept)	2.3700	0.1944	12.191	5.72e-06 ***
Trade_War (Corn)	-0.3471	0.2204	-1.575	0.159
Multiple R-squared	0.2616			
Adjusted R-squared	0.1561			

In this regression we focus on the effect of the trade war period on the corn price. The regression output (Table 5) shows us that the effect of the trade war on the corn price is not very significant. Here, the p-value is about 0.16, indicating that the trade war is not significantly affecting the corn price even with a 10 percent level. Nevertheless, to give an interpretation, the coefficient is - 0.3471, suggesting that, during the Trade War period, there was an estimated decrease in corn prices compared to the periods not affected by the trade war.

Table 6: Single Variable Regression of the Peanut Price on the Trade War Dummy

Variable Name	Estimated Coefficient	Std. Error	t value	P - value
(Intercept)	12.5200	0.5010	24.992	4.19e-08 ***
Trade_War (Peanut)	-0.7171	0.5680	-1.262	0.247
Multiple R-squared	0.1855			
Adjusted R-squared	0.0691			

Here, we look at the effect of the trade war period on peanut prices. The regression output (Table 6) shows us that the effect of the trade war on the peanut price is not significant. The coefficient is -0.7171, suggesting that, during the Trade War period there was an estimated decrease in peanut prices compared to the periods not affected by the trade war; again, this coefficient is not significant.

Table 7: Single Variable Regression of the Pork Price on the Trade War Dummy

Variable Name	Estimated Coefficient	Std. Error	t value	P - value
(Intercept)	22.995	5.262	4.370	0.0033 **
Trade_War (Pork)	5.145	5.966	0.862	0.4171
Multiple R-squared	0.0960			
Adjusted R-squared	-0.0331			

In the next model, we look at the effect of the trade war period on the price of pork. Since soybeans are a big factor affecting pork feed, we expect that the effect of the trade war on the soybean price might affect the price of pork. The regression output, in Table 7, shows us that the effect of trade war on the pork price is not significant. The coefficient is 5.145, this positive coefficient suggests that, during the Trade War period, there was an estimated increase in pork prices compared to the periods not affected by the trade war. But it is interesting that this coefficient is not significant; any effect on soybean prices did not translate into pork prices.

Table 8: Single Variable Regression of the Poultry Price on the Trade War Dummy

Variable Name	Estimated Coefficient	Std. Error	t value	P - value
(Intercept)	17.3750	0.4435	39.173	1.84e-09 ***
Trade_War (Poultry)	0.5150	0.5029	1.024	0.34
Multiple R-squared	0.1303			
Adjusted R-squared	0.0060			

In this model we explore the effect of the trade war on the price of poultry. The output from the regression is in Table 8, and we see that the trade war on the poultry price is not significant. The coefficient is 0.5150, suggesting that during the Trade War period there was an estimated increase in poultry prices compared to the periods not affected by the trade war; but, again, this estimate is not significant.

Table 9: Single Variable Regression of the Beef Price on the Trade War Dummy

Variable Name	Estimated Coefficient	Std. Error	t value	P - value
(Intercept)	58.870	4.298	13.697	2.61e-06 ***
Trade_War	4.607	4.874	0.945	0.376
Multiple R-squared	0.1132			
Adjusted R-squared	-0.0135			

In the final model, we regress the price of beef on the trade war dummy variable. The regression output is shown in Table 9; we see that the trade war did not significantly affect the beef price. The coefficient is 4.607, meaning that the Trade War period is positively correlated with the price of beef, but not significantly so.

4. Conclusion

The comprehensive analysis conducted in this study reveals the multifaceted impact of the U.S.-China trade war on the prices of soybeans and their potential substitutes. The trade tensions between China and the United States in 2018 resulted in a trade war marked by tariffs imposed on each other's imported goods. Among the commodities significantly impacted were agricultural products, with soybeans being one of the most affected. Given China's substantial import of soybeans from the United States, it was anticipated that the soybean trade would bear the brunt of the trade war. This circumstance is also the main motivation for conducting this research. From a closer examination of actual price trends and responses to alternative purchasing strategies, some key insights emerge.

The study draws its data and foundation from official government documents of China and the two countries involved, along with reputable statistical websites. This encompasses government reports detailing the trade war, statistics on China's soybean imports, fluctuations in nominal and real prices of soybean substitutes, and various informative charts essential to the analysis. Our analysis rests on several linear regression models, focusing on how the trade war affected the soybean price. We control for the related prices of six potential substitutes for soybeans (corn, peanut, pork, fish, poultry, and beef), both together and separately. Our results indicate that changes in the prices of peanuts, corn, and pork are significantly related to prices of soybeans, and that the trade war is significantly related to the price of soybeans. The prices of fish, poultry, and beef were not significantly associated with the prices of soybeans at the 10 percent level. However, none of the price changes of the substitutes are highly significant due to the policy changes. Only corn is significant at the 10 percent level.

Despite the trade war, data from authoritative websites shows that soybean prices have remained stable, highlighting the resilience of China's agricultural import market. It is likely that the Chinese government's rapid adjustment of its import strategy, including diversification of sources into Brazil and Argentina, played a crucial role in avoiding major disruptions in soybean supply and pricing. Since the price and supply of soybeans have remained at a relatively good level, the public does not need to use significantly more soybean alternatives. This highlights the importance of taking proactive policy measures to maintain food security and stability in the context of geopolitical uncertainty.

Reference

China's consumer price inflation rate (CPI growth rate) over the years. China's consumer price inflation rate (CPI growth rate) over the years - Kuaiyi Data. (Citation originally in Chinese:*中国历年居民消费价格通货膨涨率(CPI 增长率)*. 中国历年居民消费价格通货膨涨率(CPI 增长率) -- 快易数据. (n.d.).) https://www.kylc.com/stats/global/yearly_per_country/g_inflation_consumer_prices/chn.html

Congressional Research Service. (2022, April 5). *CRS reports*. Section 301 Tariffs on Goods from China: International and Domestic Legal Challenges. https://crsreports.congress.gov/product/pdf/LSB/LSB10553#:~:text=On%20September%2021%2C%202018%2C%20USTR,billion%20worth%20of%20U.S.%20goods.

Gorman, L. (2022, April 1). *How the US-China trade war affected the rest of the world*. NBER. https://www.nber.org/digest/202204/how-us-china-trade-war-affected-rest-world

Inouye, A. (2017, October 4). *Report name: Poultry and Products Semi-annual*. Poultry and Products Annual. https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Poultry+and+Products+Semi-Annual_Beijing_China+-+People's+Republic+of_02-15-2022

Inouye, A. (2019, February 26). *China - People's Republic of poultry and products semi ...* China - People's Republic of Poultry and Products Semi-annual. https://apps.fas.usda.gov/newgainapi/api/report/downloadreportbyfilename?filename=Poultry+and+Products+Semi-annual_Beijing_China+-+Peoples+Republic+of_2-26-2019.pdf

Ministry of Commerce Announcement No. 34 of 2018 Regarding the Imposition of Additional Tariffs on Certain Imported Goods Originating in the United States. Ministry of Commerce of the People's Republic of China. (Citation originally in Chinese: *商务部公告 2018 年第 34 号 关于对原产于美国的部分进口商品加征关税的公告*. 中华人民共和国商务部. (2018, April 4).) http://www.mofcom.gov.cn/article/b/c/201804/20180402728516.shtml

Siripurapu, A. (2023, September 26). *The contentious U.S.-China trade relationship*. Council on Foreign Relations. https://www.cfr.org/backgrounder/contentious-us-china-trade-relationship

Soybeans in China. The Observatory of Economic Complexity. (n.d.). https://oec.world/en/profile/bilateral-product/soybeans/reporter/chn

You, S., Liu, T., Zhang, M., Zhao, X., Dong, Y., Wu, B., Wang, Y., Li, J., Wei, X., & Shi, B. (2021, September 27). *African swine fever outbreaks in China led to gross domestic product and economic losses*. Nature News. https://www.nature.com/articles/s43016-021-00362-1