

THE EFFECTS OF TRADE RESTRICTIONS ON BASIS

by

Laina Dee Anderson

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DEDICATION

To Trevor, who would never pass up an opportunity to end my research discussions with 'on that basis.'

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ABSTRACT

After accusing China of stealing intellectual property and engaging in unfair trade practices, the United States announced a \$46.2 billion tariff on Chinese imports in April 2018. Immediately, China announced a retaliatory 25 percent tariff on soybean imports from the United States. Both tariffs went into effect on July 6, 2018. Due to China historically buying 60 percent of total U.S. soybean exports the tariff had a major effect on the soybean market as 2018 exports dropped by 74 percent compared to 2017 exports (Ward, 2018; Adjemian et al., 2019). While the soybean futures contract price dropped nearly two dollars, research has not studied the consequences on prices in local markets where almost all marketing transactions occur. Using a difference-in-differences model with corn basis as a counterfactual, I measure the relative change in soybean basis between the announcement period and after the tariff went into effect across 3,222 cash markets. The results suggest that basis for soybeans weakened five cents per bushel relative to its expected relationship with corn basis during the intermediate period, and after the tariff went into effect in July, soybean basis weakened an additional 14 cents per bushel and remained relatively weaker throughout the rest of 2018. The tariff caused basis to weaken in every state, Minnesota and Oklahoma soybean farmers faced the largest effects, with soybean basis weakening 25 cents and 23 cents per bushel relative to corn, respectively. Missouri and Nebraska faced the lowest impact, with soybean basis weakening 12 and 15 cents per bushel relative to corn basis, respectively.

INTRODUCTION

Free trade between countries provides economic growth for both importers and exporters (Smith & Glauber, 2019; Frankel and Romer 1999). However, policy-driven barriers to trade can disrupt well-established trade flows. Quantifying the impacts of these disruptions is important in understanding the effects of a policy change and understanding the gains of trade prior to the policy. These insights can inform future policy decisions and shape our perspective and attitudes towards trade.

One such policy-based trade disruption occurred in 2018 between the United States and China. The United States announced a \$46.2 billion tariff on imports from China, citing the growing trade deficit and China's unfair trade practices surrounding intellectual property as the motivation (Liu & Woo, 2018). China responded with a \$46.2 billion tariff on U.S. goods. When these tariffs went into effect on July 6, 2018, they significantly altered the U.S. soybean industry. A year earlier, China bought 60 percent of the total U.S. crop (Ward, 2018). After the tariff, China purchased only 0.8 million metric tons (MMT) of U.S. soybeans between July and December, compared to the 22 MMT purchased during the same time frame in 2017 (U.S. Department of Commerce, 2018). With the tariff in place, U.S. soybeans became relatively more expensive to Chinese importers than competitors' exports (Gale et al., 2019). The United States tried to pivot to other markets, but the loss of exports to China could not be fully recovered (Adjemian et al., 2019). The trade policies enacted by the United States and China and their significant impact on the U.S. soybean market present a natural experiment to understand how trade disputes affect farmers' marketing opportunities.

While a large body of research focuses on how trade policy affects country or commodity-level market characteristics (e.g., changes in the national-level price, changes in export volumes, among others), few studies consider how trade policies affect more local markets and whether differences between national and local impacts exist. This consideration is particularly important for U.S. agricultural commodity markets, which are structured in a way that there are many local markets where many farmers sell a homogenous good to many grain elevator firms. Every elevator considers local market conditions when they offer a cash price for a farmer's crop. As such, national-level trade policies—such as the 2018 trade dispute that almost entirely depleted the demand for U.S. soybean exports—may have differential impacts on individual elevators' pricing decisions.

One approach for measuring local trade policy impacts—and in this way, develop a more precise way to understand the effects on agricultural producers—is to quantify changes in basis faced by farmers within their local markets. Basis is defined as the difference between a national price—traditionally the futures contract price of a commodity—and the local cash price for a commodity. As such, basis can provide a more detailed characterization of how farmers are affected from price changes because basis captures price dynamics at both a national and local levels (Bekkerman & Pelletier, 2009; McNew & Griffith, 2005; Smith, 2018; Bekkerman et al., 2014). Perhaps more importantly, basis represents the actual price farmers receive for their product.

Since corn and soy are grown in the same U.S. regions, but only soybeans are exported to China to any great extent, corn basis can serve as a reasonable counterfactual to identify the effects of the Chinese soy tariff on U.S. soy basis. To measure the change in basis caused by the

tariff, I employ a difference-in-differences framework. For this model, I use basis for corn as a counterfactual. The literature presents corn as a substitute for soybean producers. Corn and soybeans thrive in the same regions, are delivered to the same elevators, and mutually benefit when planted in rotation (Hennessy, 2006; Bullock, 1992). For these reasons, farmers make land allocation decisions between planted corn and soybean acres every spring. Corn and soybeans require similar inputs and processing as well (Miller, 2003). Ultimately, this supply-side substitutability of the two crops has created a strong, long-term relative price and basis relationship within the United States (Brorsen et al., 1985; Paul, 1970).

While corn and soybeans are close substitutes for farmers, they are not substitutable outputs. Corn and soybeans are both primarily used in animal feed but serve different purposes. Corn provides carbohydrates and energy while soybeans are high in protein (McCarthy et al., 1989). Additionally, the U.S. corn industry did not have any significant ties to China importers (U.S. Department of Commerce, 2018). The United States did not export any significant quantities of corn to China before or after the tariff (U.S. Department of Commerce, 2018)¹, so corn did not face the policy effects as soybeans. For these reasons—the long-term, stable relative price relationship between corn and soybeans in the United States and the soybean-specific trade policy impact resulting from the China-U.S. trade dispute—corn serves as a valid control market to compare the changes faced by the soybean industry. This represents a new approach to quantify the effects of national trade shocks on local markets.

¹ Between 2015 to 2017, the United States exported between 271 to 811 thousand metric tons of corn to China while U.S. soybean exports to China ranged from 36,119 to 28,194 thousand metric tons (U.S. Department of Commerce, U.S. Census Bureau, 2018; USDA, 2021).

I employ weekly basis data from over 3,000 elevators across 36 U.S. states over a period of January 2015 to September 2020 to quantify the effects of the tariff. The results indicate that the trade dispute significantly affected soybean basis. Soybean basis weakened five cents per bushel relative to corn basis during the time between the April announcement and July implementation. Basis for soybeans continued to weaken an additional 14 cents per bushel compared to corn after the tariff went into effect. Additionally, markets across different states reacted to the policy in different magnitudes. Minnesota and Oklahoma experienced the largest weakening in basis at -25 and -23 cents per bushel respectively, and elevators in all states offered weaker soybean basis relative to corn. The impacts of the tariff carried over into the new marketing year and remained relatively lower than before the tariff compared to corn throughout 2018. The event study showed that the tariff continuously caused soybean basis to weaken per bushel relative to corn until November 2018.

These results shed light on the accuracy of assistance provided to farmers following the tariff. The USDA provided a \$12 billion relief package through the market facilitation program (MFP). The MFP provided direct payments to farmers facing market changes due to the retaliatory tariffs. Soybean producers received \$1.65 per bushel for half of their 2018 production (USDA, 2018). This research applies to the fullness of the MFP program in compensating losses faced by farmers. Producers already faced a lower futures market and the weakened basis added to the losses. The blanket \$1.65 per bushel payment may have compensated some producers fully while others faced additional losses. For these programs to accomplish their objective, the influence of export markets in local markets must be considered, otherwise we may miscalculate the results if the analysis remains on the national level.

INDUSTRY BACKGROUND

Overview of U.S. Soybeans

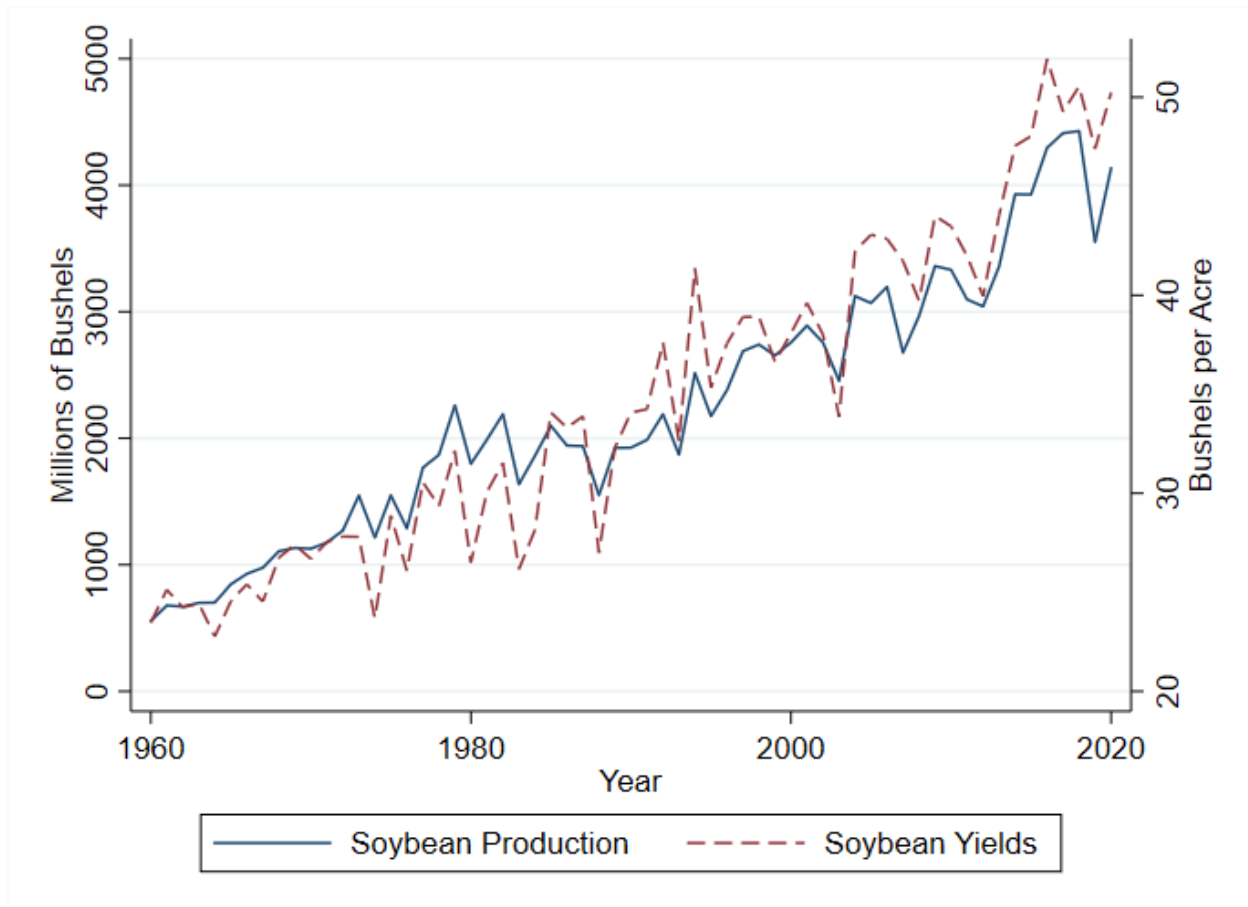
The United States began growing soybeans in the 1940s when World War II interrupted Chinese soybean supplies. (NC Soybean Producer Association, n.d.). In the 1950s, the United States planted 15.6 million acres (Schuab, 1988). Global demand for soybeans grew throughout the rest of the 20th century as livestock producers switched to soybean meal as the primary protein source in livestock feed. The United States became the main exporter for corn and soybeans over fifty years ago, selling primarily to Japan and the European Union (EU). Competition with Argentina and Brazil intensified in the mid-1980s and the United States saw its market share drop from 74 percent to 56 percent (Schuab, 1988).

To remain competitive, the U.S. production technology improved soybean yields and planted soybean acres increased. For example, the 1990s brought the development of glyphosate-resistant soybeans (Schuab, 1988). This new variety allowed for less field passes as farmers were able to spray weeds more efficiently and effectively. Today, U.S. producers plant six times as many acres compared to the 1950's (USDA Economic Research Service). Figure 2.1 shows how soybean yields per acre trended with total U.S. production.

Seventy five percent of U.S. corn and soybeans production comes from the United States' heartland. This region includes Iowa, Illinois, Indiana, Missouri, Minnesota, Nebraska, South Dakota, and Kentucky (Meade et al., 2016). A majority of producers in this region practice crop rotation between corn and soybeans. Crop rotation is the practice of sequencing different plant species on the same land (Bullock, 1992). Research shows planting corn and soybeans in rotation increase yields for both crops (Miller, 2003; Bullock, 1992) because soybeans, a legume,

help fix nitrogen from the air into the soil, aiding land productivity for corn planted in the following year.

Figure 2.1 National Production in Millions of Bushels and Yield per Acre for Soybeans in the United States (1960-2020) Source: USDA Economic Research Service



Nitrogen is a primary input for corn, so planting soybeans in rotation reduces fertilizer costs. The spillover yield and input effects persist one year after corn is planted and two years for soybeans, meaning that producers see benefits of planting soybeans for two years in their corn production (Hennessy, 2006). These spillover effects include decreased weeds, pests, and disease and enriched soil. Synthetic fertilizers and herbicides cannot compensate for the benefits of crop rotation (Bullock, 1992).

While the rotation between corn and soybeans occurs every year to every few years, producers may alter their decision framework under uncertainty regarding output prices or yields. When government price supports reduce price risk for a commodity, acreage for that commodity increases (Chavas & Holt, 1990). However, other research suggests that the cost of forgoing a crop rotation may exceed the gains from a relatively high output price (Livingston et al., 2014).

Soybean Marketing Overview

After harvest between September and November, soybean farmers decide if they should sell soybeans immediately or store the crop and wait for more favorable market conditions. This decision is not void of constraints; producers must consider storage costs, market changes, and degradation. If the producer decides to store the harvest, the soybeans could go to on-farm storage, if available, or to commercial storage. The theory of storage states that the price of storage incorporates the opportunity cost of a bin storing one commodity over another. This explicitly means that commodities compete for storage (Paul, 1970; Schuab, 1988). Commercial storage facilities mainly consist of country elevators. The elevators storing the commodities want to store efficient ratios of grains so that they may optimize their net return per bushel. An elevator needs to be equipped to handle a crop before they decide to take that crop on. For example, a rail car of soybeans need to be cleaned, removing weeds and field debris, then dried (Paul, 1970).

Elevator handling practices influence soybean quality (Barger, 1981; Mounts et al., 1978). Moisture control is crucial to the integrity of the beans; soybeans must be stored in

weather-tight bins so that the moisture content of the beans does not change from 12 to 13 percent (Barger, 1981).

At the core of commodity marketing, elevators handle, transport, store, and merchandise grain (Casavant & Griffin, 1983). An elevator will buy large quantities of grain from local producers and store the crop in large bins. Through leveraging economies of scale, the elevator will ship the grain down the supply chain to mills or refineries (Vachal & Tolliver, 2001). Because transportation is central to an elevator's operation, they are typically located in rural communities along rail lines or waterways. Elevators vary in storage capacity and handling rate—or how frequently the firm moves product (Vachal & Tolliver, 2001; Casavant & Griffin, 1983). The county elevators that purchase soybeans from producers sell the soybeans to terminal markets, domestic processors or exporters (Schuab, 1988). At export elevators, basis for soybeans reflects the competitiveness of soybean exports in Brazil—therefore, basis at export elevators strengthen when export demand increases and weakens in response to weak export demand (Bullock & Wilson, 2020)

The United States competes for market share most closely with Brazil (Adjemian et al., 2019; Bullock & Wilson, 2020). Brazil has lower production costs per acre for soybeans but these costs are offset in the United States through higher yields per acre. The United States' other advantage is its low-cost transportation network. The United States' widespread rail lines and barges allow a cost-effective method for soybeans to be delivered to shipping ports while Brazil relies on high-cost trucking (Meade et al., 2016). China is the major buyer for Brazil and U.S. soybeans (Meade et al., 2016; Bullock & Wilson, 2020).

China's Agricultural Growth

The United States and Brazil produce more than 80 percent of global soybean exports, and China orders over 60 percent of soybean imports. This is the largest import share for any commodity for any country. The growth in imports began in the 1990s and spiked 80 million metric tons (MMT) when China joined the WTO during the 2000/2021 trade year. Imports continued to grow before peaking at 95 MMT in the 2017/2018 marketing year (Ward, 2018). Imports did not decrease in China until 2018, when they fell to 94 MMT (Gale et al., 2019; Ward, 2018). Consider the engines driving this growth.

The growing middle class in China attributes to the growing soybean imports. The Chinese middle class expanded at rates not observed. Today, over 20 percent of the global middle class resides in China. While China's economy grew steadily over the past several decades, household incomes lagged behind, stunting middle class growth. This began to transition in 2006 when 60 million people were added to the middle class in China annually (Kharas & Dooley, 2020). Massive urbanization within China led to more productive jobs and higher living standards. With higher incomes, this middle class switched from plant-based diets to higher-quality diets containing more meat (Gale, 2015). With higher demand for meat, China bolstered its livestock production.

The Chinese government began reforming the livestock industry in 1978. Before this reformation, China operated an extremely centrally planned agricultural sector (Li, 2009). Livestock production immediately grew 20 percent in response to China decriminalizing non-grain production. The livestock industry consisted of backyard farms with a few hogs and chickens per family. The government encouraged backyard farmers to specialize in one species in order to scale towards modern production. In the 1980s, the small farms grew under further

liberalization policies when the state allowed farmers to trade animals and determine prices themselves (Li, 2009).

With the liberalization of farm products, farm growth rates increased. Yet, household farms still made up the majority of livestock production into the 2000s. For example, 102 million household farms, raising one to nine pigs annually, produced nearly 53 percent of the country's total pig output in 2003 (Li, 2009). The government pushed for industrial agricultural production during 2006-2010 through its 11th five-year plan. This plan incentivized increased use of commercial feed over locally available foraged feed and subsidized construction of large-scale farms and improved breeding practices (Gale et al., 2019).

Large-scale farms gained traction in China over the past fifteen years. In 2005, 23 percent of hog production came from “above-scale” farms, classified as farms slaughtering 500 or more hogs annually. By 2020, these farms produced 52 percent of China's pork (Gale, 2015). These methods worked to grow China's livestock industry. The dairy industry grew an average nine percent from 1978 to 2009, and China has been the top egg producer since 1985 (Li, 2009). China also maintains the world's largest pig herd (Mason-D'Croz et al., 2020). The massive growth experienced by China's livestock industry left the country straining to develop a reliable feed source.

In order to maintain these livestock, China developed a robust feed manufacturing industry. Launched in the 1970s, the Chinese feed industry grew through government support and foreign investment. The industry mainly serviced backyard farms. Village feed mills cropped up to supply these small-scale farms, relying on locally available grains and proteins

gathered with surplus labor. These small mills were the vehicle behind much of the livestock growth during the 1980s (Gale, 2015).

Soon, livestock output outpaced feed production, leading to China liberalizing imports of feed materials in 1995. China cut tariffs and taxes on imports for feed protein sources, including soybean meal and subsidized the milling industry (Hansen & Gale, 2014). Soybean meal in animal improved livestock diets and productivity. Feed mills shifted to private ownership and increased from 9,000 mills in 1991 to 13,000 in 1996 (Gale, 2015). This allowed the world to supply China's growing commercial feed industry and mills to expand to a commercial scale, proved by China's soybean imports expanding from \$75 million in 1995 to \$38 billion in 2013 (Hansen & Gale, 2014).

As previously discussed, China holds a major share of global soybean imports. With the United States providing a large portion of China's demand, the U.S. soybean industry developed strong ties to China that resulted in the industry being a clear target during the trade war with China. This trade relationship developed over several decades and was fueled by growing economies in both the United States and China. China transitioned from a developing country struggling to produce enough resources for its own population to the world's largest exporter. The United States and China have a complicated trade relationship. Let us consider the inception and development of these ties over the past decades so that the recent trade conflicts are contextualized.

China–U.S. Trade Relationships

China's rise in exports is founded in its clear comparative advantage: manufacturing. From 1990 to 2013, China exported an average of 88 percent of global merchandise exports

(Autor, Doran & Hanson, 2016). China radically liberalized trade, starting in the 1980s, through cutting tariff rates and removing licenses and quotas (Sun & Heshmati, 2010). In 2001, China became the 143rd member of the World Trade Organization (WTO). This strengthened the country's multilateral trade network and helped reduce the technology gap between China and developed countries through access to foreign equipment and technology (Sun & Heshmati, 2010). The 1990s to the 2010s witnessed China's trade volume grow an average of 18.1 percent annually. Over time, China's exports have shifted from labor-intensive manufacturing towards high-technology exports (Sun & Heshmati, 2010). Trade had evident positive impacts on Chinese citizens—Shanghai's blooming skyline, higher household incomes, and a multitude of export factories were non-existent in 1980 (Autor, Dorn & Hanson, 2016).

The benefits of trade were murkier for U.S. manufactures. Dubbed as the “China shock,” U.S. industries exposed to import competition from China faced dips in employment. (Autor, Dorn & Hanson, 2016). While domestic industries struggled to compete with China, the United States accumulated a \$400.1 billion trade deficit with China in 2018. The United States imported \$500.4 billion from China while exporting \$100.3 to China (U.S. Census, 2021). The deficit expanded in the early 2000s with China rapidly gaining traction in the global market.

Trade Disputes under the Trump Administration

When Donald Trump campaigned for president, he was upfront to state that “trade deficits hurt the economy very badly” via Twitter (Nelson, 2017). The trade deficit's impact on U.S. industry was one of the three main concerns that led the United States to initiate the trade war. The other two involved belief that China was illegally obtaining and using intellectual

property and that China intended to weaken the United States national security and economic ranking (Liu & Woo, 2018).

The Trump administration began a trade policy overhaul in 2017. President Trump pulled out of the Trans-Pacific Partnership, a trade agreement with countries in the Pacific Rim, excluding China, and the United States. In addition, the Trump administration imparted tariffs on foreign steel, aluminum, solar panels and washing machines from partners such as Canada, Mexico, the EU and Japan (Swanson, 2018). Each barrier was justified by legal rationale. For example, the tariffs on imported solar panels and washing machines were filed under Section 201 of the Trade Act of 1974. This law allows the president to impose temporary trade measures if the U.S. International Trade Commission (ITC) determines increased imports pose a significant threat to a U.S. industry (Williams, 2019; Bown & Joseph, 2017).

The Trump administration placed protective tariffs on steel and aluminum on March 23, 2018 under Section 232, citing a national security threat. While there were tiers of exemptions, China's \$3 billion steel and aluminum exports came under the tariff. China retaliated with a 15 percent tariff on imports from the United States, such as fresh fruit, nuts, wine, and aluminum pipes (Ministry of Commerce News Office, 2018).

In the middle of the steel and aluminum conflict, the U.S. Trade Representative (USTR) released its report regarding China's unfair trade practices (Bown, Jung & Lu, 2018). The USTR concluded that the Chinese government inappropriately regulated or intervened in U.S. companies' operations in China and performed cyber intrusion and cyber theft against U.S. firms (USTR, 2018). The Trump Administration now had legal grounds to pressuring China further.

On April 4, 2018, the Trump Administration announced tariffs on \$46.2 billion of Chinese exports under Section 301. Section 301 of the Trade Act of 1974 ‘(a)llows the United States Trade Representative (USTR) to suspend trade agreement concessions or impose import restrictions if it determines a U.S. trading partner is violating trade agreement commitments or engaging in discriminatory or unreasonable practices that burden or restrict U.S. commerce (Williams, 2019).’ The U.S. tariffs primarily focused on machinery, electrical equipment and mechanical appliances. China announced retaliatory tariffs of equal value—targeting soybeans and transportation equipment (Bown & Kolb, 2018)². This tariff is the key market shock behind this research.

On July 6, 2018, the United States imposed the first phase of tariffs, \$34 billion, on China as China places \$34 billion tariffs on the United States. After these tariffs activated, the United States Department of Agriculture announced a \$12 billion subsidy for American farmers for lost export sales (USDA Press, 2018).

The United States imposed \$16 billion additional tariffs on Chinese imports in August, 2018. China mirrored with \$16 billion of their own tariffs on U.S. goods. In September, both the United States and China added an additional \$200 billion and \$60 billion of tariffs, respectively (Bown & Kolb, 2021). Due to the trade deficit, China lost leverage when there simply were not as many imports to place under the tariff. Negotiations between the United States and China began in December 2018. Additional tariffs scheduled to take place in January were postponed. The beginning of 2019 swirled with talks of negotiations and lifting tariffs followed by threats to prolong or heighten tariffs rates. President Trump manifested the threat in May 2019, raising

² This initial tariff targeted primarily soybeans and transportation equipment but the full breadth of the tariff targeted 106 products (Bown & Kolb, 2021).

tariffs placed in the September from 10 percent to 25 percent (Bown & Zhang, 2019). China announced it would increase tariffs on \$60 billion of imports on June 1st (Bown & Zhang, 2019). The United States announced in August that it planned to place protections on the vast amount of imports that thus far remained unscathed beginning in September. When China rolled back some tariffs and promised to resume buying U.S. soybeans, the United States postponed any additional new tariffs (Bown & Kolb, 2021). Table 2.1 outlines the progression of the trade war.

Table 2.1 Timeline of Trade War between the United States and China

Date	Event	Goods	Value
3/22/2018	United States Trade Representative releases report on China's trade practices	Intellectual property and technology	
3/23/2018	United States places tariff on countries, including China	Steel and aluminum	\$3 billion
4/2/2018	China places tariff on United States	Fresh fruit, nuts, wine, and aluminum pipes	\$2.8 billion
4/4/2018	United States announces tariffs	Machinery, electrical equipment and mechanical appliances	\$46.2 billion
4/4/2018	China announces tariffs	Transportation and vegetable products	\$46.2 billion
7/6/2018	United States imposes tariffs	Machinery, electrical equipment and mechanical appliances	\$34 billion
7/6/2018	China imposes tariffs	Soybeans and transportation equipment	\$34 billion
8/23/2018	United States imposes tariffs	Semiconductors, plastics, chemicals and railway equipment	\$16 billion
8/23/2020	China imposes tariffs	Coal, copper scrap, fuel, steel products, buses and medical equipment	\$16 billion

9/24/2018	United States imposes tariffs	Meat products, industrial equipment, and 5,745 other items	\$200 billion
9/24/2018	China imposes tariffs	Liquefied natural gas and certain types of aircraft.	\$60 billion
12/1/2018	China begins to buy U.S soybeans	Soybeans	\$500 million
5/10/2019	United States increases tariff rate	September list of goods	\$200 billion
6/1/2019	China increases tariff rate	September list of goods	\$60 billion
8/1/2019	United States announces tariffs	Final consumer goods	\$300 billion
9/1/2019	China imposes tariff	Additional 5% on soybeans	
1/15/2020	United States and China sign Phase One	Additional U.S. exports	200 billion
1/1/2021	China failed to meet goals	2020 U.S exports	124.6 billion
Sources: Bown & Kolb, 2021; Bown, 2021; Lee & Zhang, 2018; USTR, 2018; Reuters Staff, 2019; Plume, 2018			

The next chapter of the trade war consisted of the Trump Administration meeting with Chinese leaders for numerous negotiation attempts. On January 15, 2020, the United States and China signed Phase One of the new trade deal. China promised to purchase an additional \$200 billion of U.S. exports, compared to 2017 levels (USTR, 2020; Bown & Kolb, 2021). These goals became less realistic as the year progressed. China failed to keep pace with this promise and the balance sheet for 2020 U.S exports to China totaled \$124.6 billion—\$205.4 billion under target (U.S. Census, 2021). It will take further research and time to determine if the United States met their original goals of shoring up the trade deficit, protecting intellectual property and strengthening national security.

LITERATURE REVIEW

Rationale Behind Trade Policies in Agriculture

Fundamental trade theory illustrates that trade is a positive-sum game, meaning the total of the gains and losses is positive. Free trade allows a country to leverage their comparative advantage, increase income per capita, reduce price volatility and spur growth (Smith & Glauber, 2019; Frankel and Romer 1999). While the ‘gains from trade’ is deemed orthodox economic theory, barriers to trade still run rampant. There must be some rationale for countries waiving the full gains from trade.

Trade intervention in agriculture may be rational welfare enhancing policies, based off the market structure and policy type (Abbott, 1996). However, free trade is preferable from a global perspective. A cooperative equilibrium between countries may be reached, resulting in freer trade, but each country has the incentive to ‘cheat.’ This dynamic may be thought of as a ‘prisoners’ dilemma,’ where each country is well off if neither inflicts additional policy, but the payoff is highest for the country that enacts policy while the other country maintains free trade (Grossman & Richardson, 1985). We can understand how trade policies accumulate as countries respond to other market distortions. In addition, loss aversion, short-term responses to national emergencies and lobbyist influences are all catalysts to trade policy.

With respect to trade disputes, U.S. policy makers exert more effort in disputes regarding a breached trade agreement than developing new markets. This suggests that foreign trade policy is influenced by loss aversion—the principle that losses outrank improvements or gains (Berejikian & Early, 2013). This contributes to why countries focus on protecting existing trade

flows more than expanding their trade relationships. The fear of lost markets outweighs the gains from growing foreign trade.

Policy makers also respond to political interests. Lobbyists represent various economic interests with the intention of swaying policy in a direction favorable to their organization or industry. Trade barriers increase surplus for domestic industries, therefore lobbying is an endogenous determinant of restrictive trade policy (Gawande et al., 2012). Certain agricultural industries are heavily distorted by agricultural policy. For example, the United States places import quotas on sugar leading to artificially high prices. In a free-market, the United States would be a net importer of sugar, but that is not the case due to these quotas. The removal of trade and production distortions would induce a large productions relocation away from protected countries, such as the United States (Elobeid & Beghin, 2005).

Some opponents to free trade cite that economic growth, especially in agriculture, leads to negative externalities in the form of deforestation and natural resource depletion. Deforestation research finds the impact of trade openness is small and ambiguous on deforestation; however, economic growth has a relatively large negative effect on forest cover—meaning policies such as subsidized capital may have a large negative impact on the environment (López & Galinato, 2005). Countries want to protect their resources and ensure that commerce may continue for years to come. In the same way, anti-dumping laws prevent importers from flooding a market with supply to drive prices down and force competition to exit in an attempt to gain market power.

Anti-dumping laws are essentially tariffs on imported goods to protect domestic producers against lower-priced foreign goods. Countries can impose anti-dumping laws or may

choose to bring an anti-dumping dispute to the GATT/WTO. Economists have studied the implications behind both strategies. In the context of agricultural products, anti-dumping tariffs are ineffective when products are homogenous. The tariff acts as an implicit subsidy for domestic supply sources—driving prices higher (Kinnucan & Myrland, 2006).

Concerning American foreign relations during the Trump Administration, few would argue that it was nothing short of aggressive. Former president Donald Trump stated during his 2017 inaugural address, “We must protect our borders from the ravages of other countries making our products, stealing our companies, and destroying our jobs. Protection will lead to great prosperity and strength”(Trump White House, 2017). These anti-trade attitudes manifested into actions. Almost immediately, the Trump Administration pulled the United States out of the Trans-Pacific-Partnership (TPP), imposed tariffs on aluminum and steel imports and initiated negotiations regarding the North American Free Trade Agreement (NAFTA) that eventually led to the United States Mexico Canada Agreement (USMCA) (Trump Administration, 2021). As the United States retreated from globalization and the administration placed protective measures on trade, the trade disputes between the United States and China erupted, eventually leading to the retaliatory tariff on U.S. soybeans.

The trade dispute between the United States and China caused an estimated \$8.2 billion dead weight loss. The government received \$14 billion in tariff revenue from domestic consumers and importers (Amiti & Weinstein, 2019). Former President Trump claimed these revenues funded the relief package paid to farmers (Trump Administration, 2021) although the package totaled over \$16 billion.

While free trade, or at least freer trade, results in greater global welfare, it is clear that there are many incentives working against free trade. Governments are influenced by the possibility of other countries restricting trade, loss aversion, lobbyists and political gains, and the need to preserve natural resources. The United States has moved towards a more nationalistic view of trade during the Trump administration, which was observed through pulling out of the TPP, renegotiating NAFTA, and of course, inciting the trade war between trading partners—most notable China.

Policy Effects on Agriculture

While the reasons behind trade policy were discussed above, we now turn to how trade policies affect agriculture. Economists can measure the effects of trade on an economy by observing changes that occur when a policy is removed, trade is liberalized, or when a new barrier to trade is implemented. Changes in prices are the first layer of impacts of trade. While prices are instrumental in determining the changes in welfare caused by changes in trade, limiting the impacts of trade to monetary changes narrows the full breadth. Exposure to trade affects countries, firms, and individuals in vastly dynamic ways.

In measuring the degree of globalization, gains from trade, and the elasticity of trade volumes with respect to trade costs in agriculture, Reimer & Li (2010) found trade costs are driving national economics to autarkic equilibria. It is estimated that world trade volumes would increase fifteen times if all costs of trade were eliminated. There are two broad categories of trade costs: reducible and unreducible. Reducible trade costs include policies such as tariffs, quotas, and non-tariff measures. Unreducible costs cannot be easily removed, such as transportation costs. Due to the thin international crop market, trade volume in agriculture is

very elastic to trade costs. The market is thin due to protective trade policies making trade relatively more expensive, reducing the quantity of exports demanded. Commodity trade would be very responsive to lower protectionist policies..

Developed countries, such as the United States, Japan, and the European Union (EU) provide domestic and export subsidies. These subsidies allow producers to receive a price above the market-clearing price while selling product below the world price. The market distorts and leads to deadweight loss for importing and exporting countries. However, the subsidies may fulfill some other social goals, such as spurring regional development and innovation (Howell, 2017). The U.S. domestic corn subsidies resulted in \$661 million in dead weight loss for the United States while exporting countries lost \$143.7 million and importers faced \$385.8 million in losses (Koo & Kennedy, 2006). When Canada removed a subsidy on rail costs, transportation costs greatly varied regionally; the locations farthest from the nearest seaport faced the greatest increase in transportation costs. A difference-in-differences model shows that the removal of the subsidy leads to a decline in farm incomes, farm asset values, and a decline in the number of farms. This study also shows that the supply of labor is more elastic in non-agricultural sectors and the export subsidy supported many non-agricultural jobs in Canada (Bollman & Ferguson, 2019). Export subsidies are highly contested in the GATT/WTO and their removal is a high-priority for the organization.

Established by 23 countries in 1947, the General Agreement on Tariffs and Trade (GATT) enriches global trade through reducing trade barriers. Since 1995, the GATT's successor, the World Trade Organization (WTO), facilitates negotiations between member-countries. The organization will be referred to as GATT/WTO. The GATT/WTO established

regulation for world trade based on the principles that originated from the GATT Articles. Membership today includes 164 countries, accounting for more than 95 percent of global trade. While agricultural trade comprises a small margin of total global trade, membership in GATT/WTO approximately doubles agricultural trade volumes. Due to the GATT/WTO offering a forum to negotiate tariff reductions, reduce uncertainty, and facilitate coordination, membership may be a viable way for countries to boost agricultural trade (Beckman & Zahniser, 2018). However, American nationalism is replacing the standard view that trade is a positive-sum game, suggesting the total gains are greater than total losses. The shift to increased protectionism could strain the effectiveness of the GATT/WTO enforcement (Sheldon et al., 2018).

While these insights are helpful, trade has impacts that go beyond prices. It is important to remember that there are gains and losses with every trade, but the monetary net social welfare increases, as trade becomes freer (Thompson et al., 2001). Labor economics demonstrates how liberalization impacts labor flows and wages.

Increased foreign competition led to firms restructuring employee incentives, leading to higher wage differentials. When a domestic industry is exposed to import competition, a large negative employment response follows, as seen in the U.S. manufacturing sector after Chinese imports increased (Acemoglu et al., 2016). When the United States began importing more goods from China, local labor markets within the U.S. manufacturing industry faced higher unemployment, decreased labor-force participation, increased use of disability benefits and workers faced lower wages (Autor et al., 2013). High-wage workers were more able to transfer

to new employers and faced less earning losses than low-skilled workers in manufacturing in the wake of increased imports from China (Autor et al., 2014)

Blue-collar workers in highly affected industries saw significantly lower wage growth than other industries following the rollout of NAFTA (Hakobyan & McLaren, 2015). Jobs move from these exposed industries to non-exposed sectors (Asquith et al., 2019).

While domestic industries exposed to imports face depressed wages and decreased employment (Acemoglu et al., 2016; Hakobyan & McLaren, 2015), Edmonds et al. studies the impact of trade shocks on children. Areas subject to larger tariff declines after tariff reform saw lower school attendance relative to India's national trend. These areas experienced slower poverty reduction than other districts not exposed to the tariff reform. The result of increased foreign market access lead to less education for children exposed to the previous tariff (2010).

The effect of liberalization is heterogeneous across households. In rural China, farmers of imported products became more food-insecure if the household faced food insecurity to begin with while the more food-secure households benefited from the liberalization through off-farm income and other means (Baylis, Fan & Nogueira, 2018). Trade liberalization leads to greater agricultural productivity as it forces the exit of the least-productive farmers and reallocates resources to highly productive producers (Yoo, Gopinath & Kim, 2012).

While trade facilitates economic growth and increased social welfare, it is tempting for governments to protect their domestic industries and thus increase trade costs. As markets adjust to these policies, some are better off and others are worse off to restricted trade. The impacts of reversing these policies and liberalizing trade are also vast and only narrowly understood. As highlighted in the literature, employment in industries exposed to trade decreases, education

outcomes may be negatively impacted and resources are allocated to highly productive producers. At the same time, net monetary welfare increases, gross incomes rise while some individuals may face lower incomes and economies apply their comparative advantages. These effects of trade liberalization mentioned are rarely considered, or even predicted, when trade policy changes. Clearly, the impacts of trade in agriculture are multifaceted and range from education outcomes to transportation costs.

Contribution to the Literature

While most of the research surrounding commodity price dynamics focuses on either the local market or the aggregated futures market, no one has conducted research to marry the two and explore how a national market shock affects local market conditions. The United States Department of Agriculture estimated the impacts to producers at \$16 billion, per the relief package issued to farmers across the county in the wake of the tariff (USDA Press Release, 2018). This research will, in some sense, audit this relief measure and estimate the total drop in prices faced by farmers.

The literature also lacks any analysis regarding market-level elasticity of supply with respect to exports. We may observe that certain areas ship a greater load of soybeans to China than other regions, but this analysis will begin to reveal the dependence on the Chinese market and trade across the sample. Understanding the sensitivity of trade disputes by region will allow policy makers to have greater understanding of policy impacts, allow state soybean councils to develop markets overseas, and help farmers manage market risk.

While the tariff affected local markets through weakened basis immediately after it was implemented, we are curious about how this shock altered the market in the long term. The

intention of this thesis is to determine how a national trade shock affected local producers and elevators. We will further determine how long these impacts lasted and how sensitive to trade shocks each market was. The mechanism used to measure these impacts is basis, which reveals local market conditions. The literature has many insights into how to perform this analysis, which will be discussed in the next section.

Literature Methodology

A large body of literature focuses on understanding the dynamics behind basis. The research branches into papers that focus on developing models to fit the data and papers that use a shock to a local market to analyze basis. The results point to several factors, such as storage rates, transportation rates, and risk premiums affecting basis but differ with respect to the magnitude and duration of these influences on basis.

Davis and Hill (1974) were among the first to model basis among corn elevators. Among a list of variables, local supply and demand conditions are the main contenders in determining price. Basis patterns are systematic and are influenced by different factors throughout the year. For example, storage rates have a larger impact on basis in the fall than during other times of the year (Garcia & Good, 1983). Through a three-state variable model, soybean price volatility is found to be a linear function of inverse inventory (Geman & Nguyen, 2005). Symeonidis et al (2012) show that inventory is positively associated with basis, suggesting negative basis and low inventory has a stronger influence on price volatility than a positive basis and high inventory.

Transportation costs also affect basis. Transportation rates are used in reference to rail rates, trucking costs, and barge rates. Transportation costs are a proxy to an elevator's market access. Locations with greater market access can offer a higher price for grain—strengthening

basis (Davis & Hill, 1974). Increases in transportation costs pass to producers in the form of weaker basis (Bekkerman & Taylor, 2018). Therefore, transportation costs are negatively correlated with basis.

Some finance literature explains basis through the lens of risk premiums. Bailey & Chan (1993) attributed risk premiums and the business cycle to a large portion of basis variation. While this paper fit the data to a forecasting model, other research uses unexpected market shocks to explain risk premiums in basis. Basis spread correlates negatively with investment shocks, meaning that when a market shock occurs, basis weakens (Yang, 2011). Higher basis volatility is the result of higher risk premiums for farmers, essentially increasing the cost of forward contracting to farmers. Volatility suggests greater potential losses from basis, therefore elevators increase the price to forward contract for producers in order to offset this risk (Taylor et al., 2013). The development of the market also affects basis. A present value model applied to commodity prices for options and futures reveals that as emerging markets gain market share, futures prices become more volatile (Watugala, 2015).

Several econometrics approaches may analyze the influences on basis, including a difference-in-differences framework. After an unexpected shock to a market, the change in basis explains the impact of the shock to the local market.

A classic example of a difference-in-differences method applied to changes in basis comes from the StarLink corn contamination in food corn. After the GMO corn variety, StarLink, was discovered in food-grade corn, Carter & Smith (2007) applied the relative price of a substitute (RPS) method to measure the relative change in prices between corn and sorghum. The time of the contamination was narrowed down through Bai-Perron tests. After the break to

the relative price occurred, corn prices dropped 6.8 percent relative to sorghum based off the 25-year price relationship. This implies that the market was willing to accept the potentially contaminated corn for a discount.

Difference-in-differences methods may also analyze policy effects. After a tax-code that benefited grain-marketing cooperatives was passed, price spread between the cooperatives and independently owned facilities increased five cents (Swanson, 2019).

Difference-in-differences is applied to price analysis in markets outside of agriculture. Trade liberalization increases firm-level growth by one to two percent through a semi-parametric difference-in-differences and a matching approach (Buehler et.al, 2001). Similarly, Beatty et al. (2019) applied difference-in-differences to retail gasoline prices following a hurricane to illustrate that stations face reduced margins following a natural disaster, rebutting the common argument that gas stations price gouge during natural disasters.

These papers motivate my approach to applying a difference-in-differences framework in determining the impacts of the tariff on soybean basis. For the model, I need a control market. The control ideally would be soybean markets that were isolated from the tariff while remaining exposed to similar market pressures faced by exposed firms. While this cannot be achieved in the soybean market, there may be a close substitute to soybeans that would suffice. The Law of One Price (LOP) explains the framework for this experiment. The LOP explains that apart from transaction costs, regional markets that are linked by arbitrage and trade will condense into one common price. The LOP is used in spatial economics to explain price relationships. The assumption is the difference of price between two identical goods is the transportation cost between the markets. The LOP can be used to measure the information flow efficiency in

spatially separated markets. This extends to measure the extent structural changes in a market impacts price dynamics (Gumbley, 2018).

In ongoing discussions of the Law of One Price, a controversial issue has been how far economics can push the LOP. On the one hand, some have found that exchange rates and commodity prices tend to be nonstationary but not co-integrated, so the LOP breaks down in the long run (Ardeni, 1989). On the other hand, however, others argue that the LOP does not break down but rather is not analyzed properly. With unit root tests, the LOP does not hold if economists use retail prices, omit transportation costs, ignore time and do not compare identical products. When these errors are corrected, the LOP holds (Pippenger & Phillips, 2008).

Due to soybean basis and corn basis trending together prior to the 2018 tariff, we can loosely apply the LOP for the DnD analysis to apply. DnD requires parallel trends between the control group and the treatment group prior to the policy. Corn and soybean basis tend to trend together because corn and soybeans are substitutes on the supply side, meaning that producers decide between planting corn or soybeans every spring (Miller, 2003; Kim & Moschini 2018; Hennessy, 2006; Livingston et al, 2015; Chavas & Holt, 1990). Because they are close substitutes in production, and require similar inputs and storage, similar forces influence the markets for corn and soybeans. The exceptions include global demand changes for one crop not realized by the other. For example, U.S. corn and soybeans have different global importers, so if an event occurs in a country that imports a substantial amount of U.S. soybeans, but not corn, then the basis will diverge or converge and no longer follow parallel trends (Thukral & Gu, 2018; U.S. Census Bureau, n.d.).

An event such as this occurred when China placed a tariff on U.S soybeans. To the extent of my knowledge, no other event occurred during this time that would cause soybean basis to weaken relative to corn.

Aside from the difference-in-differences studies, several studies demonstrate that basis can be affected by changes to the market. Basis responded to market changes in the past, such as the ethanol mandate and change to elevator technology (Bekkerman & Pelletier, 2009; McNew & Griffith, 2005; Smith, 2018; Bekkerman et al., 2014). The literature has focused less on how changes to trade affects basis. Surry and Rude (2019) found that when the Canadian cattle market faced less access into the U.S. market, basis weakened, and slaughter costs increased while American producers and consumers were not necessarily better off either (Effraim, 2016). Basis weakened due to the decreased demand faced by Canadian cattle producers when the U.S. market became more restricted. With less demand, local producers faced lower prices.

We are beginning to understand the consequences of the tit-for-tat trade war with China. The relative price of soybeans dropped 17 percent and recovered by November of 2018. Nationally, soybean prices dropped \$0.65 per bushel while Brazil saw a \$0.95 per bushel increase. The United States was able to send some soybeans to alternative markets, but not enough to recover the Chinese market share (Adhemian et al., 2019). The tariff impacted welfare globally. Canada, China, and United States faced net losses in welfare while Brazil again gained from the tariff (Sabala & Devadoss, 2019). These studies do not examine local markets. This thesis has the opportunity to ask how the trade war between the United States and China altered local commodity markets and expound on the length and magnitude of these impacts.

This area has yet to be considered by other research but is crucial for producers and grain marketers across the country to understand to better adapt to trade turmoil in the future.

In this section, I presented the gains from trade and some reasons why governments enact restrictions on trade. These restrictions are frequently motivated by the desire to protect domestic industries. Market distortions from protective policies may incite more trade restrictions. The costs of trade globally are very high and agricultural trade is very elastic with respect to trade costs. Research studied the impacts of changes to trade structure through welfare analysis as well as measuring other outcomes, such as labor flows and food insecurity. Where the literature lacks, however, is quantifying the local impacts of a national trade shock. We would expect local impacts to differ as exports to China make up various levels of total sales within a market. For example, an elevator that markets a large share of soybeans to export prior to the tariff would be impacted more than an elevator that sells their soybeans domestically. Understanding the regional reliance of trade provides helpful insights towards forecasting future impacts of trade policy changes on local markets.

THEORETICAL MODEL

Partial Equilibrium Analysis of Trade

When the Chinese government placed the retaliatory tariff on U.S. soybeans, Chinese importers substituted toward soybeans from other countries, such as Brazil (Adjemian et al., 2019; Gale et al., 2019). This occurred because these other soybean exports were cheaper than U.S. soybeans under the tariff (Gale et al., 2019). During the 2017/2018 marketing year, the United States exported 28,194 thousand metric tons of soybeans to China. This was a 22 percent decrease from the 2016/2017's total of 36,119 thousand metric tons. Exports continued to drop by another 52 percent in 2018/2019 with 13,407 thousand metric tons of U.S. soybeans exported to China (Hubbs, 2021). With the steady rise of U.S. soybean exports to China in past years, this

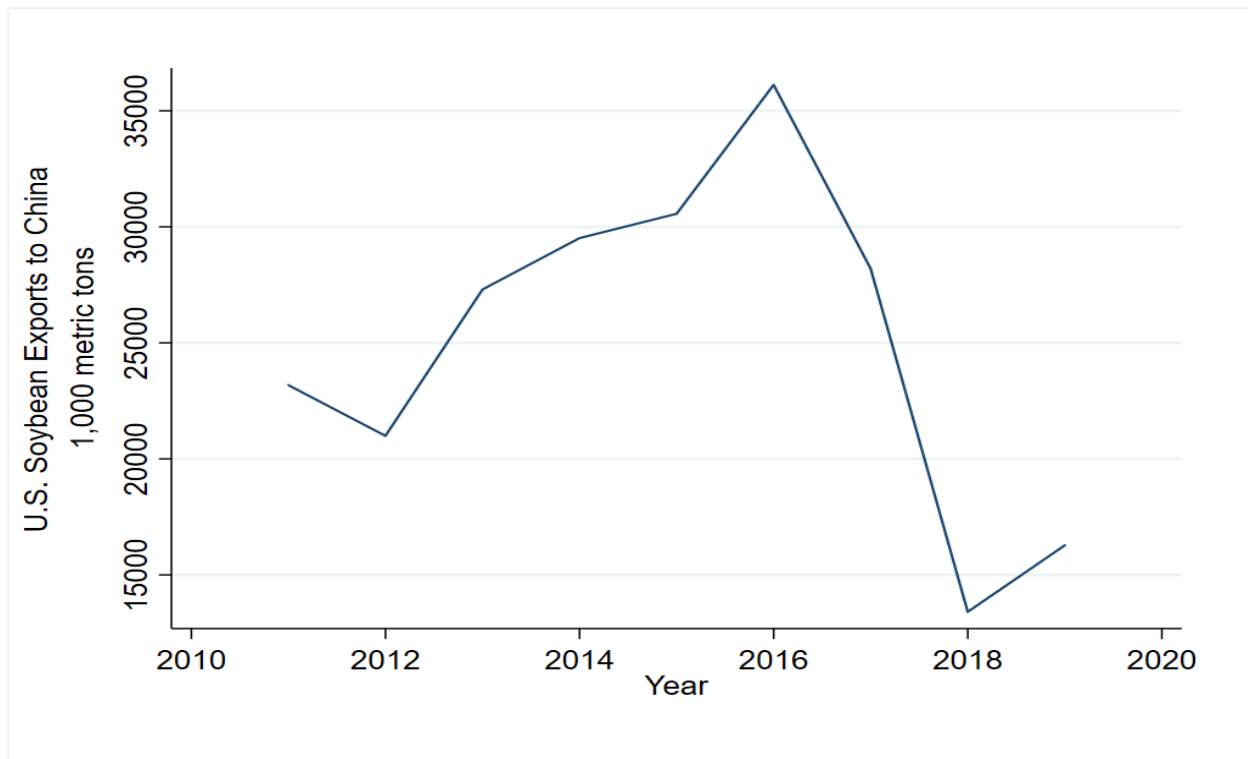


Figure 4.1 U.S Soybean Exports to China from 2011 to 2020 in 1,000 million metric tons. Note: Total exports counted during soybean marketing year, September – August. Each year

represents a marketing year, not a calendar year. Source: U.S. Department of Commerce, Bureau of the Census, Foreign Trade Statistics.

substantially affected the U.S. soybean market. China was a prominent buyer for U.S. soybeans, historically buying one quarter of the total U.S. crop (Hart & Schulz, 2015). With the tariff making U.S. soybeans less competitive, the domestic market increased soybean inventories, storing the soybeans previously bound for export. As a result, U.S. soybean prices nearly hit a ten-year low from the increase in soybean quantities waiting to be sold. However, policy makers and researchers may not have fully grasped the full impact of the tariff. I develop a stylized model of affected markets to understand the factors at work across the markets in question.

The global market for soybeans is composed of net exporters and net importers. The major exporters of soybeans are the United States, Brazil and Argentina with the United States representing thirty seven percent of global exports in 2017 and Brazil and Argentina accounting for over half of global exports (USDA, 2021). China buys sixty percent of the world's soybean imports (Gale et al, 2019). China's demand for soybeans exploded in recent decades due to increasing incomes; higher incomes in the country have led to increased demand for higher-quality food products, such as meat (Gale, 2015). Soybeans have high protein content and are one of the main feed products for China's growing livestock herds. Crushing facilities process the beans and separate them into oil and soybean meal. The oil is used in food products while the soybean meal's primary use is animal feed. China boasts the largest oilseed crushing industry and pig herd in the world (Hart & Schulz, 2015). These factors contribute to China's large share of global soybean imports. Import tariffs make imports more expensive.

Following Salvatore (2012), I use a partial equilibrium representation of soybean markets to demonstrate the likely impacts on prices from the Chinese import tariff. Both the United

States and China's economies are large enough to have an influence on the rest of the world's soybean price. Figure 4.2 shows the United States market for soybeans. The supply curve is comprised of aggregate domestic supply of soybeans while the downward facing demand curve represents the aggregate domestic demand for soybeans. As a net exporter of soybeans, the United States faces the initial price, P_0 per bushel prior to the tariff. The graph shows the initial level of exports at the distance between $Q_4 - Q_1$. Recall that China buys sixty percent of initial exports. China on the far right of Figure 4.2, imports $Q_{10} - Q_7$ at the initial price, P_0 per bushel. These are the assumed market conditions before China implements the tariff.

The middle graph shows the world market for exports and imports. The supply curve for global exports is the horizontal distance between the United States' supply and demand curves above the autarky price. The demand curve for bilateral imports is the horizontal distance

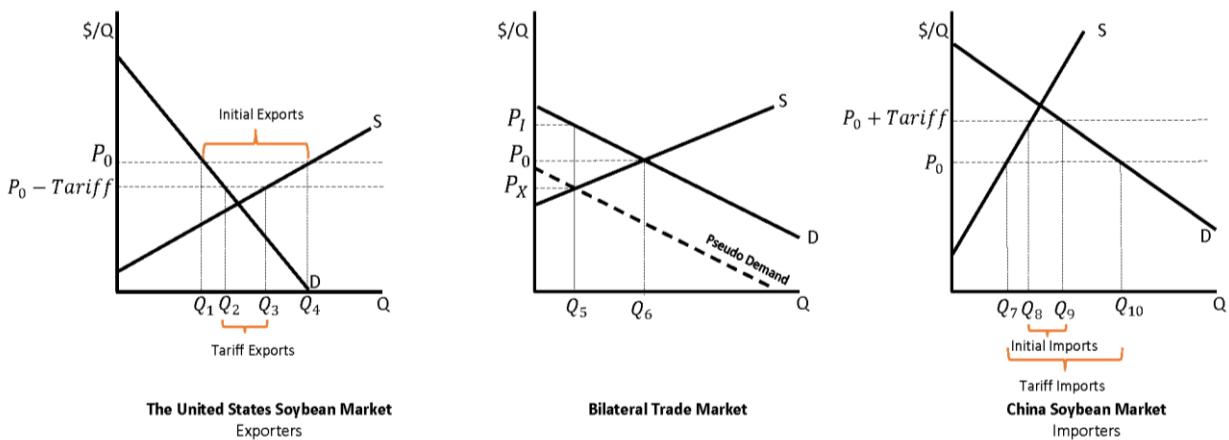


Figure 4.2 Partial Equilibrium Analysis of Trade between the United States and China. Note: Price is considered to be the price per bushel. Quantity would also be measured in bushels of soybeans.

between China's supply and demand below the autarky price. The bilateral trade market clears Q_6 soybeans for the price P_0 per bushel.

When China implements the 25 percent tariff, the price for soybeans increases to $P_0 + \text{Tariff}$ per bushel. The quantity demanded for U.S. soybeans decreases. Imports fall to $Q_9 - Q_8$. In the bilateral market for exports and imports of soybeans, P_I which equals $P_0 + \text{Tariff}$ in the Chinese soybean market, intersects the demand for imports at Q_5 . Exporters are willing to supply Q_5 for P_X per bushel. With imports facing a higher price, demanding a lower quantity of soybeans, exporters in the world market face the pseudo-demand curve that crosses their supply for soybean exports at Q_5 and P_X per bushel. While Chinese importers face a price higher than the initial world price, U.S. exporters face a lower price than P_0 per bushel at P_X per bushel. The United States' soybean producers export a lower quantity of $Q_3 - Q_2$ at this new price.

The national soybean price, P_0 , for the United States is an aggregate representation of the numerous individual markets in which prices are determined. It is in these markets the farmers discover prices at which their actual sales occur. Showing the effects on the aggregate U.S. soybean market is not sufficient to understand the full retaliatory tariff implications on soybean producers. We need to zoom in on elevator-level effects to reach a more comprehensive analysis.

Figure 4.3 shows the market conditions faced by a representative elevator that markets both corn and soybeans. Before the tariff, the elevator manager shipped a portion of soybeans to the west coast to export to China.

With the tariff in place, soybean exports to China diminish such that there are no soybean export orders for the elevator manager to fill. Demand for soybeans faced by the elevator decreases due to the decrease of buyers. Figure 4.3 characterizes the impact: the elevator faced

the demand curve D_1 prior to the retaliatory tariff, but without the opportunity to sell to China, demand decreases to D_2 .

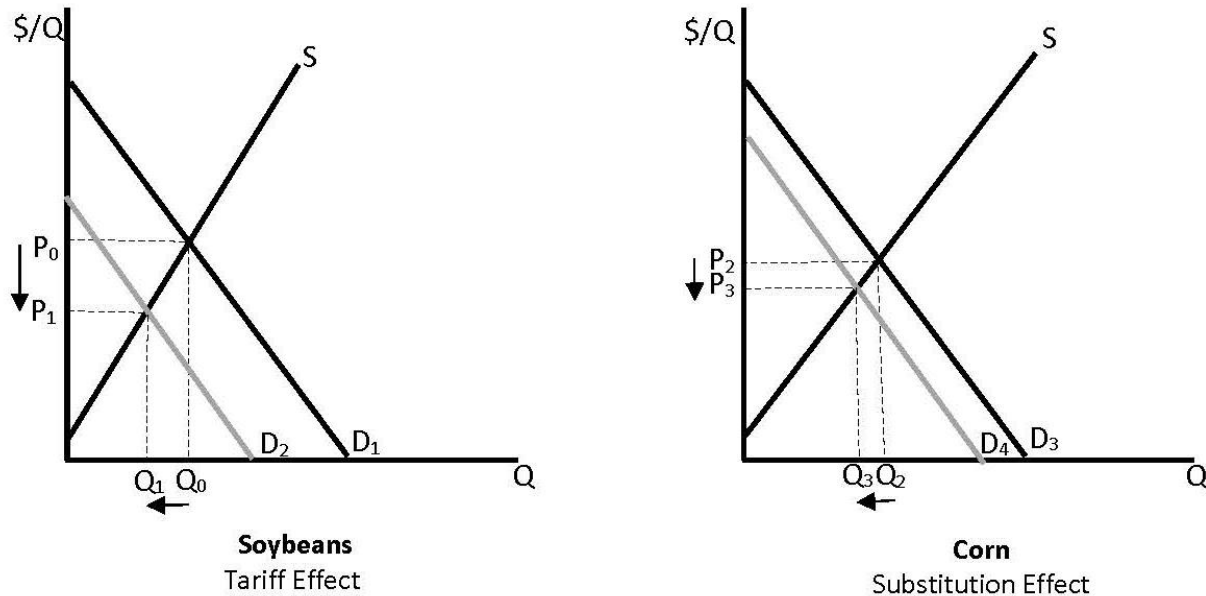


Figure 4.3: Soybean and corn markets faced by representative elevator. Note: Price is per bushel and quantities are in bushels of soybeans.

Note that the elevator faces upward sloping supply and downward facing demand curves. These curves are likely less elastic than the national aggregate supply and demand curves. As supply and demand aggregates, the curves become more elastic. Because the elevator faces relatively inelastic demand compared to the national market, the local effects of the tariff may have a larger effect on the elevator than the national demand shift.

Basis can be used as an indicator of additional losses due to tariffs. The decrease to the national price, seen in the U.S. soybean export graph, may actually be less than the price reduction in individual markets due to the supply curve in the national market being more elastic than the supply curve in individual markets. Therefore, the price along the supply curve in an individual market could be more responsive to a decrease in demand than the national price

under a relative demand shift. Figure 4.3 shows the additional reduction of the individual market price relative to the reduced national price. This additional local price reduction—relative to the national price reduction—would be characterized by a weaker local basis. As such, basis can serve as an appropriate instrument for measuring the impact of the tariff in addition to its effects on the national soybean price. Basis measures the additional weakening in price faced by local elevators in addition to the national price drop.

Supply Substitution between Corn and Soybeans

While the soybean market faced direct exposure to the trade dispute, other commodities may have been indirectly exposed. Consider a producer who may choose to plant corn or soybeans. If she knows that soybean exports to China drop, she may choose to plant more corn than soybeans than she would have otherwise. If this occurs, the farmer substituted soybean acres for corn acres.

There is much evidence pointing toward the supply-side substitutability of corn and soybeans. Corn and soybeans are the dominant crop rotation across the mid-west due to both crops thriving in the same environment and requiring similar capital (Miller, 2003). Producers decide the ratio of corn and soybean acres to plant annually (Kim & Moschini 2018; Hennessy, 2006). Typically, a farmer will alternate planting corn and soybeans on a one-year to three-year rotation. The gains from rotation include higher yields, lower pests, and lower fertilizer costs. Producers may only repeat planting a crop if the farmer believes that crop will receive relatively better returns than the alternate will. Planting decision factors include, but are not limited to relative prices between corn and soybeans, risk and wealth effects, and expected yields (Livingston et al, 2015; Chavas & Holt, 1990). New price supports and deficiency payment

programs for corn affect soybean producers as much as corn producers (Lee & Helmberger, 1985).

After harvest, the commodities compete for storage. The scarcity of storage leads to elevator managers choosing the optimum ratio of commodities to store. The price of storage accounts for the opportunity cost of storing one crop over another, such as corn over soybeans (Paul, 1970). Because of the supply-side substitutability of the two crops, corn and soybean

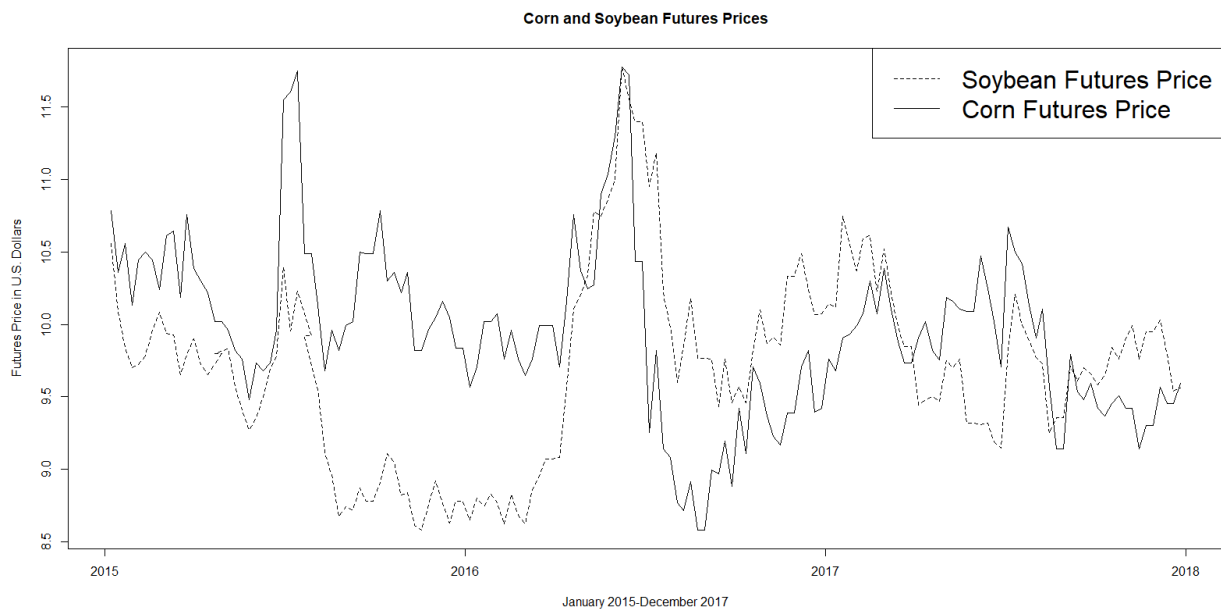


Figure 4.4 U.S Corn and Soybean Near-by Futures Prices from January 2015-December 2017 in U.S. dollars

prices typically move closely together. Figure 4.4 shows the nearby futures price for corn and soybeans from January 2015-December 2017. This graph illustrates how corn and soybean futures prices tend to track in similar patterns. In addition, although there are production and market conditions that can create some deviations from parallel price movements, these are relatively short before prices return to their typical relationships.

While corn and soybean prices are closely related through land allocation and production decisions at the national level, the United States developed very different international markets for both crops. The United States historically ships 60 percent of soybean exports to China (Hart & Schulz, 2015) while China bought 0.03 percent of U.S. corn exports in 2019 (U.S. Census Bureau, n.d.). While the United States has developed strong trade relationships with China for the soybean sector, there is no relationship with regard to U.S. corn. Consider the substitution between corn and soybeans globally.

When U.S. soybeans became relatively expensive in China due to the tariff, China placed a large order for Brazilian soybeans—revealing that U.S. and Brazil soybeans are stronger substitutes than U.S. soybeans and U.S. corn (Thukral & Gu, 2018). This does not come as a surprise, considering that China buys soybeans for high-protein feed and soybean oil—corn cannot serve these same purposes. U.S. soybeans were the main commodity directly exposed to the tariff and corn did not experience significant impacts.

Producers are aware of the trade dynamics between the United States and China. Producers factor in news and changes in expectations regarding trade into planting decisions. China announced the tariff in tandem with the beginning of planting season. By the time the tariff was in effect, the soybeans in the fields were blooming (Barrett, 2018). Producers did not have enough warning to substitute away from planting soybeans to corn.

Corn was not exposed to the retaliatory tariff placed on U.S. soybeans. This is evident through China not increasing corn imports from the United States and corn prices remaining stable after the tariff. Due to farmers allocating acres between corn and soybeans, the commodities are close substitutes in production. This means that corn works as a valid control

group because it faces similar market conditions as soybeans in production yet isolated from the tariff treatment.

EMPIRICAL MODEL

The previous section suggests that we are likely to observe differential price reactions between a national price and prices in the local markets. Specifically, local prices may behave differently than national prices. Basis measures the differential drop in prices because basis is the local price minus the futures price. Basis gauges the how supply-driven or demand-driven a market is. For example, if basis is negative, the market has greater supply than demand for the commodity. However, basis strengthens in markets with higher demand or lower supply. Moreover, the spring and summer timing of the tariff provided a particularly opportune situation because many soybean producers already made planting decisions before China proposed the tariff and definitely before China placed the tariff on U.S. soybeans. The soybean market was completely exposed to this tariff with little to no foresight.

As previously discussed, corn did not fall under the same trade fire as soybeans. Due to corn and soybeans having different nutritional makeups in animal feed and the U.S. corn industry not having trade relations with China, we did not observe China substituting corn for soybeans. Instead, corn exports remained stable. We established that while U.S. corn is a weak substitute to U.S. soybeans for China, they are close substitutes to producers within the United States. Domestically, corn and soybeans compete for everything from planted acres to elevators' storage. This implies that the prices between corn and soybeans will be closely related. Figure 5.1 illustrates the parallel trends between corn basis and soybean basis up until the tariff was announced and implemented, marked on the 2018 graph. To address the inconsistencies in the 2015 and 2016 graphs, we control for seasonal differences in soybean basis not experienced by corn basis.

2015 and 2016 brought shocks to the soybean market not faced by corn. In August 2015, the USDA surprised the U.S. soybean market when they announced higher-than-expected yields. The futures price dropped, leaving basis to do the work to incentive farmers into selling their crop in order to meet export and processing demand. The market expected lower yields after heavy rains and flooding decimated many fields throughout the Eastern Corn Belt (Kennedy, 2015). With the new crop year bringing a large carryout supply, the supply was less than predicted in May 2016. Demand pressures countered the record yields, leading to soybean basis strengthening throughout the summer of 2016 (Braun, 2016). While these compounding events lead to soybean basis and corn basis breaking parallel trends in 2015 and 2016, a week-by-soy fixed effects controls for the variation in soybean basis not faced by corn basis.

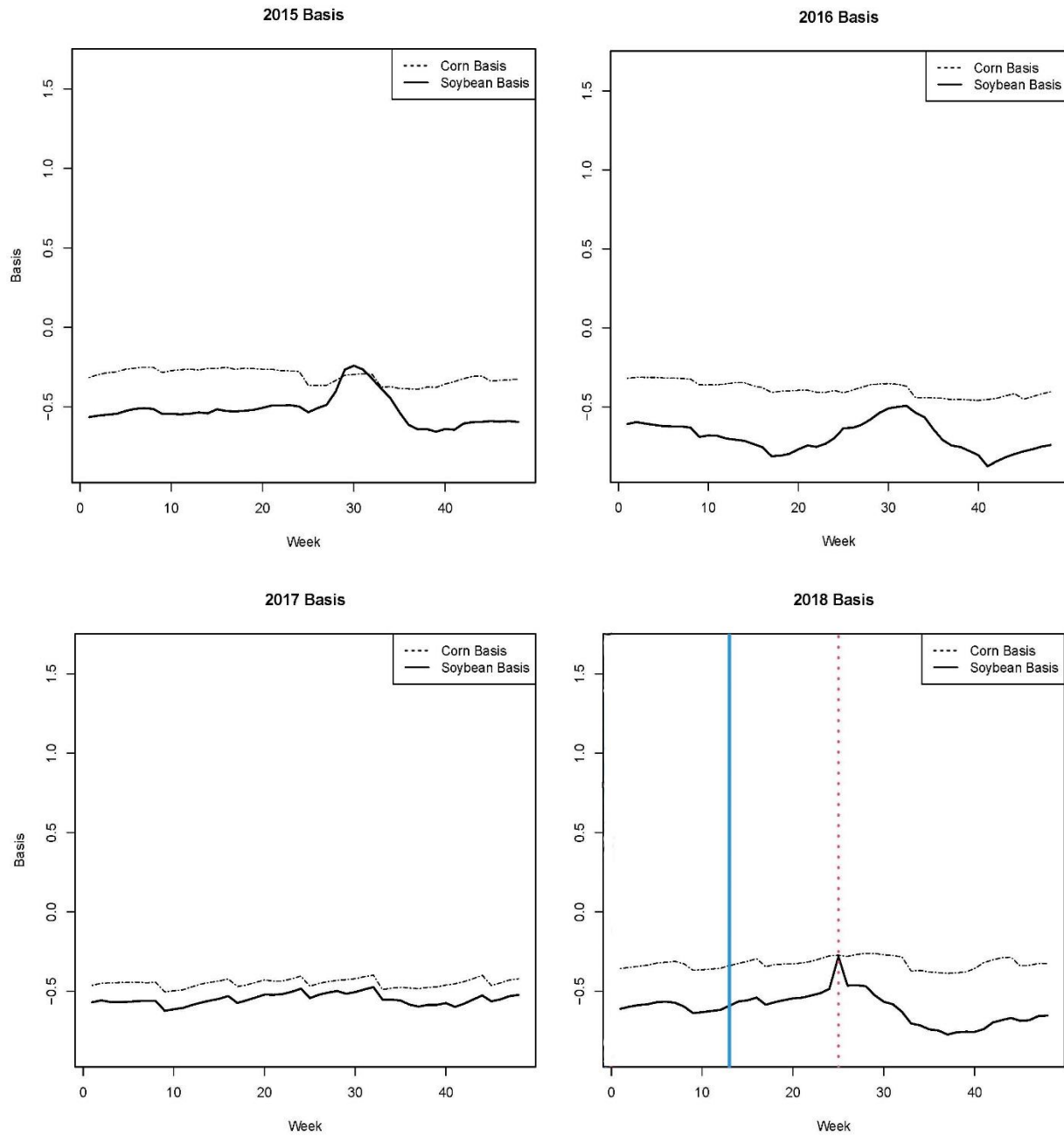


Figure 5.1: National Weekly Corn Basis and Soybean Basis per bushel in U.S. dollars for 2015-2018. Note the solid left line in the 2018 graph marks when China announced the tariff in April and the dashed vertical line marks when the tariff went into effect in July.

Difference-in-Differences Model

Corn and soybean basis followed parallel trends most closely in 2017 and the beginning of 2018 only to diverge during the 25th week of 2018 with the placement of the tariff on soybeans. The objective of this research is to measure the impacts of the tariff on local markets and a difference-in-differences framework lends itself as useful in quantifying these impacts. I model the nearby basis for elevator i for crop r in county c during week w and year y as follows.

$$(5.1) \quad BS_{ircwy} = \alpha + \gamma Soy_r + \theta AprJul_{wy} + \lambda Tariff_{wy} + \beta_1(Soy_r * AprJul_{wy}) + \beta_2(Soy_r * Tariff_{wy}) + \omega_{wr} + \sigma_y + \mu_c + \varepsilon_{ircwy}$$

Equation 5.1 contains two treatments. The first being the period between when the tariff was announced by China on April 4, 2018 until the tariff went into effect twelve weeks later on July 6, 2018, hereby referred to as the ‘intermediate period.’ The second treatment period begins when the tariff took effect on July 6, 2018. This is referred to as the tariff period.

The model accounts for difference between average corn and average soybean basis for the whole sample through the binary variable equal to one for soybean basis Soy_r . This variable controls for the differences between corn and soybean basis. The differences in the average basis common across both crops during the intermediate period are measured with $AprJul_{wy}$. The differences in the average basis across the sample after the tariff was implemented is controlled for by the binary variable $Tariff_{wy}$.

Week-by-soybean fixed effects are given by ω_{wr} and control for historic weekly basis movements for soybean basis throughout the marketing year. This addresses market influences on soybeans, such as harvest reports from Brazil, which influence soybean basis but not corn basis and may cause seasonal changes in soy that are not parallel to corn basis. Year fixed

effects, σ_y , control for unobserved effects year-dependent factors that influence both corn and soybean basis such as weather patterns or changing input prices. County fixed effects, μ_c , to control for time invariant geographic factors. These could include proximity to rail lines and barge routes or crushing facilities. The county fixed effects also controls for unobservable time-invariant factors that are specific to the county.

In reference to these equations, if soybean basis tends to be different on average from corn then the γ coefficient will capture this difference. If the intermediate period between the tariff being announced in April and implemented in July contained unobserved time-varying factors that would affect corn and soybean basis this will be captured in θ . λ will estimate the average change in basis following the tariff. If the intermediate period or the period following the tariff caused firms to lower their cash price offers for soybeans, then β_1 and β_2 capture these effects, respectively.

Clustered standard errors by county account for spatial correlation between elevators. The model controls for county fixed effects and clusters the standard errors by county to address two different issues. The county fixed effects helps control for unobserved time-invariant heterogeneity unique to each county. Clustering the standard errors addresses the collinearity in basis observations within a county, assuming that elevators within a county are not perfectly independent. The error term in Equation 5.1 reflects the idiosyncratic variation in basis that varies across elevators, crops, county, week and year. Elevators directly competing against each other are likely to have comparable idiosyncratic error terms. If one elevator lowers their basis, an elevator nearby or within the same county is more likely to lower their basis than a firm outside the area (Swanson, 2018). For this reason, I assume the error terms between nearby

elevators are likely to be correlated and the data are unlikely to be independent across observations within the county (Angrist & Pischke, 2009). If not addressed, correlated errors within groups can lead to smaller standard errors, increasing the likelihood of a Type 1 error where the true null hypothesis is wrongly rejected. Clustering the standard errors by county, where competition between elevators is likely to occur reduces the possibility of a Type 1 error, or a ‘false positive.’ For this to be an appropriate method, I make an asymptotic inference that the model has a large number of clusters, or counties such that the standard errors are not biased (Angrist & Pischke, 2009). For these reasons, standard errors are clustered at the county level.

Event Study Model

I modify Equation 5.1 to include a semi-parametric summation. This specification in Equation 5.2 loosens the constraints in the previous model, allowing the treatment effect to change weekly.

$$(5.2) \text{ } BS_{ircwy} = \alpha + \sum_{w=24}^{48} \beta_w (\lambda_w * Soy_r) + \gamma Soy_r + \omega_{wr} + \mu_c + \varepsilon_{ircwy}$$

The model estimates the effect of the tariff on soybean basis for 24 weeks following the implementation. Due to the time period containing a single year, I drop the control variables for the announcement period and the tariff. These would be multicollinear with the week fixed effects. Soy_r still controls for the difference between corn basis and soybean basis throughout the sample. λ_w is an indicator equal to one if the observation is w weeks after the tariff implements. The term $(\lambda_w * Soy_r)$ is a variable for the treatment effect of the tariff on soybean basis during week w following July 6, 2018. β_w represents the policy effect of the tariff on soybean basis w weeks after the implementation relative to the week before the tariff was announced. β_w is the

relative difference between corn basis and soybean basis caused by the tariff w weeks after the implementation relative to the week before the tariff was announced.

The exogenous shock to the U.S. soybean market while the U.S. corn market remained relatively isolated provides a clear opportunity to understand how trade disputes disrupt local markets. Basis serves as an opportune independent variable because the change observed in basis serves as a proxy for degree of the tariffs impact absorbed by the elevator. Due to the nature of the tariff being announced and implemented during a period where soybean producers already made production decisions and the fact that corn works as a control market, a difference-in-differences framework is the best method for estimating the variation in basis. I can apply this framework to estimate the intensity and duration of the tariff by area. With the methodology established, we now turn to understand the best data to execute these analyses.

DATA

Basis Data

To measure the effect of how the retaliatory tariff placed by China on U.S. soybeans affected basis, I use weekly corn and soybean basis data collected at the elevator-level from January 1, 2015³ until September 9, 2020. The elevators in the sample span 36 states across the United States. Part of the data came from Kansas State University and contain basis records for 837 elevators while the remaining data come from GeoGrain and contain basis for 2,385 markets. These panel data consist of latitude and longitude for each market and the GeoGrain data contain spot price, so I was able to pull the nearby futures prices by subtracting the basis from the spot price.

The observations occurred every Wednesday. Each month contains four observations. If the month had five Wednesdays, then the fourth and fifth observation were averaged together. Under nine percent of the observations occurred during the fifth week of the month.

Table 6.1 presents the average basis by crop before and after the tariff. The data show that before the tariff was implemented, the average soybean basis for all states weakened after the tariff while the average basis for corn strengthened after July 2018. The number of firms for both commodities decreased after the tariff.⁴ This may be due to the time period before the tariff being longer, allowing more time for firms to enter the market.

³ Observations from 2013-2014 were dropped from the regressions due to inconsistent pre-trends.

⁴ I inquired about elevators exiting the sample with GeoGrain and was unable to make a conclusion behind the reason elevators exit the sample. There is not a way to determine if the elevator stopped reporting, but continued to operate or left the market.

Table 6.1: Summary Statistics by Crop: January 2015 - September 2020

Statistic	Full Sample				More than 10				More than 50				More than 100			
	Soybeans		Corn		Soybeans		Corn		Soybeans		Corn		Soybeans		Corn	
	Before Tariff	After Tariff	Before Tariff	After Tariff	Before Tariff	After Tariff	Before Tariff	After Tariff	Before Tariff	After Tariff	Before Tariff	After Tariff	Before Tariff	After Tariff	Before Tariff	After Tariff
Number of Firms	2,727	2,406	3,095	2,733	2,693	2,384	3,055	2,707	2,600	2,322	2,898	2,594	2,475	2,208	2,720	2,434
Number of Observations	746,115	204,005	829,135	231,317	742,346	202,973	824,675	230,139	729,559	199,119	801,930	222,035	706,200	189,970	764,855	209,182
Average Basis	-0.47	-0.61	-0.32	-0.25	-0.47	-0.61	-0.37	-0.25	-0.48	-0.62	-0.34	-0.27	-0.48	-0.61	-0.34	-0.27
Maximum	4.00	0.86	2.45	1.20	4.00	0.86	2.45	1.20	4.00	0.86	2.21	0.87	4.00	0.86	2.21	0.87
Minimum	-2.96	-2.05	-1.95	-1.29	-2.96	-2.05	-1.95	-1.29	-2.96	-2.05	-1.95	-1.29	-2.96	-2.05	-1.95	-1.29

Note: A firm is categorized as selling corn or soybeans, or even both, if it reported basis for the respective crop more than fifty percent of the observations. The ‘Before Tariff’ period spans from January 2015 until April 2018. ‘After Tariff’ begins in July 2018 and extends to September 2020. Basis is reported in U.S. dollars. Summary statistics are calculated by subsets such that the ‘More than 10’ contains data from the states with more than 10 elevators in the data. ‘More than 50’ contains observations from states with more than 50 elevators, and so forth for ‘More than 100.’

The firms would still be counted in the pre-tariff period even if they exited the sample before the tariff was implemented. Some firms joined the sample after the tariff even as both groups faced a net loss of elevators.

The average basis between the April and July of 2018 is not reported because the interpretation would be vague and not helpful to the analysis⁵.

The average basis across corn and soybeans trended differently following the tariff going into effect. Table 6.2 illustrates the average basis for corn and soybeans across the United States in the months following July 2018.

Table 6.2: Average Monthly Basis Before and After Tariff across United States for Full S

Soybeans				Corn			
Months Before Tariff	Average Basis	Maximum	Minimum	Average Basis	Maximum	Minimum	Difference
24	-0.72	0.32	-2.19	-0.39	0.83	-1.00	-0.33
12	-0.50	0.20	-1.46	-0.42	0.75	-1.15	-0.08
6	-0.59	0.25	-1.45	-0.36	0.75	-0.90	-0.23
3	-0.56	0.53	-1.45	-0.32	0.80	-0.89	-0.24
1	-0.51	0.44	-1.30	-0.31	0.90	-1.15	-0.20
Months After Tariff							
1	-0.43	0.50	-1.51	-0.27	0.90	-1.24	-0.16
3	-0.70	0.35	-2.05	-0.38	0.90	-1.00	-0.33
6	-0.65	0.16	-1.78	-0.34	0.70	-1.01	-0.32
12	-0.60	0.38	-1.95	-0.24	1.10	-1.05	-0.36
24	-0.47	0.34	-1.61	-0.22	0.83	-1.00	-0.25

Note: Basis reported in dollars per bushel. Difference calculated by subtracting corn basis from soybean basis. One month marks four weeks after tariff went into effect.

⁵ Basis strengthens during the spring and summer as the stored crop is used. We would expect basis to weaken at the announcement of the tariff, so with these two forces working in opposite directions, the impacts are small.

Elevator Data

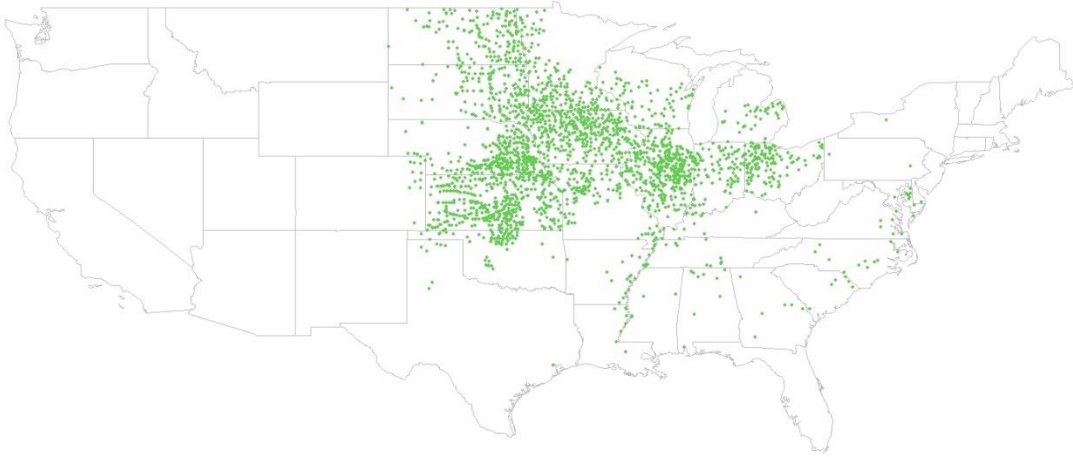
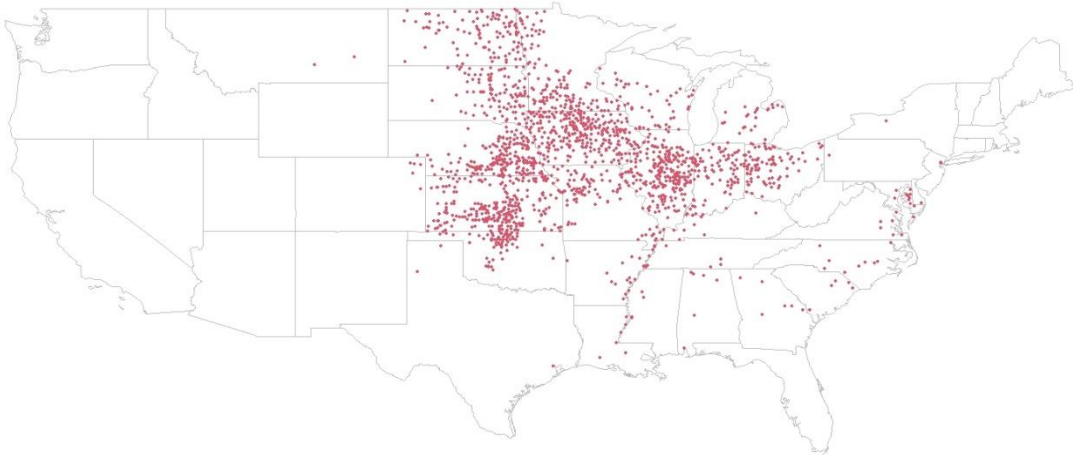
Table 6.3 depicts the counts of elevators that market either commodity by state while Figure 6.1 maps the elevators by group. The largest portion of elevators, at 2,444, market corn and soybeans. The sample contains more corn-only elevators than soybean-only at 485 and 293, respectively. The states with the most firms are Kansas, Nebraska, Iowa, and Illinois. As the states move away from the Midwest, the firm counts diminish. This is to be expected, as these states do not produce the volume of corn and soybeans that we see in the Midwest. States like Delaware and New Jersey only have one or two firms. Western states have a low number of firms observed as well. Idaho and Wyoming both report one corn market.

Table 6.3: Firm Counts by State

Firm Counts By Commodity				
State	Soybeans & Corn	Soybeans Only	Corn Only	Total
Kansas	437	52	50	539
Nebraska	327	25	88	440
Iowa	314	20	43	377
Illinois	299	11	18	328
South Dakota	169	20	37	226
Minnesota	156	16	18	190
North Dakota	152	28	10	190
Missouri	153	8	21	182
Ohio	114	11	13	138
Indiana	87	3	17	107
Oklahoma	65	21	20	106
Wisconsin	57	13	5	75
Colorado	4	12	42	58
Michigan	41	1	9	51
Texas	1	7	37	45
Arkansas	10	10	8	28
Washington	0	0	17	17
North Carolina	4	6	6	16
Kentucky	9	2	3	14

Tennessee	8	4	2	14
Georgia	0	6	6	12
Alabama	7	3	1	11
Maryland	8	2	1	11
Louisiana	7	2	1	10
Virginia	6	1	3	10
Mississippi	3	3	1	7
South Carolina	3	3	0	6
Montana	0	1	3	4
New Jersey	0	2	0	2
Pennsylvania	1	0	1	2
California	0	0	1	1
Delaware	1	0	0	1
Idaho	0	0	1	1
New Mexico	0	0	1	1
New York	1	0	0	1
Wyoming	0	0	1	1
Total	2444	293	485	3222

Note: An elevator is determined to sell corn and soybeans if the elevator reported basis for corn and soybeans for at least 50 percent of the observations. An elevator classifies as a ‘soybean only’ or ‘corn only’ elevator if the elevator only reports basis for one commodity for more than 50 percent of the observations.

Elevators Marketing Soybeans and Corn**Elevators Marketing Soybeans**

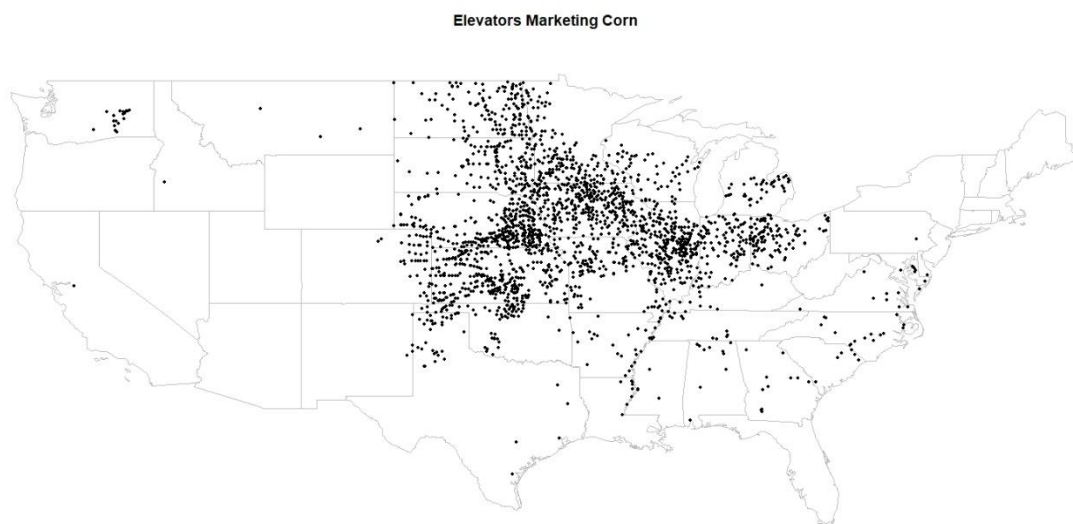


Figure 6.1: Locations of Firms by Commodity

RESULTS

I applied a difference-in-differences model to test three hypotheses. The first being the retaliatory tariff on China's U.S. soybean imports led to weaker soybean basis relative to corn in the United States. Second, this tariff affected states and regions differently. Finally, the tariff altered the soybean market such that soybean basis took time to recover to previous levels.

Tables 7.1 and 7.2 present the estimated difference in soybean basis relative to corn basis across the sample, the time effects of the announcement period and the period after the tariff was implemented, and the policy effects of soybean basis. The first column presents the difference-in-differences estimates for all firms in the sample. The second column shows the results of states that contain more than ten elevators in the sample with the third and fourth column presenting estimates for states with more than 50 and 100 elevators, respectively. All results control for unobserved heterogeneity between counties and time with county fixed effects, week-by-soy fixed effects, and year fixed effects, as shown in equation 5.1.

The main assumption for a difference-in-differences model to be valid in estimating a causal relationship is that the treatment group and control group must have parallel trends prior to the treatment. The period from January 2015 to March 2018, referred to as the pre-tariff period before China announced the tariff serves as the baseline counterfactual. Appendix A contains the results of these robustness checks. The tariff period had no weakening effects on soybean basis. The estimates compare the change to soybean basis relative to corn basis in the pre-period to the tariff era. Results indicate the intermediate period-by-soybean, the tariff-by-soybean interactions had significant impacts on the estimated difference in soybean, and corn

basis. I will present the results in detail and discuss the national regressions, the state-level regressions and the duration of the tariff observed in the event study.

Table 7.1 Impacts of the Tariff on U.S. Soybean Basis: January 2015-September 2020

	Full Sample	More than 10	More than 50	More than 100
Differential in soybean basis relative to corn basis across whole time period	-0.174***	-0.172***	-0.177***	-0.167***
	-0.006	-0.006	-0.006	-0.006
Differential in corn basis during intermediate period relative to pre-tariff period	0.059***	0.059***	0.060***	0.059***
	-0.003	-0.003	-0.005	-0.003
Differential in corn basis post-tariff relative to pre-tariff period	0.082***	0.082***	0.128***	0.085***
	-0.006	-0.006	-0.004	-0.007
Differential in soybean basis compared to corn during the intermediate period relative to pre-tariff period	-0.054***	-0.053***	-0.052***	-0.045***
	-0.005	-0.005	-0.005	-0.005
Differential in soybean basis compared to corn during the post-tariff period relative to pre-tariff period	-0.191***	-0.191***	-0.190***	-0.186***
	-0.005	-0.005	-0.005	-0.005
Constant	-0.111***	-0.111***	-0.110***	-0.102***
	-0.005	-0.005	-0.002	-0.007
Observations	1,578,495	1,570,514	1,534,022	1,471,693
Adjusted R^2	0.584	0.579	0.534	0.547

Standard errors in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: Model contains week-by-soy fixed effects, year fixed effects, and county fixed effects. Standard errors are clustered at the county. All coefficients are measured in U.S. dollars per bushel. Data are subset in columns to include the states with more than as many elevators as indicated, so the full sample contains all 36 states while 23 states contain more than 10 elevators in the sample, 14 states had more than 50 elevators and 11 states had more than 100 in the sample.

Difference-in-Differences Results Discussion

I find evidence that trade disputes have a negative impact on soybean basis, indicating that producers received a lower price for their crop than they would have had the dispute not occurred. Results in Table 7.1 present the parameter estimates of the difference-in-differences model comparing the average difference in corn and soybean basis between January 2015-March 2018 to the average difference from the tariff era during which China announced and implemented the tariff.

The total effect of the tariff during the intermediate period is captured by the coefficients for the intermediate period and the intermediate period-by-soybean interaction. These coefficients capture the time effect and policy effect, respectively. During the intermediate period, basis strengthened an average of six cents per bushel for both crops but the difference in basis between corn and soybeans widened five cents relative to the pre-tariff period. The expected value of soybean basis was five cents below the expected value before the announcement. This may have occurred as elevator managers, anticipating the changes to the soybean market, did not want their bins filled with soybeans that would become more difficult to market.

Soybean basis weakened an additional 14 cents per bushel relative to corn basis in the two years after the tariff went into effect compared to the three years prior to the announcement. The 19 cent relative decrease per bushel between corn and soybeans is economically significant. For example, if a farmer decided to plant soybeans on 1,000 acres and harvests 50 bushels per acre, revenue would be \$9,500 lower relative to the revenue received if the farmer planted corn instead, all else equal. The divergence between corn basis and soybean basis lasted to the end of

the data, but the tariff had more immediate effects as well. The results for a reduced treatment period are in Appendix B. The data contained in these regressions end on August 31, 2018—the last day of the 2017/2018 marketing year during which the tariff occurred. Additional results extend to the end of December 2018 to estimate how the tariff’s impacts carried over into the new marketing year. The results are consistent with the extended results listed here.

State-Level Difference-in-Differences Results Discussion

This relative loss of revenue helps quantify the average impact of the tariff on producers but does not explain the differential of effects across regions. I estimated how the effects of the tariff varied across states with the same model by limiting the data to one of the 11 states in the sample with more than 100 reporting elevators. I hypothesized that states with a more inelastic supply curve would face larger impacts from the tariff. States closer to export ports and farther from domestic soybean processors would see soybean basis weaken more than states with more marketing options. Figure 7.1 displays the treatment effect of the intermediate period and the tariff era on soybean basis relative to corn basis compared to the baseline period with a 95% confidence interval. The line at 0 represents the tariff having no relative effect on soybean basis during the respective treatment.

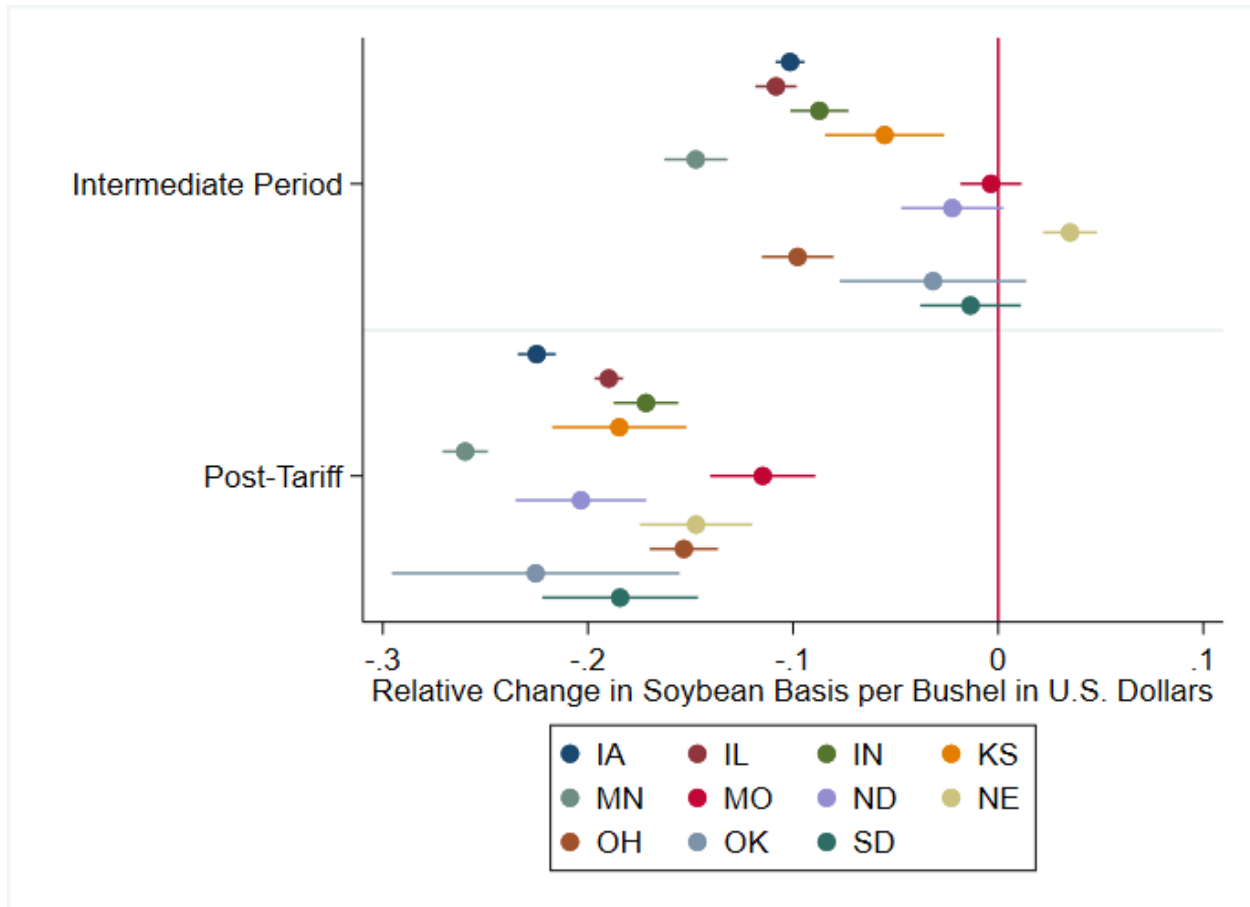


Figure 7.1: State-Level Treatment Coefficients: January 2015-September 2020. Note: The coefficients estimate the relative change in soybean basis relative to corn basis per bushel in U.S. dollars during the intermediate period and after the tariff relative to the difference prior to the tariff announcement.

The effects of the tariff on the relative change in soybean basis during the intermediate period are grouped around 0. The results show that basis for soybeans strengthened relative to corn during this period in Nebraska. Missouri, North Dakota, Oklahoma, and South Dakota faced no statistical difference between corn basis and soybean basis. The remaining states in the sample saw soybean basis weaken relative to corn. The difference in effects during the announcement period may serve as a proxy for the time the local markets adjusted to the news of

the tariff. For example, elevators in North Dakota did not significantly respond while elevators in Minnesota immediately quoted lower relative prices for soybeans. Note that the 95% confidence intervals overlap across many states. This suggests that the impacts of the tariff are not statistically different between the states with overlapping intervals. For example, the effect of the tariff on soybean basis in Nebraska is not statistically different from the effects in Indiana, Illinois, Kansas, Missouri, North Dakota, Oklahoma and South Dakota—but Nebraska's effect is statistically different at the 0.05 level from the effects in Iowa and Minnesota. Because these results are not statistically different and the states do not follow a clear regional variation, the results do not speak to the regions of the United States more impacted by the tariff.

After the tariff, soybean basis weakened more relative to corn in every state. The tariff effects were greatest in Minnesota, Iowa and North Dakota. This makes intuitive sense, when we consider North Dakota, for example. North Dakota does not have as much access to mills, crushing facilities, and refineries relative to states further east. North Dakota may have shipped most of their soybeans to export terminals along the extensive rail network. Missouri's basis weakened the least. This may suggest that Missouri was the least reliant on soybean exports to China.

Some states group at -20 to -15 cent difference in relative basis. We see that the tariff caused soybean basis to weaken in the states that have marketing channels outside of just China. Crushing facilities, biofuel refineries, and feedlots are scattered throughout these states, such as Indiana, Ohio and Illinois. Spatial economics suggest that these processing facilities would be located where their inputs are most concentrated, and these states are some of the top soybean

producers in the United States. Even so, the domestic demand was not enough to combat the loss of exports to China.

When China bought less soybeans from the United States, elevators in these states were able to market soybeans to alternative markets, but still faced significantly lower prices. These coefficients highlight how the retaliatory tariff lowered soybean basis across the country yet reliance to the Chinese market varied across regions. The states known to export, such as North Dakota and Minnesota faced the greatest relative loss while states with more alternative markets did not face the same immediate relative change in basis.

Event Study

Throughout the fall of 2018, the United States and China placed tariffs on additional goods, drawing out the trade war. We can observe how the initial tariff caused the difference between soybeans and corn to change over time. Figure 7.3 presents the event study results achieved through the semi-parametric modification to the base model. The model continues to address seasonality to soybean basis but does not contain county fixed effects.

The base week for the study occurs one week before China announced the tariff—12 weeks prior to the implementation. The announcement event is noted by the vertical line on the left while the tariff went into effect the week marked by the black line. The point estimates show the estimated difference in soybean basis relative to corn basis compared to the difference in basis during the week before China announced the tariff. The 0 line signifies that the difference between basis is equal to the relative basis that occurred at the end of March 2018, marking pre-announcement levels. The estimates grouped around the 0 line prior to the announcement reinforce that the shock to the soybean market occurred because of the tariff and reinforced the

assumption that corn basis and soybean basis followed parallel trends once soybean basis is adjusted for seasonality.

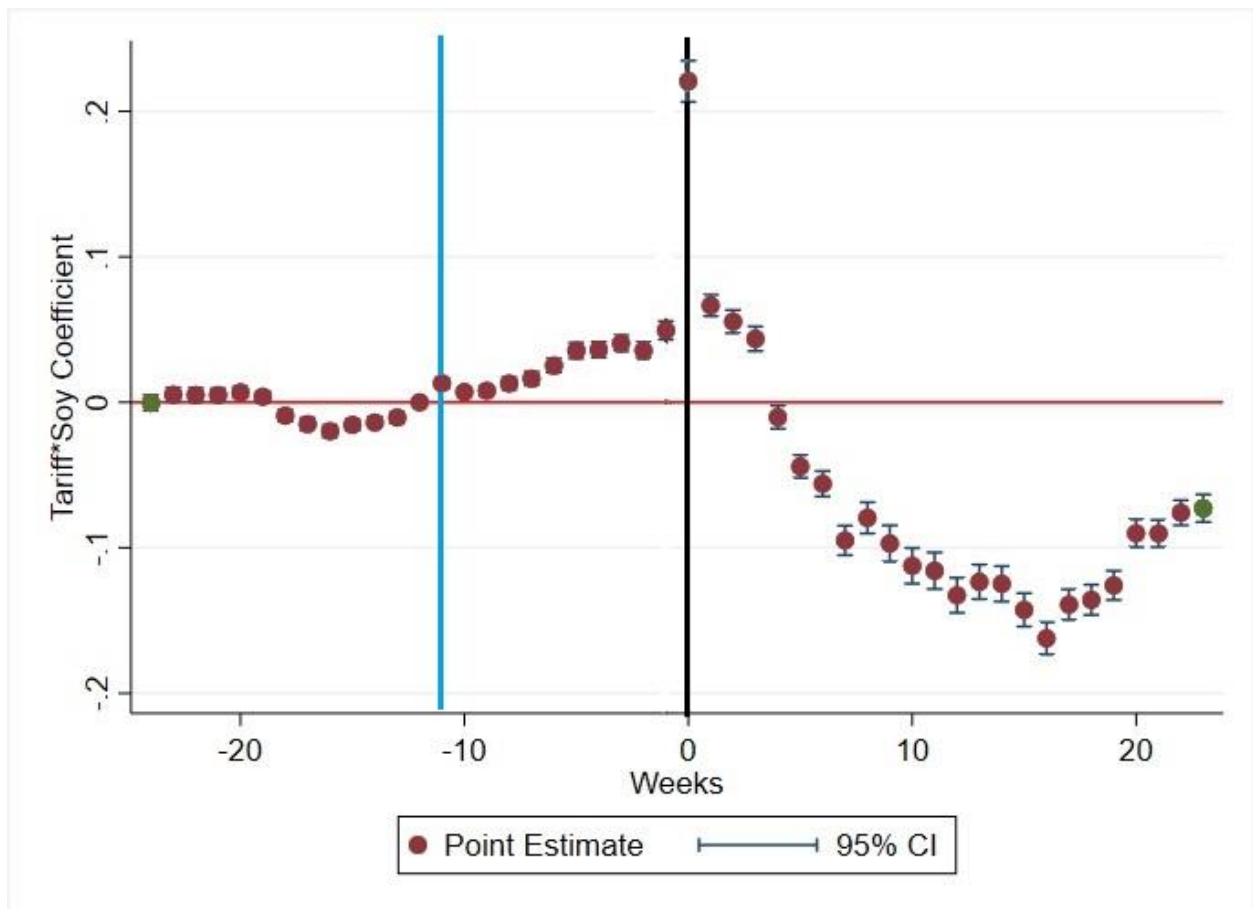


Figure 7.3 Event Study of the Tariff on Soybean Basis relative to Corn Basis: January-December 2018 Note: The blue vertical line represents the week the tariff was announced while the black line marks when the tariff went into effect. The horizontal line is the baseline that compares every point estimate to the base point estimate that occurred 12 weeks before the tariff went into effect and one week before China announced the tariff. Each point estimates the average change in soybean basis relative to corn basis relative to the 12 weeks prior difference. If the point is above the 0 line, the relative difference strengthened between corn and soybeans.

The results suggest that the intermediate period lead to soybean basis strengthening compared to the week prior to the announcement. These results vary from Table 7.1. One possibility for this discrepancy is these two results have different baseline groups. Table 7.1

contains data reaching back to January 2015 for the counterfactual while the event study compares the change in soybean basis to the week before the announcement. Soybean basis strengthened over 20 cents relative to corn the week following the tariff. Futures markets incorporate information faster than local markets. As the futures price dropped quicker than the local price, basis would strengthen before elevators would adjust to local decreases in demand. Following that spike, soybean basis weakened relative to corn before beginning to recover mid-November. By the end of 2018, soybean basis remained 8 cents weaker than corn basis relative to the difference seen in the spring.

CONCLUSION

The trade war between the United States and China left an example of the impacts trade disputes have on local elevators. This was the first systematic work that analyzed these impacts through changes in basis. This research traced a global event, the retaliatory tariff placed on U.S. soybeans, down through the economy to the individual farmer. By quantifying the change in basis relative to corn, this research helped estimate the magnitude, duration, and regional impacts of the tariff.

The natural experiment that the trade dispute presented allowed me to provide reasonably causal evidence soybean basis (and, thus, local cash prices) weakened. After China placed the 25% tariff, U.S. soybean exports dropped. With the crop already planted, farmers could not change production decisions in response to the tariff. The futures price for soybeans nearly hit a ten-year low and as local markets faced decreased demand, elevators weakened basis for soybeans. The combination of both the national price drop and an additional local price drop indicates that any national-level analysis likely underestimated the extent to which prices faced by agricultural producers actually decreased.

As the tariff distorted the soybean market, the market for corn remained relatively stable. While corn and soybeans grow in the same areas, often by the same producers, the commodities serve different purposes. Corn provides carbohydrates to animal feed while soybean meal supplies protein. In addition, the U.S. corn industry did not have the same ties to China as U.S. soybeans. China bought essentially no corn from the United States before or during the tariff. After checking for robustness, I concluded that the basis for corn would serve as a valid counterfactual to soybean basis.

I compared the difference in soybean basis to the difference in corn basis using a difference-in-differences model. The model contained two treatment periods. The first occurred between the tariff's announcement in April 2018 and implementation in July 2018, referred to as the intermediate period. The second treatment began after China implemented the tariff in July and continued to the end of the sample. Through this model, the results suggest that soybean basis weakened five cents relative to corn during the intermediate period and 19 cents per bushel relative to corn following the tariff. These results were robust and economically significant. When I adjusted the time period and controls, the results continued to indicate the tariff caused soybean basis to weaken a significant amount relative to corn regardless.

The impacts of the tariff varied regionally. Every state saw the average soybean basis weaken relative to corn. Table 8.1 quantifies the average lost revenue per marketing year faced for every 1,000 acres of harvested soybeans yielding 50 bushels an acre.

Table 8.1: Lost Soybean Revenue in U.S. Dollars Caused by Tariff per Marketing Year: January 2016-September 2020

State	Intermediate Period	Post-Tariff
Minnesota	-7,370	-12,991
Oklahoma	-1,586	-11,273
Iowa	-5,073	-11,247
North Dakota	-1,119	-10,168
Illinois	-5,414	-9,492
Kansas	-2,770	-9,234
South Dakota	-675	-9,215
Indiana	-4,360	-8,584
Ohio	-4,888	-7,662
Nebraska	1,753	-7,362
Missouri	-177	-5,738

Note: Total lost revenue per 1,000 acres by state, assuming 50 bushels of soybeans per acre. Revenue estimates averaged over 2018/19 and 2019/20 marketing years

These results speak to the spill over effects of trade disputes into unrelated industries' local markets. In an effort to reprimand China for mishandling intellectual property and narrow the trade deficit, the United States announced the initial tariff that would lead to the tit-for-tat trade war with China. The U.S. soybean industry faced a significant drop in export demand when China placed the retaliatory tariff on soybean imports from the United States.

This study observed how the national tariff trickled down to effect soybean farmers. These results can help inform relief payment rates for USDA programs such as the Market Facilitation Program. By considering the influence of market shocks on local markets, policy makers can make a more accurate calculation of program payments to farmers that better reflect losses faced due to local market conditions. Trade conflicts are not likely to completely cease—this study speaks to how future research can assess the impacts of disturbances to trade flows within local markets.

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APPENDICES

APPENDIX A

RESULTS OF EMPIRICAL ROBUSTNESS CHECKS

A.1 Tariff Effects in 2016/2017 Marketing Year	
VARIABLES	(1) Full Sample
Soy	-0.171 (0.00477)
Intermediate Period*Soy	0.083 (0.00239)
Post-Tariff*Soy	0.106 (0.00275)
Constant	-0.338 (0.00369)
Observations	349,274
R-squared	0.589
Week Fixed Effects	YES
Year Fixed Effects	YES
County Fixed Effects	YES

APPENDIX B

RESULTS WITH EXTENDED DATA

B.1 Results with 2015-2020 data, no week*soy or county fixed effects

VARIABLES	(1) Full Sample	(2) More than 10	(3) More than 50	(4) More than 100
Soy	-0.119*** (0.00548)	-0.117*** (0.00543)	-0.108*** (0.00503)	-0.104*** (0.00496)
Intermediate Period	0.0692*** (0.00378)	0.0694*** (0.00378)	0.0679*** (0.00376)	0.0701*** (0.00380)
Tariff	0.0803*** (0.00824)	0.0811*** (0.00825)	0.0799*** (0.00832)	0.0850*** (0.00853)
Intermediate Period*Soy	-0.112*** (0.00413)	-0.111*** (0.00414)	-0.106*** (0.00395)	-0.105*** (0.00408)
Post-Tariff*Soy	-0.247*** (0.00587)	-0.247*** (0.00588)	-0.241*** (0.00565)	-0.239*** (0.00584)
Constant	-0.468*** (0.00794)	-0.470*** (0.00792)	-0.481*** (0.00776)	-0.481*** (0.00796)
Observations	1,121,563	1,116,851	1,093,171	1,051,760
R-squared	0.198	0.198	0.196	0.188
Week Fixed Effects	YES	YES	YES	YES
Year Fixed Effects	YES	YES	YES	YES

B.2 Difference-in-Differences Results September 2016-December 2019 with week, year, and county fixed effects

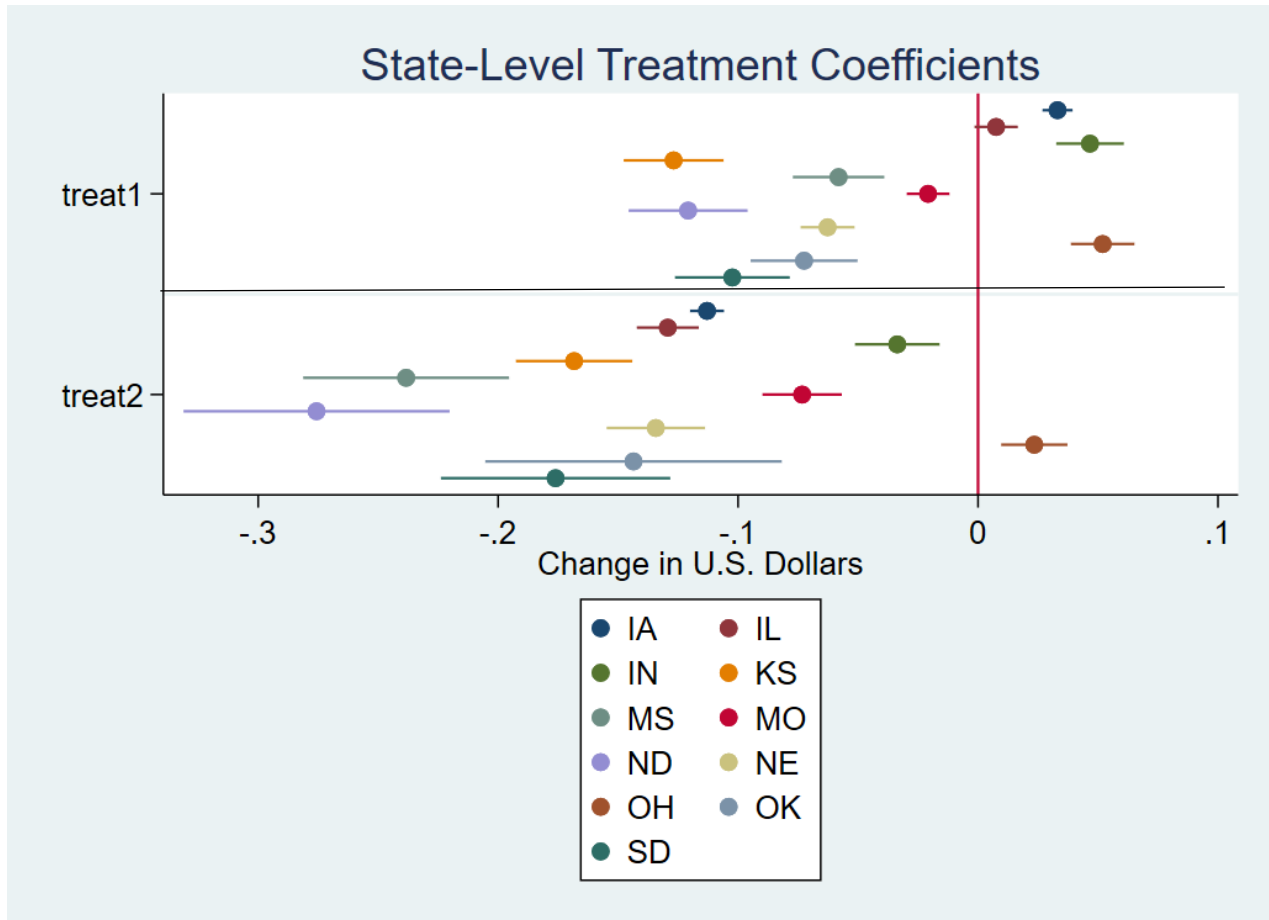
	Full Sample	More than 10	More than 50	More than 100
Soy	-0.129*** (-26.41)	-0.128*** (-26.35)	-0.125*** (-26.15)	-0.121*** (-25.52)
Intermediate Period	0.0950*** (20.41)	0.0951*** (20.40)	0.0963*** (20.37)	0.0983*** (20.37)
Tariff	0.165*** (39.73)	0.165*** (39.73)	0.166*** (39.39)	0.167*** (38.11)
Intermediate Period*Soy	-0.0835*** (-24.07)	-0.0830*** (-23.90)	-0.0831*** (-23.99)	-0.0826*** (-22.94)
Post-Tariff*Soy	-0.244*** (-47.05)	-0.244*** (-46.82)	-0.243*** (-46.13)	-0.241*** (-43.66)
Constant	-0.272*** (-95.73)	-0.272*** (-95.90)	-0.150*** (-54.58)	-0.289*** (-65.17)
Observations	1099773	1094981	1071756	1032449
Adjusted R^2	0.563	0.559	0.529	0.526

t statistics in parentheses

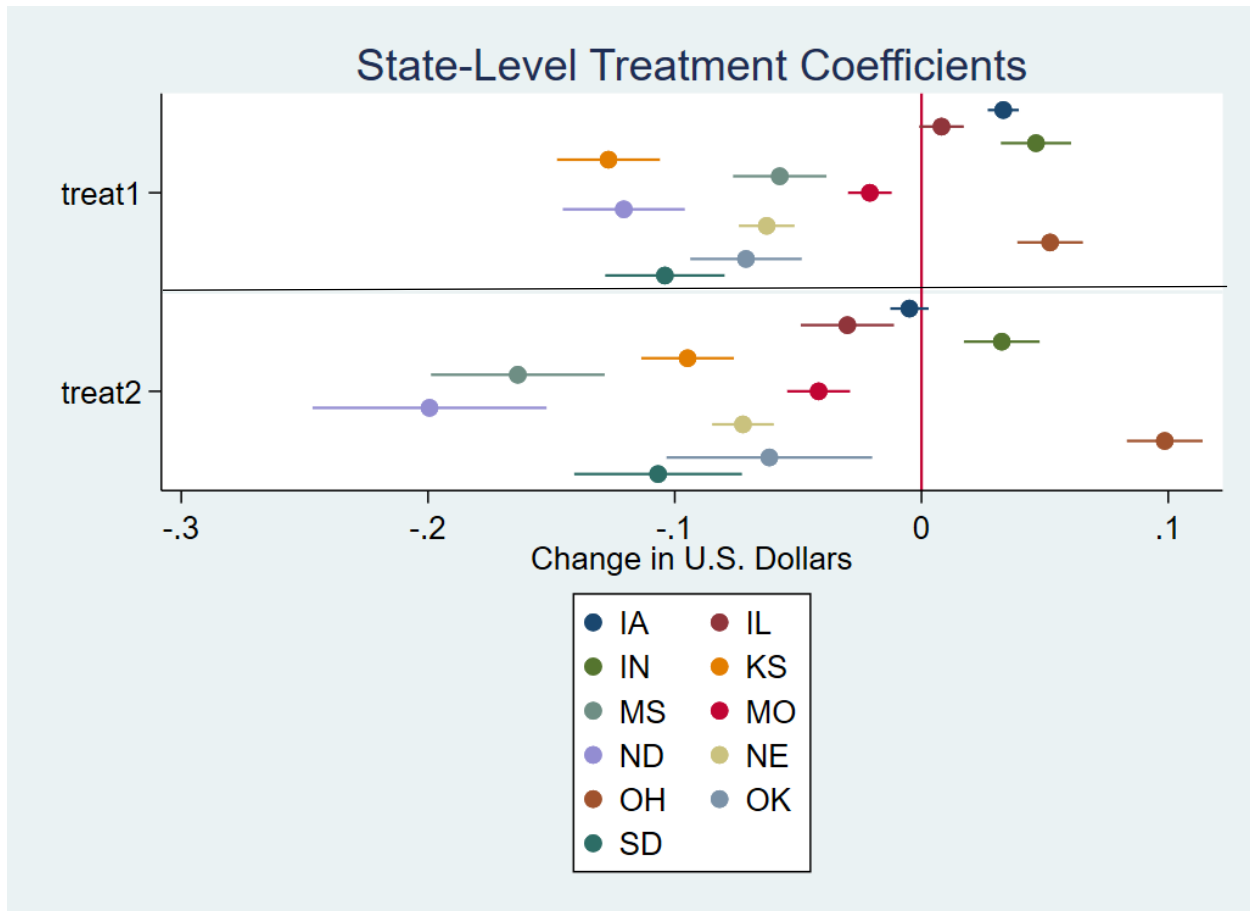
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

B.3 Difference-in-Differences Results with 2016/2017 and 2017/2018 Marketing Years with county, year and week fixed effects

	Full Sample	More than 10	More than 50	More than 100
Soy	-0.129*** (0.00487)	-0.128*** (0.00484)	-0.125*** (0.00477)	-0.121*** (0.00474)
Intermediate Period	0.0456*** (0.00347)	0.0450*** (0.00348)	0.0442*** (0.00353)	0.0470*** (0.00357)
Tariff	0.0725*** (0.00823)	0.0720*** (0.00826)	0.0713*** (0.00841)	0.0748*** (0.00866)
Intermediate Period*Soy	-0.0837*** (0.00346)	-0.0832*** (0.00346)	-0.0832*** (0.00346)	-0.0828*** (0.00360)
Post-Tariff*Soy	-0.0986*** (0.00421)	-0.0984*** (0.00422)	-0.0982*** (0.00424)	-0.0968*** (0.00440)
Constant	-0.354*** (0.0108)	-0.356*** (0.0108)	-0.263*** (0.0113)	-0.346*** (0.0118)
Observations	804504	801155	785941	761089
Adjusted R^2	0.576	0.571	0.539	0.538



B.4 State-Level Treatment Coefficients with September 2016-December 2018. Note: The coefficients estimate the relative change in soybean basis relative to corn basis per bushel in U.S. dollars during the intermediate period and after the tariff relative to the difference prior to the tariff announcement.



B.5 State-Level Treatment Coefficients with September 2016-August 2018. Note: The coefficients estimate the relative change in soybean basis relative to corn basis per bushel in U.S. dollars during the intermediate period and after the tariff relative to the difference prior to the tariff announcement.

B.6 State-Level Treatment Coefficients January 2015 - September 2020

Variable	Intermediate * Soybeans	Tariff * Soybeans
MS	-0.147	-0.260
IL	-0.108	-0.190
IA	-0.101	-0.225
OH	-0.098	-0.153
IN	-0.087	-0.172
KS	-0.055	-0.185
OK	-0.032	-0.225
ND	-0.022	-0.203
SD	-0.014	-0.184
MO	-0.004	-0.115
NE	0.035	-0.147

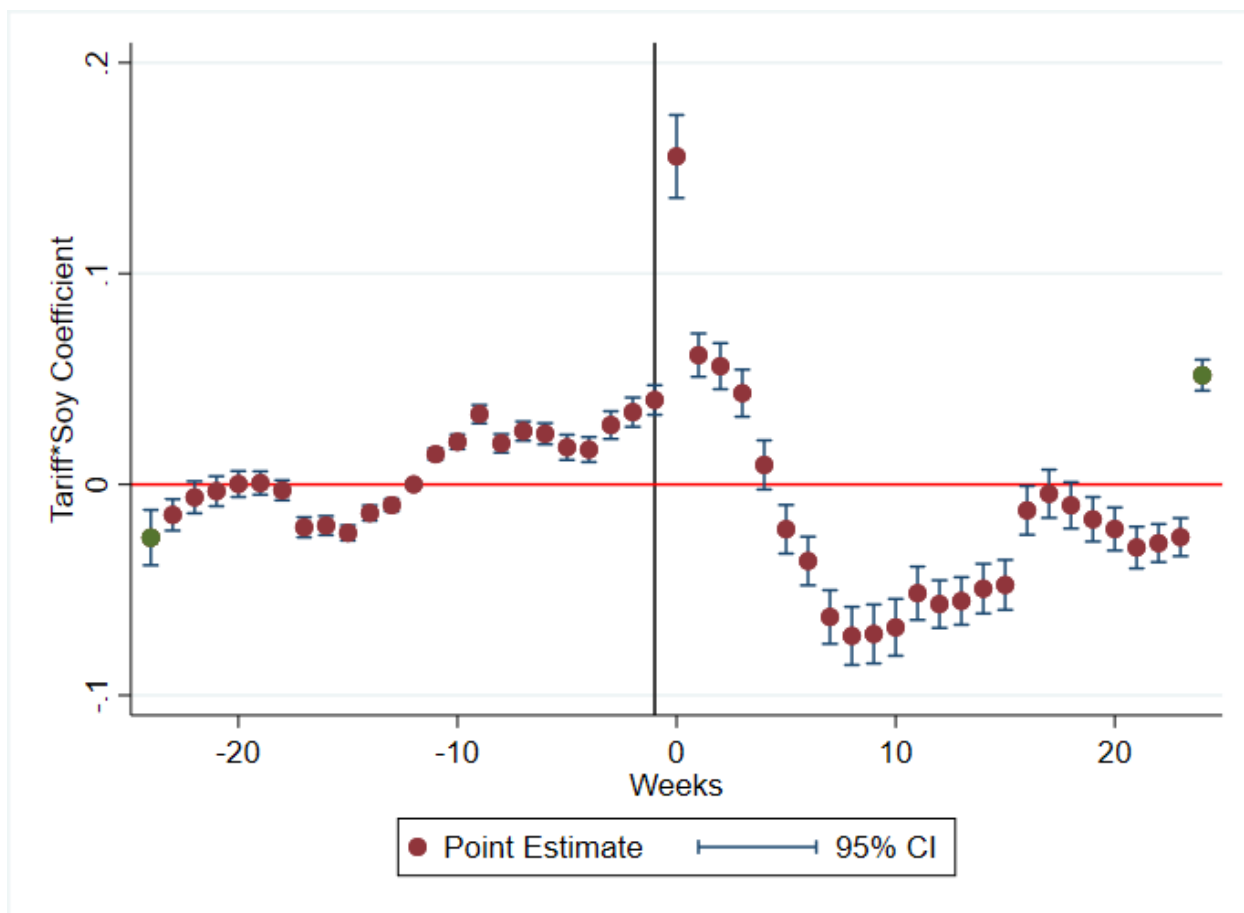
Note: The coefficients estimate the relative change in soybean basis relative to corn basis per bushel in U.S. dollars during the intermediate period and after the tariff relative to the difference prior to the tariff announcement.

B.7 Difference-in-Differences Results with data from 2015-2020

VARIABLES	(1) Full Sample	(2) More than 10	(3) More than 50	(4) More than 100
Soy	-0.220*** (0.00627)	-0.218*** (0.00627)	-0.208*** (0.00590)	-0.204*** (0.00600)
Intermediate Period	0.0392*** (0.00334)	0.0391*** (0.00334)	0.0371*** (0.00334)	0.0390*** (0.00340)
Tariff	0.0285*** (0.00698)	0.0294*** (0.00700)	0.0277*** (0.00711)	0.0310*** (0.00735)
Intermediate Period*Soy	-0.00863** (0.00340)	-0.00769** (0.00339)	-0.00313 (0.00321)	-0.00225 (0.00331)
Post-Tariff*Soy	-0.0849*** (0.00451)	-0.0850*** (0.00451)	-0.0799*** (0.00437)	-0.0783*** (0.00455)
Constant	-0.312*** (0.0109)	-0.315*** (0.0109)	-0.334*** (0.0107)	-0.336*** (0.0112)
Observations	1,578,495	1,570,514	1,534,022	1,471,693
R-squared	0.169	0.169	0.170	0.164
Week Fixed Effects	YES	YES	YES	YES
Year Fixed Effects	YES	YES	YES	YES

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1



B.8 Event Study with data extended to January 2015- September 2020