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# Abstract:

In 2018, China retaliated to U.S. trade actions by levying a 25% retaliatory tariff on U.S. soybean exports. That tariff shifted market preferences so that Chinese buyers—who make up a substantial share of total world consumption—favored Brazilian soybeans. We use the relative price of a substitute (RPS) method to estimate that the resulting trade disruption effectively drove a wedge into the world soybean market, lowering U.S. prices at Gulf export locations by \$0.74/bu on average for about five months, and increasing Brazilian prices by about \$0.97/bu, compared to what would have been observed without the tariff in place. By the end of that period, world markets adjusted and the soybean prices in both countries returned to the ex-ante state of near parity, although the U.S. export volume did not recover until the end of the following marketing year. Our price impact estimate is substantially lower than subsequent U.S. government "trade aid" payments to American soybean producers: although actual payments to producers varied based on county-level differences, USDA's nominal calculation of the commodity-specific payment rate for soybeans under MFP summed to \$3.70 for two bushels produced over the course of two years. We project that USDA's near-\$8.5 billion in trade aid to U.S. soybean producers exceeded the tariff damage by about \$5.4 billion. These difference could be attributed to USDA's broader definition of "economic injury", beyond the short-run price impacts we estimate.

Key words: Farm subsidies, Market Facilitation Program, Trade aid, US-China Trade War.

JEL codes: H25, Q18, Q11.

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## 1. Introduction

In 2018, several of the United States' major trading partners placed retaliatory tariffs on U.S. agricultural exports in response to U.S.-initiated tariffs on washing machines, solar panels, steel, aluminum, and a range of Chinese products.<sup>1</sup> According to Congressional Research Service (2018b), a collection of the United States' top trading partners, led by China, announced new tariffs directed at \$26.9 billion in 2017 U.S. agricultural exports, or 18 percent of all U.S. agricultural exports that year (CRS, 2018b). In 2017, USDA estimated that agricultural exports represented 33.4 percent of total gross cash U.S. farm income (Schnepf 2017), so export disruptions of this size have the potential to cause significant harm to U.S. agricultural interests. Throughout this paper, we refer to the rising tensions and new trade barriers as a "trade war."

U.S. soybean exports were easily the foremost target of agriculturally-directed trade retaliation. They accounted for \$12.3 billion in threatened U.S. exports (in 2017, the year before the trade disruption), nearly half of the total trade war retaliation, and were directed by China, historically the United States' main soybean export destination. In the years leading up the trade war, U.S. producers exported about half of all the soybeans they produced, and sold well over half of those exports to Chinese buyers. As evidence of the trade war's impact, after China applied an additional 25 percentage point tariff to U.S. soybeans in July 2018,<sup>2</sup> U.S. census data indicate that the U.S. exported only 8.2 million metric tons (MMTs) of soybeans to China in 2018, compared to 31.7 MMTs over the same timeframe in 2017, a

<sup>&</sup>lt;sup>1</sup> The United States based these trade actions on concerns over national security threats imposed by imports, and unfair trade practices; the Trump Administration characterized retaliation to these trade actions as "unjustified" (CRS, 2018a). It is important to note that the international reaction was not confined only to tariffs. For example, in August, 2018 China directed its state-owned firms to suspend its purchases of U.S. agricultural products (Bloomberg, 2018).

<sup>&</sup>lt;sup>2</sup> This new tariff raised China's total *ad valorem* barrier for U.S. soybean imports to 28%, as it's World Trade Organization Most Favored Nation tariff rate is 3% (see, e.g., Table A-1 in CRS, 2019a).

reduction of 74%.<sup>3</sup> Notably, China did not apply that tariff to its other main soybean vendor, Brazil. Rather, China substituted Brazilian for U.S. soybeans; its purchases from South America spiked following the imposition of its retaliatory tariffs (Thukral and Gu, 2018). Figure 1 shows Chinese imports of soybeans by volume and location; following the onset of the trade war, China displays a clear preference for Brazilian purchases.

In response to the retaliatory tariffs directed towards American agriculture, the U.S. federal government implemented a "trade aid" package to reimburse farmers for the damages they would face due to the market disruption, under powers enumerated in the Commodity Credit Corporation (CCC) Charter Act. The Market Facilitation Program (MFP), a major component of the trade aid, provided direct payments to the producers of affected commodities and was paid over two years under two different structures. Although actual payments to producers varied based on county-level differences, USDA's nominal calculation of the commodity-specific payment rate for soybeans under MFP totaled \$3.70 for two bushels produced over the course of two years (CRS, 2019b; USDA OCE, 2019).

In this article, we describe the onset of the trade war, the damage it caused to U.S. soybean producers, the policy designed by the U.S. government to compensate them for that damage, and then compare the rate that the government paid to remunerate soybean producers against the actual effect of the trade war on the commodity price in the United States. Several studies have simulated the latter by specifying a full supply and demand model of the soybean market, and differencing the equilibrium domestic price between scenarios with and without a 25% retaliatory tariff in place.<sup>4</sup> Our study is the first to use a retrospective time series technique that filters out shocks unrelated to the trade war in order to estimate

<sup>&</sup>lt;sup>3</sup> The reduction is even more significant when focusing on the July-December period. During that timeframe in 2018 China purchased just 0.6 MMT of soybeans from the United States, compared to the 22 MMT it had purchased over those months in the previous year. See Grant et al. (2021) for a comprehensive exploration of the in-season versus out-of-season retaliation effects.

<sup>&</sup>lt;sup>4</sup> See, e.g., Taheripour and Tyner, 2018. We summarize the findings of this and other related work in section 2.3, below.

the price effect, which accounts for the global reshuffling of trade that occurred after the tariff disruption—a missing element from USDA's calculation methodology.

We estimate that China's trade retaliation depressed the price of U.S. soybeans for Gulf export by \$0.74/bu for the five-month period from late-June through late-November, 2018. Our point estimate is about five times smaller than the aggregate nominal soybean payment rate calculated under the MFP (at the high end of our confidence interval, it is four times smaller), but this difference is moderated by the fact that the second year of MFP payments were made using single county-level rates based on the production of all affected non-specialty crops, as we discuss below. By December of 2018, the relative price series returned to previously-observed levels as the market adjusted to the shift in worldwide trade patterns, the U.S. and China called a (temporary) trade war truce, traders expected a large new South American soybean crop in early-2019, and Chinese soybean demand was affected by an outbreak of African Swine Fever (ASF)—a highly contagious and deadly disease for pigs that began to damage the Chinese swine population in early-August 2018 (APHIS 2019, Erickson 2018), very near the height of U.S.-China trade war tensions (Bown and Kolb 2020). In aggregate, we project that USDA's near-\$8.5 billion in trade aid to U.S. soybean producers exceeded the tariff damage to the value of the U.S. soybean crop by about \$5.4 billion.

# 2. Background

## 2.1 Trade War Retaliation Targeted U.S. Agriculture

According to the Congressional Research Service (CRS, 2018b), U.S. agriculture and food products were targeted with retaliation because (1) the United States is the world's largest agricultural exporter, (2) agricultural products are relatively easy to substitute with products from different suppliers, and (3) communities that produce agricultural products represent important political constituencies to U.S. lawmakers. Trading partners involved in the United States' various 2018 trade disputes included China,

Mexico, and Canada, three of the United States' largest agricultural export markets. China (\$20.6 billion), Canada (\$2.6 billion), Mexico (\$2.5 billion), the EU (\$1 billion), India (\$0.9 billion), and Turkey (\$0.3 billion) announced new tariffs directed at \$26.9 billion in 2017 U.S. agricultural exports (CRS, 2018b), or 18% of all U.S. agricultural exports that year. The most prominent of these new trade barriers was China's 25% additional tariff on virtually all U.S. agricultural exports; of these, the hardest hit was U.S. soybean products.<sup>5</sup>

China is the world's largest soybean importer. Most of the soybeans it purchases are crushed and used in animal feed and cooking oil (CRS, 2018b; Qiu, Gu, and Woo, 2019). China's massive hog herd is a major source of its demand for soybean imports.<sup>6</sup> As a result, China's retaliatory tariff displaced a significant amount of U.S. soybeans from the export market. Figure 2 shows that exported share of the U.S. 2018/19 crop sank to 39%, after averaging about 50% for the previous five years. At the same time, soybean ending stocks increased sharply to over 900 million bushels, 60% higher than the previous historical record. Following retaliation, although other trading partners like the European Union (EU), Argentina, and Egypt purchased more soybeans from the United States than they had in the past, their additional demand did not fully offset the losses resulting from Chinese retaliation, as shown in figure 3: American soybean exports dropped from 55.3 MMTs in 2017 to 46 MMTs in 2018.

As of this writing, the trade war is still ongoing, although perhaps in more of a cold war posture.<sup>7</sup> Average U.S. tariff rates on Chinese imports increased from 3.1% in January, 2018, to 12% by January, 2019, and then to 21% by January, 2020; over the same timeframe, Chinese tariffs on U.S. imports increased from 8% to 16.5% to 20.9% (Bown, 2020). Elevated tariffs remain in place. At one point in December 2018, the leaders of both countries reportedly agreed to a trade war "truce" following a G20 meeting (Landler, 2018;

<sup>&</sup>lt;sup>5</sup> China increased its tariff on U.S. agriculture to 30% in September 2019 (Bown and Kolb, 2020), then reduced it to 27.5% in February 2020 (Gu and Thukral, 2020).

<sup>&</sup>lt;sup>6</sup> China is home to over half of the world's pigs (FAS 2019a).

<sup>&</sup>lt;sup>7</sup> Grant et al. (2021) helpfully break these trade tensions down into five different phases.

Xin, 2018), halting the escalation of tariffs. But by May 2019, both countries began trading tariff threats once again (Bown and Kolb, 2020). Chinese tariffs on U.S. soybean imports remain in place. In January 2020, the United States and China agreed to a "Phase One" deal characterized by Chinese agreement to purchase large amounts of U.S. goods—\$80 billion of agricultural goods alone over two years (S&P Global, 2020). Analysts, some of whom questioned whether these targets were realistic or obtainable, presumed that soybeans were intended to make up a large portion of these purchases (Klebnikov, 2020). But even with a new administration in Washington, prospects for the survival of the Phase One deal—or any subsequent deals to actually remove the new trade war tariffs—are exceedingly difficult to predict given increased tensions between the two countries over the coronavirus pandemic and China's crackdown on pro-democracy protests in Hong Kong. For example, in June 2020 Chinese officials reportedly ordered major state-run firms Cofco and Sinograin to stop purchasing American farm goods including soybeans (Kitanaka et al., 2020), and then reversed course almost immediately (Plume et al., 2020). It is likely that this sort of policy volatility will continue into the future.

## 2.2 Possible Price and Welfare Effects of China's Tariff

If China did not enforce its retaliatory tariff, or if U.S. soybeans could be transshipped costlessly through third countries, e.g., shipping them first to Canada and then on to China to avoid the import tax, it would have no price or welfare impact. Otherwise, assuming no transactions costs associated with altering world trade patterns, if Brazil could meet all of China's demand (at the same cost of production as the United States—the initial market-clearing price), then China would simply buy from Brazil, and U.S. soybeans would be purchased by Brazil's former customers—a perfect reshuffling. Once again, there would be no effect on world prices or welfare.

However, if Brazil's supply schedule is less elastic (which was especially likely in the short run after June 2018, given that the bulk of the country's harvest takes place between January and April), and it can't meet China's demand at the original price, then China's retaliatory tariff will alter world shipping patterns,

relative prices, and world welfare (Gardner and Kimbrough, 1990). It would drive up the Brazilian export price, lower the United States' price, and increase the Chinese import price. These effects raise welfare for Brazilian and Chinese producers, who benefit from a higher price, and for U.S. consumers, who benefit from a lower price. Conversely, U.S. soybean producers are made worse off by the lower domestic price, and Brazilian and Chinese consumers would be made worse off by the higher price they face.

Our empirical strategy to identify the effect of the retaliatory tariff focuses on identifying structural breaks to the relative price of U.S. to Brazilian soybeans, allowing us to determine whether China's tariff policy (and its enforcement) was binding in the short run. A non-binding policy produces no change in relative price. On the other hand, a relative price change equal to the full amount of the tariff implies that Chinese buyers are indifferent between Brazilian and U.S. soybeans, and the marginal post-tariff U.S. soybean would be exported to China. If the relative price changes by less than the amount of the tariff, then Chinese buyers favor Brazilian soybeans, and the marginal U.S. soybean must find an alternative market spatially (e.g., overseas) or temporally (i.e., placing it in storage).

### 2.3 Extant Findings About the Impact of the Trade War on Soybean Prices

Most of the research into the impact of the trade war on soybean prices relies on the specification of a model of the U.S. and/or world soybean market (Janzen and Hendricks, 2020). Researchers estimate the impact of the retaliatory tariff by simulating the change in price with and without a tariff wedge in place. Taheripour and Tyner (2018) use the Global Trade Analysis Project (GTAP)-Biofuels model to estimate that China's 25% tariff would reduce U.S. producer prices for soybeans by 4.9%. Zheng et al. (2018) use the Global Simulation Model, an Armington partial equilibrium trade model developed by Francois and Hall (2009), to project that domestic soybean prices would fall by 3.9% in the short run due to the retaliatory tariff. Sabala and Devadoss (2019) develop a spatial equilibrium trade model to simulate that China's retaliation would lower U.S. soybean prices by about 12%, and raise Brazilian prices by 8%. Westhoff,

Davids, and Soon (2019) use a modified spatial equilibrium model to estimate that the trade war drove down 2019 U.S. soybean prices by 8.7%, while increasing Brazilian prices by 3.1%.

In contrast to these model-based approaches, Swanson et al. (2019) conduct a data-driven analysis, comparing observed U.S. soybean prices in 2018 against historical patterns. Conditioning on crop yield, those authors estimate that Illinois soybean prices in October 2018 were 11.9% lower than would be normally be expected, and attribute the difference to the trade conflict. Another method to consider the price effects of the trade war is to measure the way it impacted contemporaneous USDA-forecasted prices. USDA forecasts of the season-average price received by U.S. soybean producers declined by 18.1% from May through September 2018 (CRS, 2019b). However, because many factors influence domestic commodity price levels, that approach is incomplete. For example, good harvests in both the United States and Brazil during 2018 contributed to the weakening of each country's export prices over the course of the year.

## 2.4 African Swine Fever Outbreak

ASF-related losses to China's breeding herd contracted the country's pork output in 2019 and 2020 (FAS, 2019b; FAS, 2020). Li et al. (2019) report that China's hog and sow inventories contracted by 14 and 13 percent, respectively, from December 2018 – February 2019. A smaller herd reduces China's demand for soybeans, and lowers the world soybean price. Moreover, it reduces the effect of the tariffs because Chinese buyers must shift fewer purchases from the United States to Brazil, and limits costly reshuffling of U.S. soybeans to alternative markets. ASF, therefore, attenuates the impact of the retaliatory tariff on the relative U.S.-Brazil soybean price.

## 2.5 USDA's efforts to assist trade war-damaged producers

To assist producers affected by ongoing trade war damages, USDA was directed to devise the MFP *exante*, before both the harvest for major U.S. commodities was complete, and before the full impact of the

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trade war on U.S. exports was known.<sup>8</sup> Through the program, initiated under CCC authority, USDA issued direct payments to the producers of affected commodities over two years, under two different structures (MFP1 and MFP2). In both, USDA followed a standard approach to trade dispute cases before the World Trade Organization and calculated these payments based on its assessment of gross "direct trade damage," or export losses to retaliatory partners as result of additional tariffs imposed during the trade war. That is, the Department compared projected export values to retaliatory partners only under the new tariffs to a baseline pre-trade war level, differenced them, and then divided that lost value by total production (plantings) in 2018 (2019) to arrive at a per-bushel damage figure. Because the methodology ignores trade flow adjustment to the new barriers that occurs as trade networks shift and rebalance (Janzen and Hendricks, 2020), along both the extensive and intensive margin (in the form of increased soybean exports to new and existing non-retaliatory partners), it risks overestimating the impact of trade retaliation, at least in the short-run. It is important to note that USDA intended the MFP to compensate vulnerable producers for extra costs they were exposed to in identifying new markets for their crops (USDA OCE, 2018). Under that definition of economic injury, these additional costs may be interpreted to include long-term negative effects of a trade war, such as enhanced soybean competitiveness in South America (Cowley, 2020).

Under MFP1, initiated in 2018, USDA generated specific payment rates for different commodities based on its assessment of gross damages, calculated using a 2017 (the calendar year prior to the trade war) baseline and a version of the GSIM model (USDA OCE, 2018). The Department estimated the gross trade loss from soybean retaliators at \$7.3 billion, and divided that total by the level of 2018 production to arrive at an MFP1 rate of \$1.65/bu. U.S. soybean producers who applied for MFP1 aid could receive two payments summing to \$1.65 for every bushel of their actual harvested 2018 soybean production. To

<sup>&</sup>lt;sup>8</sup> In addition to MFP, the trade aid package included commodity purchases under a Food Purchase and Distribution Program (FPDP) and an Agricultural Trade Promotion (ATP) marketing program.

remain consistent with CCC authority, USDA stated that these payments were intended to help producers remarket their goods, potentially cover additional transportation, storage, and spoilage costs imposed on farmers as the United States adjusts to the new marketing landscape following the disruption caused by China's tariff retaliation.

USDA designed MFP2 with several important changes. First, it applied a different baseline of trade, crucial to the calculation of trade war damage and thus payment rates. Rather than focus on 2017 exports, as MFP1 had done, for MFP2 USDA selected the highest level of exports observed in the ten-year period 2009-2018 as the baseline. According to USDA, this change helped address longstanding trade barriers as well as any longer-term impact of tariff retaliation (USDA OCE, 2019). It also increased government payments (Paulsen et al., 2019; Janzen and Hendricks, 2020), raising the per-bushel nominal soybean commodity rate to \$2.05 (USDA OCE, 2019). However, unlike the case of MFP1, USDA combined MFP2 commodity rates for affected commodities to generate a single county-wide per-acre rate paid to all producers of affected (non-specialty crop) commodities, based on historical production of affected commodities in the county. The government paid soybean producers who applied for relief under MFP2 the county-wide payment rate multiplied by the producer's planted soybean acres in 2019.<sup>9</sup> USDA made this choice to avoid influencing planting decisions in 2019. Although the total per-bushel MFP payments to soybean producers varied by their county location and its historical production profile, USDA's aggregate nominal commodity payment rate to affected producer amounted to \$3.70 for two bushels from 2018-2019.

## 3. Methods and Data

3.1 Exploiting the Substitutability of U.S. and Brazilian Soybeans

<sup>&</sup>lt;sup>9</sup> As in 2018, total MFP payments were subject to caps by individual/entity (CRS, 2019b; CRS 2019c).

Carter and Smith (2007) show that deviations in the relative price of substitute goods can be used to identify the price impact of an event that disrupts a stable market equilibrium. They introduced the Relative Price of a Substitute (RPS) method, relying on the demand substitutability of sorghum and corn to measure the effect of the StarLink food scare on the prices of both commodities in 2000. In a trade context similar to ours, Schmitz (2018) uses RPS to measure the impact of China's 2013-2014 embargo of North American corn exports on Canadian corn producers. RPS isolates price impacts of changes in relative preferences or technology and has several advantages over other approaches, so we use it to measure the impact of China's 2018 retaliatory tariff on the price of U.S. soybeans. These advantages include that RPS enables estimation of the time at which the trade war began to influence soybean prices, it is insulated from income shocks as well as demand or supply-side innovations that affect both goods equally, and it avoids costly specification errors associated with a full structural supply and demand system.

RPS involves three steps: (1) verifying the presence of a stable relative price before the event, (2) identifying a break in that relationship around the event, and (3) using a forecasting model based on the pre-event relationship to estimate the average forecast error following the break.

To satisfy the first step, for any two substitutes RPS requires a stable pre-event relationship of the form

(1) 
$$\ln P_{1t} - \ln P_{2t} = \mu + \beta' Z_t + u_t$$

implying that  $u_t$  is a stationary disturbance term, and supply and demand shifters in  $Z_t$  only need to be included if the log price difference between substitute goods is itself not stationary. A stable relative price implies that departures of the relative price from its mean (conditional on  $Z_t$ ) correct in the long run, so that  $u_t$  is stationary. Significance of a given event's price impact is tested by searching for shifts in  $\mu$ .

Like Carter and Smith (2007), we apply RPS to exploit the long-run relationship between prices for close demand substitutes: U.S. and Brazilian soybeans. In response to U.S. tariffs on Chinese goods, the Chinese government imposed a 25% tariff on U.S. soybeans (both nations announced tariff lists on June 15<sup>th</sup>, and

imposed tariffs on July 6<sup>th</sup>). China is the world's dominant importer of soybeans, purchasing most of the soybean exports from the world's two largest exporters: the United States and Brazil.<sup>10</sup> China's 25% retaliatory tariff is a clear candidate for an event that shifts consumer preferences, so we test for its suitability under step (2) by searching for structural breaks in the relative price of U.S. and Brazilian soybeans:  $ln P_{US,t} - ln P_{Br,t}$ .

## 3.2 Testing for Structural Breaks

Following Carter and Smith (2007), and because we require no  $Z_t$  variables for our application, we apply Bai and Perron (1998) tests for multiple unknown structural breaks in the mean of the log difference of U.S. and Brazilian soybean prices. Bai and Perron tests compare the maximum *F* statistic, or *sup-F*, over all possible break points in the sample. First, we use a sequential approach to identify individual structural breaks in the relative prices, testing each additional break against the null hypothesis of one fewer. Next, we verify the robustness of those findings using a double-maximum test, which evaluates the null hypothesis of no structural breaks against the alternative of some unknown number of breaks up to a maximum of *M*.

### 3.3 Estimating Price Impacts

If the pre-event relationship is stable, and can be represented with a (1,-1) cointegrating vector, then we can form an error-correction model (ECM) (Engle and Granger, 1987) to forecast how post-event prices would have behaved if the pre-event relative price relationship had held:

(2) 
$$\Delta \ln P_{US,t} = \alpha_{US}\omega_{t-1} + \gamma_{US}(L)\Delta \ln P_{US,t} + \delta_{Br}(L)\Delta \ln P_{Br,t} + \varepsilon_t$$
$$\Delta \ln P_{Br,t} = \alpha_{Br}\omega_{t-1} + \gamma_{US}(L)\Delta \ln P_{US,t} + \delta_{Br}(L)\Delta \ln P_{Br,t} + \varepsilon_t$$

<sup>&</sup>lt;sup>10</sup> According to figure 1, China's purchases from the rest of the world are a small fraction of its purchases from the U.S. and Brazil, even after the commencement of the trade war.

where  $\gamma_{US}(L)$ ,  $\delta_{Br}(L)$ ,  $\gamma_{Br}(L)$ , and  $\delta_{US}(L)$  are polynomials described by the lag operator (*L*), and the error-correction term is  $\omega_t = ln P_{US,t} - ln P_{Br,t} - \mu$ . In our example, we use the ECM to forecast log soybean prices in both the United States and Brazil, and compare those forecasts to the actual realized values. The impacts  $PI_{US}$  and  $PI_{Br}$  of the event on the respective U.S. and Brazilian soybean prices equal the mean forecast error from the ECM over the relevant time period. Together, the ECM and the breaks testing procedure imply that  $PI_{Br} = PI_{US} - \Delta\mu$ , where  $\Delta\mu$  denotes the change in the mean relative price caused by the event. We estimate  $PI_{US}$  as the weighted forecast error for the ECM over the trading days that represent the structural break caused by the trade war, and then calculate  $PI_{Br}$  according to the relation in the previous sentence. Following Carter and Smith (2007), we generate forecast error weights based on the variance of in-sample model forecast errors—which are heteroskedastic and correlated—by applying the ECM to the pre-trade war break data.

#### 3.4 Data

We use daily cash bids at export locations in both the United States and Brazil. Our U.S. prices are drawn from export elevator bids in at the Louisiana Gulf, as reported by the USDA Agricultural Marketing Service. Our Brazilian price series is collected by the Brazilian Center for Advanced Studies on Applied Economics (CEPEA) at Paranaguá port warehouses that load ships for export. Both prices are denominated in dollars and therefore insulated from exchange rate effects. Because CEPEA reports Brazilian prices for 60kg bags, we convert them to per bushel prices using a standard 60lb/bushel weight (as maintained by, e.g., the U.S. Soybean Export Council, 2015), so that a 60kg bag is equivalent to just over 2.2 bushels. We use trade volume data from Trade Data Monitor, as well as export shares, ending stocks, and plantings from USDA. USDA is likewise our source for county-level 2018 soybean MFP1 payments,<sup>11</sup> and the historical yield and acreage data that we used to estimate the soybean share of the government's 2019 MFP2 county-level

<sup>&</sup>lt;sup>11</sup> Local soybean MFP1 payments were obtained from USDA's Farm Service Agency (FSA) via a Freedom of Information Act request.

payments. To generate a spatial representation of MFP overpayments in the United States, we also use local basis bids data from Geograin, averaged to the county level. Our period of observation runs from January 2013 until December 2020.

#### 4. Results and Discussion

#### 4.1 Relationship between U.S. and Brazilian Soybean Prices

Figure 4A plots the log of both series from 2013-2020. Following an initial set of deviations, the U.S. and Brazilian soybean prices moved together quite closely for a period of five years; small disruptions appear periodically, but tend to be short run in nature. This strong relationship is intuitive since both countries compete heavily for export opportunities, especially in Asia. However, coinciding with rising trade tensions in 2018 and especially just before both sides imposed tariffs, U.S. soybeans at the Gulf of Mexico began to attract substantially discounted bids relative to their Brazilian counterparts. This is also evident in the very large change in the log relative price displayed in Figure 4B, beginning in mid-2018.

Table 1 documents pre-tariff price stability. Augmented Dickey-Fuller tests are unable to reject the null hypothesis that each individual log price series contains a unit root. However, the differenced series is found to be stationary so we conclude that the two log soybean prices are cointegrated. The test statistics produced by a Johansen Trace Test confirm the presence of a single cointegrating vector. The Bai-Perron tests in Table 2 indicate that the relative price series exhibits four structural breaks over the period of interest. The first two breaks selected are on 6/26/2018 and 11/26/18. The June date is shortly after both the United States and China published revised 25% tariff lists (on June 15th), signaling their strong intentions to erect barriers to \$50 billion worth of goods traded in both directions (including China's planned additional 25% tariff on U.S. soybeans), and President Trump's direction (on June 18th) that the U.S. Trade Representative identify an additional \$200 billion of imported Chinese goods to tariff at 10% (Bown and Kolb, 2020). The timing of this break is also one week before July 6th, the date that China and

the United States both officially imposed the tariffs they had threatened. The second break identified by the sequential Bai-Perron tests occurs in late-November 2018, just as the leaders of both countries reportedly agreed to a trade war "truce" following a G20 meeting. From then until the Phase One deal was signed in January 2020, the relative soybean price series behaves as you might expect, and consistent with the phases of the trade war identified by Grant et al. (2021), although the variation it exhibits is not sufficiently outside the usual range to classify as a statistical break.

The Bai-Perron procedure finds two other significant breaks in addition to 6/29/2018 and 11/26/18. They are near the beginning and end of the sample period. Observations before the first break are consistent with seasonal fluctuations in Brazilian and U.S. prices predicted by Miranda and Glauber (2021), where U.S. prices rise during the Spring and Summer when the prior crop is disappearing rapidly, and fall during the Autumn and Winter as the crop is harvested and exports commence, while Brazilian prices do the opposite. These fluctuations are also present *after* the initial break, but are more muted. They become noticeable again in mid-2020—coinciding with the last break identified in Table 2—a period of rapidly rising prices and export volumes.

The regime we identify from 6/29/2018 through 11/26/2018 is associated with an average relative price decline of 17.6%, which is less than the 25% tariff. This implies that although China's retaliatory tariff was binding, U.S. producers were able to find alternate markets for soybeans, either by re-shuffling exports to new and/or non-retaliatory markets, increasing domestic consumption, or increasing storage. Relative soybean prices returned to their pre-tariff level in late-November, 2018. At that time, news headlines indicated that the United States and China were entering into a trade war truce. By December, state-run Chinese firms began making commitments to purchase U.S. soybeans (Reuters, 2018). In addition, news of the large Brazilian soybean crop in early 2019 (a supply response to the retaliatory tariff), a higher-than-expected Brazilian soybean export forecast, and possibly ASF-driven demand side effects in China may

have played a part in eroding the premium that Brazilian soybeans enjoyed beginning with the onset of trade war tensions in June, 2018.

## 4.2 Measuring the Price Impact of the Trade War

Figure 4B imposes the regime means identified in the structural break procedures over the log relative price series from 2015-2020. Clearly the structural break associated with the trade war had a meaningful impact on market preferences. Taken together, our stationarity results and structural break findings suggest that RPS conditions (1) and (2) are met. We therefore construct an ECM using the pre-event price data from the Sep. 2013 – Jun. 2018 sub-period in order to generate price forecasts to use in quantifying the soybean price impact of the trade war.

Table 3 presents our error-correction model results. The adjustment parameters  $\alpha$  for each equation represent the response of the respective log prices to deviations from the long-run relationship. For U.S. soybean prices, the adjustment parameter in the table is negative but not significantly different from zero. For Brazilian prices,  $\alpha_{Br}$  is estimated at 0.03 and for U.S. prices,  $\alpha_{US}$  is estimated at -0.004. Therefore, Brazilian prices bear the burden of adjustment following deviations from the equilibrium relative price in the pre-tariff period. That is, when the relative U.S. price is too high, i.e.,  $ln P_{US,t} - ln P_{Br,t} > \mu$ , the Brazilian soybean price tends to rise by over seven times as much as the U.S. price drops; when the spread is too low, the Brazilian price tends to fall by more than seven-fold the rate at which the U.S. price rises. These responses re-establish the equilibrium relationship. Because its coefficient represents a log change and is small, it can be interpreted as a percentage. So, we take Table 3 findings to indicate that, on average, the Brazilian price adjusts at an approximate rate of 3% per day and the U.S. price by 0.04% per day to correct any deviation.

Figure 5 shows the errors for log price forecasts generated using the ECM. As expected, the pre-tariff data suggest that U.S. soybean prices fell and Brazilian soybean prices increased as a result of China's tariff

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retaliation during the trade war. We estimate that China's retaliatory tariff decreased U.S. export prices by about 7.9% (with a standard error of 0.9%), and raised Brazilian prices by about 9.7% (with a standard error of 0.9%) from late-June through late-November, 2018. Our finding, at the mean, for the reduction in U.S. soybean caused by the tariff is higher than the 3.9% and 4.9% price losses forecasted by Zheng et al. (2018) and Taheripour and Tyner (2018), respectively, and lower than the 8.9% (Westhoff, Davids, and Soon, 2019), and 11.9% (Sabala and Devadoss, 2019; Swanson et al., 2019) reduction estimated by other researchers.

Combining our estimated price impacts with the price of soybeans in both countries on the day before the June 2018 structural break implies that the preference changes induced by the trade war depressed U.S. soybean prices by about \$0.74/bu (with a 95% confidence interval ranging between -\$0.56 and -\$0.91 per bushel) on average for the five months until around the time that the G20-meeting "truce" was called, while raising Brazilian prices by about \$0.97/bu (with a 95% confidence interval ranging between \$0.78 and \$1.16 per bushel).

The significance and direction of our estimated price effects indicate that Chinese retaliatory tariffs were effective, at least to the extent that they were enforced on American exports and that transshipment was not costless. The observed break in the relative prices series dates to the time frame around tariff implementation, is characterized by depressed U.S. prices compared to prices of Brazilian exports, and indicates that Brazilian supplies were not sufficient to meet Chinese demand at the previous market-clearing price. As a result, China's retaliatory tariff altered worldwide trade patterns, lowered world welfare, and harmed U.S. producers.

This reshuffling of trade patterns was not established instantaneously. As shown in figure 6A, despite a large harvest the United States total soybean exports during the 2018/19 marketing year fell considerably compared to their average over the previous three marketing years, and exports to alternative

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destinations (like the EU, as detailed in figure 3) were unable to compensate for sharply-reduced U.S. exports to China. Figure 6B shows that, in contrast, Brazil's exports that year—especially to China—increased relative to its recent history. Many of the displaced U.S. exports found their way into storage facilities, raising 2018/2019 soybean ending stocks to record levels.<sup>12</sup> These large inventories, coupled with ongoing trade war concerns, likely led producers to shift away from soybean plantings the next year. Figure 7 shows that 2019 U.S. soybean planting area fell by almost 15% year over year, their largest reduction since at least 1980—even larger than 2007's 14.3% drop observed in response to the institution of ethanol policies in the United States that increased the relative attractiveness of planting corn.

Yet, despite the significant disruption to the global export market and production choices generated by the trade war, figure 6A shows that by the end of the 2019/20 marketing year, total U.S. soybean exports (if not exports to China) recovered to the average level they reached during the three years prior to the trade war's onset. In figure 3, U.S. exports in calendar year 2020, a period of sharply rising prices in both the United States and Brazil, totaled 64.2 MMT—well above the 55.3 MMT recorded in 2017. In figure 2, USDA forecasts that the export share of U.S. soybeans harvested in 2020 will return to the rising trend observed during decade before the trade war began.

## 4.3 Calculating and Mapping the Overpayments

Data obtained from FSA reveal that USDA paid soybean producers nearly \$7.1 billion in MFP1, implying that that USDA awarded MFP compensation to U.S. soybean producers of 4.28 billion bushels (at \$1.65 per bushel).<sup>13</sup> For MFP2, USDA payments to soybean producers are more difficult to gauge, since the

<sup>&</sup>lt;sup>12</sup> The final 2018/2019 soybean ending stocks figure of 909 million bushels is more than double USDA's pre-harvest May 2018 forecast of 415 million (USDA, 2018).

<sup>&</sup>lt;sup>13</sup> This a 3.4% lower figure than the 4.42 billion bushels produced by the 2018 U.S. harvest (USDA, 2021). We attribute the difference to the limits USDA placed on reimbursement eligibility and possibly less than total takeup on the part of producers.

Department offered a single county-level per-acre rate to producers who planted crops that it deemed affected by trade war damages. Consequently, we used USDA's (USDA OCE, 2019) published trade damage methodology for non-specialty crops to approximate the soybean-directed share of each county's MFP2 rate; when each are multiplied by county-planted acres and summed across the United States this totals to about \$1.5 billion in payments. According to our analysis, China's retaliatory tariff depressed soybean prices by \$0.74/bu at the Gulf of Mexico for about five months, implying about \$3.2 billion in lost value for domestic producers. Therefore, the MFP1 payment exceeded our damage estimate by \$3.9 billion, so that—when added to the \$1.5 billion of soybean-directed MFP2 payments the Department made after the U.S. price and Brazilian price series returned to parity—USDA made combined MFP payments of more than \$5.4 billion in excess of the short-run harm caused by China's tariff retaliation.

Some locations in the United States were hurt relatively more by the trade war than others. For example, Adjemian et al. (2019) show that the soybean basis widened more in the upper Midwest than elsewhere. Yet mapping the impact of China's tariff over space is complicated by the fact that local grain bids data exhibit mixed robustness. While some locations offer consistent, frequent bids others record only a single bid per week or month. For those counties with sufficient observations in the 6/26/2018 to 11/25/2018 tariff window, we aggregated Geograin soybean bids to the county level and calculated the difference between the soybean price on 6/25/2018 and the average bid in the window.<sup>14</sup> Then, we used kriging—a spatial interpolation method that estimates missing values based on the variation between known data points and the distance between them—to generate the missing county-level differences. Finally, we adjusted those differences upward to arrive at a damage approximation based on the relationship between the per-bushel damage value we estimate at the Louisiana Gulf in our time series analysis, which

<sup>&</sup>lt;sup>14</sup> We included 841 counties that received MFP1 payments and (1) had bids on the 6/25/2018 benchmark day and (2) at least 60% of days with observations in the tariff window; a further 1,313 counties that received MFP1 did not satisfy those criteria.

is based on a weighted average of forecast errors, and the difference between the basis value at the Gulf on 6/25/2018 and the average price observed at the location during the tariff window.

Figures 8A-8C plot our estimates of county-level trade war damages to the soybean producers, total MFP payments, and the ratio of MFP payments to trade war damages, respectively. In the figures, grey counties have no observations, while increasing levels of the variables they represent are depicted in darker shades of red. Unsurprisingly, both county-level damages and trade aid payments are clustered in areas of high soybean production, i.e., the Midwest. However, many counties exhibit notably larger MFP payments in Panel B than tariff damages in Panel A. Panel C quantifies relates these by taking the ratio of payments to damages; no county in Panel C displays a ratio between zero and one, implying that county-level MFP payments were in every case larger than our estimate of local damages. However, certain locations in the map receive display intense overcompensation than others. Echoing Adjemian et al. (2019), we find that North (1.68) and South Dakota (1.96) exhibit the two lowest aggregate payment-to-damage ratios of any state that received soybean-directed MFP payments. Minnesota (2.63), Illinois (2.79) and Missouri (2.84) are near the national average of 2.72, while the average producers in Louisiana (4.49) and North Carolina (3.56) received more intense compensation than the damages they suffered.

### 4.4 Policy Implications

Our estimated impact of the trade war on U.S. soybean prices is far lower than the commodity rate USDA used to reimburse eligible soybean producers through MFP. The difference may be rationalized under USDA's broader definition of economic injury than the short-run price impact of the trade war. Although the Department's retaliation damage calculation methodology is standard in international trade disputes,<sup>15</sup> because it focuses only on lost exports to retaliators it does not account for trade rebalancing effects that occur as markets adjust and U.S. soybeans find new purchasers (Janzen and Hendricks, 2020), so risks overestimating losses especially in the short run. However, the trade war and uncertainty over U.S. and global trade policy are likely to carry detrimental long-term implications including discouraging domestic investment (Caldara et al., 2020 and Amiti et al., 2020), harming U.S. soybean competitiveness relative to Brazil (Cowley, 2020), and damaging U.S. credibility as a trading partner (Janzen and Hendricks, 2020). Despite the fact that the U.S.-Brazil relative price equalized by December 2018, U.S. soybean export volume recovered only as the marketing of the previous harvest completed (see the prior subsection). According to USDA, it intended MFP to compensate retaliation-damaged producers for adjustment costs they face in adapting to the new marketing landscape during the trade war, such as transportation, storage, and spoilage costs over and above the immediate price effects caused by the trade war. Yet the large difference between payments and actual short-run price effects may invite scrutiny from lawmakers in future Farm Bill discussions (Janzen and Hendricks, 2020), just as the payments have drawn some negative coverage from the press (see, e.g., Pamuk, 2020). In fairness to USDA, forecasting trade damage and rapidly establishing an *ad hoc* program to reimburse producers—as the Department was tasked to do, especially in the case of MFP1—is complicated, given the unknowns about how trade volumes will be affected by new trade barriers, the implementation of tariff enforcement, and the flexibility of the domestic supply chain and the global trade network to unexpected shocks.

# 5. Conclusion

<sup>&</sup>lt;sup>15</sup> We note also that USDA's gross trade damage estimate of \$7.3 billion is similar to the \$7.1 billion in lost U.S. soybean exports estimated by Carter and Steinbach (2020), and lower than the \$10.3 billion in lost export sales found by Grant et al. (2020).

China targeted U.S. agriculture with retaliation to U.S. tariffs imposed in 2018. Soybeans, the most important U.S. agricultural export to the China prior to the trade war, were hardest hit. American soybean exports are highly sensitive to trade disruptions, especially from China, the world's dominant importer. In the recent past, U.S. producers shipped about one of every three rows they harvested to China. Trade retaliation in the form of a 25% tariff shifted market preferences so that Chinese buyers favored Brazilian soybeans.

We use the RPS method to estimate that the resulting trade disruption effectively drove a wedge into the world soybean market, lowering U.S. prices by \$0.74/bu on average for about five months, and increasing Brazilian prices by about \$0.97/bu, compared to what would have been observed without the tariff in place. By December 2018, U.S. and Brazilian prices returned to their previous relative level—a finding confirmed by our structural break tests. Erosion of the Brazilian premium initially generated by the tariff was likely due to adjustments to the trade network, market expectations that trade war tensions might be cooling and news of a large Brazilian soybean crop by early 2019 (a supply response to the trade war tensions), and possibly the effect of ASF on China's demand for hog feed.

USDA designed a program, the MFP, to compensate trade war-damaged producers based on estimated gross trade damages, a common practice in international trade disputes. Under the MFP, USDA calculated payments to soybean producers based on a combined nominal estimate of \$3.70 for two bushels in trade war damage over the course of 2018 and 2019. Our point estimate of the price impact to soybeans, which accounts for trade rebalancing, is about five times smaller than the combined MFP rates. However, due to the way that USDA reimbursed soybean-directed damages through a single-county level rate under MFP2, we estimate that the aggregate reimbursement payment (\$8.5 billion) was 2.72 times as large as the damage (\$3.2 billion) to U.S. soybean value caused by the tariff. This difference can perhaps be rationalized under USDA's broader definition of economic injury than the short-run price impacts we estimate; the Department sought to anticipate the adjustment costs producers face in adapting to the

new marketing landscape during the trade war, a landscape that only towards the end of the marketing of the 2019 harvest observed the United States regaining its footing in the soybean export market.

We measure price impacts using bids at export locations, but factors like transportation infrastructure, storage capacity, and crush facility proximity can lead to heterogeneous effects over space. We therefore apply spatial kriging to county-level basis data to approximate the impact of the trade war at different locations across the United States. We find that North and South Dakota were indeed relatively more impacted than other states, confirming the results of other studies (see, e.g., Adjemian et al., 2019).

# References

Adjemian, Michael K. & Arita, Shawn & Breneman, Vince & Johansson, Rob & Williams, Ryan, 2019. "Tariff Retaliation Weakened the U.S. Soybean Basis," Choices: The Magazine of Food, Farm, and Resource Issues, Agricultural and Applied Economics Association, vol. 34(4). Accessed at: <u>https://www.choicesmagazine.org/UserFiles/file/cmsarticle\_722.pdf</u>

Amiti, M., S.J. Redding, and D. Weinstein. 2020. "The Impact of the 2018 Trade War on U.S. Prices and Welfare." National Bureau of Economic Research Working Paper 25672. Accessed at: <u>https://www.nber.org/papers/w25672.pdf</u>

Animal and Plant Health Inspection Service (APHIS). 2019. "African Swine Fever." USDA Animal and Plant Health Inspection Service webpage. April. Accessed at: <u>https://www.aphis.usda.gov/aphis/ourfocus/animalhealth/animal-disease-information/swine-disease-information/swine-disease-information/african-swine-fever</u>

Bai, J. and P. Perron. 1998. "Estimating and Testing Linear Models with Multiple Structural Changes." Econometrica, 66(1):47-78. Accessed at: <u>https://www.jstor.org/stable/2998540?seq=1#page\_scan\_tab\_contents</u>

Bloomberg News, 2018. "China Halts U.S. Agriculture Purchases as Trade War Heats Up." August 5<sup>th</sup>. Accessed at: <u>https://www.bloombergquint.com/global-economics/china-asked-state-buyers-to-halt-u-s-agriculture-imports</u>

Bown, C.P. 2020. "US-China Trade War Tariffs: An Up-to-Date Chart." Peterson Institute for International Economics. Accessed at: <u>https://www.piie.com/research/piie-charts/us-china-trade-war-tariffs-date-chart</u>

Bown, C.P., and M. Kolb. 2020. "Trump's Trade War Timeline: An Up-to-Date Guide." Peterson Institute for International Economics. Accessed at: <u>https://piie.com/blogs/trade-investment-policy-watch/trump-trade-war-china-date-guide</u>

Caldara, D., M. Iacoviello, P. Molligo, A. Prestipino, and A. Raffo. 2020. "The Economic Effects of Trade Policy Uncertainty. *Journal of Monetary Economics*, 109: 38-59.

Carter, C., and A. Smith. 2007. "Estimating the Market Effect of a Food Scare: The Case of Genetically Modified StarLink Corn." *The Review of Economics and Statistics*, 89: 522-533. August.

Carter, C., and S. Steinbach. 2020. "The Impact of Retaliatory Tariffs on Agricultural and Food Trade." Selected Paper prepared for presentation at the 2020 Agricultural & Applied Economics Association

Annual Meeting, Kansas City, MO. July 26-28, 2020. Accessed at: https://ageconsearch.umn.edu/record/304367/files/18456.pdf

Congressional Research Service (CRS). 2018a. *Farm Policy: USDA's Trade Aid Package*. Report #R45310. September. Accessed at: <u>https://fas.org/sgp/crs/misc/R45310.pdf</u>

CRS. 2018b. *Profiles and Effects of Retaliatory Tariffs on U.S. Agricultural Exports*. Report #R45448. December. Accessed at: <u>https://crsreports.congress.gov/product/pdf/R/R45448</u>

CRS. 2019a. *Retaliatory Tariffs and U.S. Agriculture*. Report #R45903. September. Accessed at: <u>https://fas.org/sgp/crs/misc/R45903.pdf</u>

CRS. 2019b. *Farm Policy: USDA's 2018 Trade Aid Package*. Report #R45310. June. Accessed at: <u>https://fas.org/sgp/crs/misc/R45310.pdf</u>

CRS. 2019c. *Farm Policy: USDA's 2019 Trade Aid Package*. Report #R45865. November. Accessed at: <u>https://fas.org/sgp/crs/misc/R45865.pdf</u>

Cowley, C. "Reshuffling in Soybean Markets following Chinese Tariffs," *Economic Review*, Federal Reserve Bank of Kansas City, 1:5-30, June. Accessed at:

https://www.kansascityfed.org/~/media/files/publicat/econrev/econrevarchive/2020/v105n1cowley.pd <u>f</u>

Erickson, A. 2018. "China races to corral an outbreak of deadly African swine fever." Washington Post, August 29.

Engle, R. F., and C. W. J. Granger, 1987. "Co-integration and Error Correction: Representation, Estimation, and Testing," *Econometrica* 55: 251–276.

FAS. 2019a. *Livestock and Poultry: World Markets and Trade*. USDA Foreign Agricultural Service. April 9<sup>th</sup>. Accessed at: <u>https://apps.fas.usda.gov/psdonline/circulars/livestock\_poultry.pdf</u>

FAS. 2019b. USDA PSD Online Custom Query: Swine Beginning Stocks in 1000 Head, for 2019. USDA Foreign Agricultural Service. Accessed at: <u>https://apps.fas.usda.gov/psdonline/app/index.html#/app/advQuery</u>

FAS. 2020. *Livestock and Products Semi-annual*. USDA Foreign Agricultural Service. April 16<sup>th</sup>. Accessed at: <u>https://www.fas.usda.gov/data/china-livestock-and-products-semi-annual-5</u>

Francois, J., and H.K. Hall. 2009. *Global simulation analysis of industry-level trade policy: The GSIM model*. Institute for International and Development Economics, 2009.

Gardner, G., and K. Kimbrough. 1990. "The Economics of Country-Specific Tariffs." *International Economic Review*, 31(3): 575-588.

Grant, J.H., S. Arita, C. Emlinger, R. Johansson, and C. Xie. 2021. "Agricultural Exports and Retaliatory Trade Actions: An Empirical Assessment of the 2018/2019 Trade Conflict." Applied Economic perspectives and Policy, Accessed at: <u>https://doi.org/10.1002/aepp.13138</u>

Gu, H. and N. Thukral. 2020. "China Grants Duty Exemption on U.S. Soybean Imports: Sources." *Reuters*. March 6<sup>th</sup>. Accessed at: <u>https://www.reuters.com/article/us-usa-trade-china-agriculture/china-grants-duty-exemption-on-u-s-soybean-imports-sources-idUSKBN20T14U</u>

Janzen, J.P., and N.P. Hendricks. 2020. "Are Famers Made Whole by Trade Aid?" *Applied Economic Perspectives and Policy*, 42(2): 205–226. Accessed at: https://onlinelibrary.wiley.com/doi/abs/10.1002/aepp.13045

Kitanaka, A., S. Niu, S. Yang, A. Cang, and I. Almeida. 2020. "China Halts Some U.S. Farm Imports, Threatening Trade Deal." *Bloomberg*. June 1<sup>st</sup>. Accessed at: <u>https://www.bloomberg.com/news/articles/2020-06-01/china-halts-some-u-s-farm-imports-</u> <u>threatening-trade-deal?cmpid=socialflow-twitter-business&utm\_campaign=socialflow-</u> <u>organic&utm\_content=business&utm\_source=twitter&utm\_medium=social</u>

Klebnikov, S. 2020. "The Trade Deal May Be Dead, Trump Says China Relationship 'Severely Damaged'". *Forbes*. July 10<sup>th</sup>. Accessed at: <u>https://www.forbes.com/sites/sergeiklebnikov/2020/07/10/the-trade-deal-may-be-dead-trump-says-china-relationship-severely-damaged/#243599ed5725</u>

Landler, M. 2018. "U.S. and China Call Truce in Trade War." *New York Times*. December 1<sup>st</sup>. Accessed at: <u>https://www.nytimes.com/2018/12/01/world/trump-xi-g20-merkel.html</u>

Li, M., T. Xiong, Y. Ji, D. Hayes, and W. Zhang. 2019. "African Swine Fever in China: An Update." *Agricultural Policy Review*, 1: 3-5. Accessed at:

<u>https://www.card.iastate.edu/ag\_policy\_review/article/?a=91#:~:text=Since%20then%2C%20ASF%20ha</u> s%20continued,of%20ASF%20cases%20in%20China).

Miranda, M. and J. Glauber. 2021. "A Model of Asynchronous Bi-Hemispheric Production in Global Agricultural Commodity Markets." Working paper (conditionally accepted for publication at the *AJAE*).

Pamuk, H. 2019. "Bulk of Trump's U.S. Farm Aid Goes to Biggest and Wealthiest Farmers: Advocacy Group." *Reuters*. July 30<sup>th</sup>. Accessed at: <u>https://www.reuters.com/article/us-usa-trade-farming/bulk-of-trumps-u-s-farm-aid-goes-to-biggest-and-wealthiest-farmers-advocacy-group-idUSKCN1UP28K</u>

Paulson, N., J. Coppess, G. Schnitkey, and K. Swanson. 2019. "Mapping the Market Facilitation Program." *farmdoc daily* (9):232. December 12<sup>th</sup>. Accessed at: <u>https://farmdocdaily.illinois.edu/2019/12/mapping-the-market-facilitation-program.html</u>

Plume, K., G. Hallie, and K. Zhai. 2020. "China Buys U.S. Soybeans After Halt to U.S. Purchases Ordered: Sources." Reuters. June 1<sup>st</sup>. Accessed at: <u>https://www.reuters.com/article/us-usa-trade-china-agriculture/china-buys-u-s-soybeans-after-halt-to-u-s-purchases-ordered-sources-idUSKBN238264</u>

Qiu, S., H. Gu, and R. Woo. 2018. "China to remove some import, export tariffs including alternative feed meals." *Reuters*. December 24<sup>th</sup>. Accessed at: <u>https://finance.yahoo.com/news/china-says-adjust-import-export-031717249.html</u>

Reuters. 2018. "Trade War Truce: China's Sinograin Confirms US Soybean Purchase." Commodities update. December 20<sup>th</sup>. Accessed at:

https://www.scmp.com/news/china/diplomacy/article/2178831/trade-war-truce-chinas-sinograinconfirms-us-soybean-purchase

S&P Global. 2020. "China's Purchase of US soybeans spike in Jan-Feb under phase one deal." S&P Global Platts newswire. March 25<sup>th</sup>. Accessed at: <u>https://www.spglobal.com/platts/en/market-insights/latest-news/agriculture/032520-chinas-purchase-of-us-soybeans-spike-in-jan-feb-under-phase-one-deal</u>

Sabala, E., and S. Devadoss. 2019. "Impacts of Chinese Tariff on World Soybean Markets." *Journal of Agricultural and Resource Economics*, 44(2):291-310.

Schnepf, R. 2017. U.S. Farm Income Outlook for 2017. Congressional Research Service, report #R40152. Accessed at: <u>https://fas.org/sgp/crs/misc/R40152.pdf</u>

Swanson, K., J. Coppess, G. Schnitkey, and C. Zulauf. 2019. "The Trade Conflict – Impact on Illinois Agriculture in 2018." *farmdoc daily* (9): 75. April 25<sup>th</sup>. Accessed at: <u>https://farmdocdaily.illinois.edu/wp-content/uploads/2019/04/fdd250419.pdf</u>

Taheripour, F., and W.E. Tyner. 2018. "Impacts of Possible Chinese 25% Tariff on U.S. Soybeans and Other Agricultural Commodities." Choices, 2nd Quarter.

Thukral, N. and H. Gu. 2018. "Crop chop: China shuns U.S. soybeans amid trade war, turns to Brazil." *Reuters*. September 26<sup>th</sup>. Accessed at: <u>https://www.reuters.com/article/us-usa-trade-china-soybeans/crop-chipa-shuns-u-s-soybeans-amid-trade-war-turns-to-brazil-idUSKCN1M60UT</u>

U.S. Soybean Export Council. 2015. "Conversion Table." Website maintained by the Export Council. Accessed at: <u>https://ussec.org/resources/conversion-table/</u>

USDA, 2018. *World Agricultural Supply and Demand Estimates*. World Agricultural Outlook Board, May, report #577. Accessed at: <u>https://downloads.usda.library.cornell.edu/usda-esmis/files/3t945q76s/5425kb078/tt44pn24d/wasde-05-10-2018.pdf</u>

USDA, 2021. *World Agricultural Supply and Demand Estimates*. World Agricultural Outlook Board, April, report #611. Accessed at: <u>https://www.usda.gov/oce/commodity/wasde/wasde0421.pdf</u>

USDA Office of the Chief Economist (USDA OCE), 2018. *Trade Damage Estimation for the Market Facilitation Program and Food Purchase and Distribution Program*. September. Accessed at: <a href="https://aede.osu.edu/sites/aede/files/imce/images/About-Us/USDA\_Trade\_Methodology\_Report.pdf">https://aede.osu.edu/sites/aede/files/imce/images/About-Us/USDA\_Trade\_Methodology\_Report.pdf</a>

USDA OCE. 2019. *Trade Damage Estimation for the 2019 Market Facilitation Program and Food Purchase and Distribution Program*. USDA, August 22, 2019. Accessed at: <a href="https://www.usda.gov/oce/trade/USDA\_Trade\_Methodology\_Report\_2019.pdf">https://www.usda.gov/oce/trade/USDA\_Trade\_Methodology\_Report\_2019.pdf</a>

Westhoff, P., T. Davids, and B. M. Soon. 2019. "A Hybrid Model Approach to Estimating Impacts of China's Tariff on U.S. Soybeans." Paper presented at the annual meeting of the Agricultural and Applied Economics Association, Atlanta, GA, July 21–23. Accessed at: <u>https://www.fapri.missouri.edu/wp-content/uploads/2019/07/hybrid-model-aaea.pdf</u>

Xin, Z. 2018. "Trump and Xi to reach trade war 'truce' at G20, says Hong Kong scholar with close ties to Beijing." *South China Morning Post*. November 27<sup>th</sup>. Accessed at: <u>https://www.scmp.com/economy/global-economy/article/2175130/trump-and-xi-reach-trade-war-truce-g20-says-hong-kong-scholar</u>

Zheng, Y., D. Wood, H.H. Wang, and J.P.H. Jones. 2018. "Predicting Potential Impacts of China's Retaliatory Tariffs on the U.S. Farm Sector." Choices, 2nd Quarter.

# Table 1. Pre-Tariff Tests for Cointegration

	Test Statistic	5% Critical Value	Conclusion
Augmented Dickey-Fuller Tests			
Log U.S. soybeans	-1.6	-2.86	Unit Root
Log Brazilian soybeans	-2.47	-2.86	Unit Root
Log relative price	-4.49	-2.86	Cointegration
Johansen Trace Test for Cointegration			
Log prices have one Coint. Equation	27.74	20.3	At least one Coint. Equation
Log prices have two Coint. Equations	3.92	9.2	One Coint. Equation

Notes: All tests contain an intercept and a two lags. The sample period is January 2013 - June 2018.

Source: U.S. prices are drawn from export elevator bids at the Louisiana Gulf, as repoted by the USDA Agricultural Marketing Service. Brazilian prices are taken at Paranaguá port warehouses that load ships for export.

Table 2. Bai-Perron Tests for Breaks in the Cointegrating Relationship

Test	Statistic	5% Critical Value	Date of maximal F-Statistic	Conclusion
UDmax	71.3	10.2	-	# breaks ε {1, 2, 3, 4, 5, 6, 7, 8, 9,10}
WDmax	86.8	10.9	-	# breaks ε {1, 2, 3, 4, 5, 6, 7, 8, 9,10,11,12}
sup-F(1 0)	14.5	9.6	6/26/2018	At least 1 break
sup-F(2 1)	11.3	11.1	11/26/2018	At least 2 breaks
sup-F(3 2)	31.9	12.2	9/4/2013	At least 3 breaks
sup-F(4 3)	31.9	12.8	7/27/2020	At least 4 breaks
sup-F(5 4)	8.4	13.5	5/3/2016	4 breaks

Notes: Maximum number of breaks set to twelve and minimum regime size to 5% of sample. Robust standard errors with AR(1) prewhitening used for all tests (Bai & Perron, 1998). Ba & Perron (2003) critical values used for sup-F tests. Sample period is Jan. 2013 - Dec. 2020.

Darameter		Drazilian Couhaana		
FUIUIIIELEI	U.S. Soybeans	Brazilian Soybeans		
μ	-0	-0.003		
	(0	(0.01)		
α	-0.004	0.03		
	(0.008)	(0.008)		
γ1	-0.06	0.2		
	(0.03)	(0.03)		
γ2	0.03	0.09		
	(0.03)	(0.03)		
δ1	0.05	-0.17		
	(0.07)	(0.03)		
δ2	0.03	-0.04		
	(0.03)	(0.03)		
Diagnostics				
Error S.D.	0.01	0.01		
Log Likelihood	6692			
Autocorrelation	e	5.45		
(p-value)	C	).26		
Notes: Sample period is Sept 2013 - Jun 2018. Estimation by maximum likelihood. Results of Portmanteau test for				

Table 3. Pre-Trade War Error Correction Model Estimates

autocorrelation reported as adjusted Q-statistic.



Figure 1. Chinese Monthly Imports of Soybeans, by Exporter

Source: Trade Data Monitor.



Figure 2. U.S. Soybean Ending Stocks and Export Share of Production, by Marketing Year

Note: Forecasted values for the 2020/21 marketing year are dotted. Source: USDA.

Figure 3. U.S. Soybean Export Shares, by Destination Panel A. Calendar Year 2017



2018 - 46.2 MMT

# Panel C. Calendar Year 2019



2019 - 52.2 MMT



2020 - 64.2 MMT

Source: Trade Data Monitor.

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Figure 4A. Log Soybean Prices, 2015-2020



Figure 4B. Relative Soybean Price (US-Brazil), and Structural Breaks in the Series



Notes: Structural breaks are based on author calculations.

Source: U.S. prices are drawn from export elevator bids at the Louisiana Gulf as reported by the USDA Agricultural Marketing Service. Brazilian prices are bids collected by the CEPEA at Paranaguá port warehouses that load ships for export. Units for both series are the logarithm of \$US per bushel.



Figure 5. ECM Price Forecast Errors During the Trade War

Notes: Errors in the chart measure actual minus forecasts for all series over the period after the 6/26/2018 structural break up to the 11/26/2018 structural break identified in Table 2. Source: Author calculations.









Note: Author calculations based on U.S. census data.



Figure 7. Planted Acreage to Corn, Soybeans, and Wheat in the United States

Note: At this writing, 2020 planted acreage is a forecasted figure. Source: USDA.

Figure 8. Trade War Damages and MFP Payments to U.S. Soybean Producers at the County Level Panel A. Trade War Damages to Soybean Value



Panel B. Total MFP Payments





Panel C. Ratio of Total MFP Payments to Trade War Damage

Source: Author calculations based on Geograin.com and USDA data.