Modern Time Trade Wars: Chinese Retaliatory Tariffs vs California's Tree Nut Industry

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Abstract

Trade war between the United States (US) and China started after the twitter-based incidents dating back to 2011 (Wong and Koty, 2019). China initially raised applied tariff rates for almonds from 10% to 25% in April 2018, and the second wave of retaliatory tariffs of up to 50% were imposed later in the same year. Many studies calculated the impacts of the Chinese retaliatory tariffs on the US agricultural products, however, none of the studies specifically included or discussed other market opportunities for exporting tree nuts would reduce the impact of retaliatory tariffs in their analysis. This study examines the impact of retaliatory tariffs imposed by China on almonds using a spatial equilibrium model (SEM) combined with the IMPLAN input-output model on California's economy, specifically in the Central Valley where tree nut (almonds, walnuts, and pistachios) production and processing plants are located and tree nuts production constitute a major gross farm value and employment. The results show that retaliatory tariffs impact almond industry negatively, however, the impact is relatively small compared to the magnitude of the total economic activity created by the almond industry. We also observe that retaliatory tariffs result in trade diversion as US exports to China are diverted to other buyers in the presence of high almond prices in China's domestic market and low price markets for US almonds.

Keywords: almond, Caliornia's tree nut industry, Chinese retaliatory tariff, spatial equilibrium model, IMPLAN

JEL Codes: F17, F61, D57

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Introduction

Twitter-based incidents, which led to a trade war between the United States (US) and China, can be dated back to 2011 (Wong and Koty, 2019). Nevertheless, the trade war between these two economic superpowers started when the Chinese government imposed import tariffs in April 2018 on 128 US trade goods, including agricultural products, steel pipes, and recycled aluminum in retaliation to changes in the US tariff policy (USDA FAS Gain Report, 2018). China strategically included agricultural products because they are the biggest buyer of many agricultural products from the United States, and believing that inflicting cost on US farmers who significantly support the current government would put pressure to end the trade war (Qu et al., 2019). Among the various agricultural products exported to China by the United States, tree nuts constitute the third most important category of products after soybeans and corn (USDA FAS, 2018). California is the leading state exporting the majority of the high-value tree nuts (almonds, walnuts, pistachios) to China. In 2017, the United States shipped about 11% of almonds, 6% of walnuts, and 45% of pistachios into the markets of China/Hong Kong.

Almond production has grown massively since 1980 from 146 thousand metric tons[1] (MT) to 1,150 thousand MT shelled almonds[2] in 2019 while 60% to 70% of the production goes to export markets (Figure 1). China, which started importing US almonds in the 1990s, became a significant market for US almonds. Figure 1 shows that the quantity of almond exports

[1] Metric ton is a common weight unit for international trade quantity so all the weight units are converted into metric ton in this study. 1 metric ton = 2,204.62 pounds.

[2] Harvested almonds consist of hull, shell and kernel. Shelled almonds only refers to kernel. Almonds can be sold in shelled or in-shell (with shell), and the quantities was calculated in shelled almond basis. Almond Board of California report shows that average almond fruit is composed of 27% kernel, 54% hull and 19% shell (Almond Board, 2019). Therefore, we used the conversion rate of ~1.70 between shelled and in-shell almonds.

noticeably falls in 2018 and 2019. Additionally, US almond export to China declined about 30% when we compare 2017 to 2019 quantities.

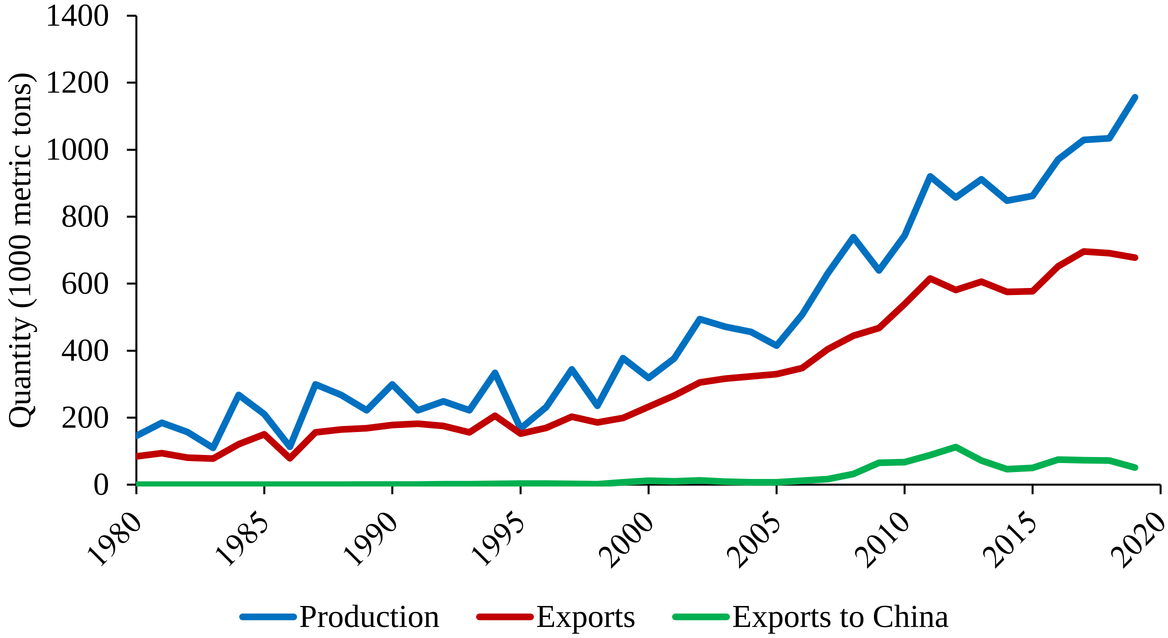

Figure 1. US Almond Production and Exports from 1980 to 2019
Source: USDA ERS (2020) and USDA FAS (2020)

China initially raised applied tariff rates for almonds from 10% to 25% in April 2018, and a second wave of retaliatory tariffs were imposed at 50% on almonds later the same year. The University of California released one of the first studies analyzing the impacts of Chinese retaliatory tariffs on California's economy, and the impact from almond trade was estimated at around $1.6 billion with 18.1% decline in crop prices (Sumner and Hanon, 2018). Carter (2018) suggests that high tariffs on almonds will cause a market loss for California exporters and lead higher almond prices in China while US almonds may be diverted to other markets or countries.

Many other studies have calculated the impacts of the Chinese retaliatory tariffs on US agricultural products and the welfare of different stakeholders (Konduru and Asci, 2019; Sabala and Devadoss, 2019; Taheripour and Tyner, 2018). Additionally, several articles in two separate

Choices Magazine themes analyzed, respectively, the *ex ante* potential impacts and *ex post* actual effects of retaliatory tariffs on several US agricultural crops and economy in general (Marchant and Wang, 2018; Grant and Sydow, 2019). Chepeliev et al. (2019) developed a more complex methodological framework that links partial equilibrium (PE) and general equilibrium (GE) models and found that the US suffers from the ongoing trade frictions with up to a 2% decline in almond export value. However, the almond industry managed to reduce this impact by rerouting or diverting exports to other countries with lower ad valorem tariff rates. Nonetheless, none of the studies specifically included or discussed other market opportunities for how exporting tree nuts would reduce the impact of retaliatory tariffs in their analysis. This study aims to improve the approach for economic impact analysis by including bilateral trade routes and other market opportunities to analyze Chinese retaliatory tariffs on California's economy, specifically in the Central Valley where tree nut (almonds, walnuts, and pistachios) production and processing contribute a major share of economic value and labor employment.

First, we quantify the optimal trade flow, production and consumption quantities, and equilibrium prices for the world almond market using a spatial equilibrium model (SEM). Sabala and Devadoss (2019) developed a SEM for world soybean market, which is the basis for this study. The sub objectives are to (1) determine the trade flows between major importing and exporting regions of tree nuts under existing trade agreements, (2) model the trade flows and trade value at status quo (when all the trade agreements and tariffs in 2017 are applied) and Chinese retaliatory tariff on US almonds, (3) compare the status quo and 50% Chinese retaliatory tariff model results, and quantify the impact of 50% Chinese tariff has on US exports.

The SEM results are then entered into IMPLAN to evaluate the impact of Chinese retaliatory tariffs on the California economy. In order to employ IMPLAN model, we constructed a scheme of the almond supply chain in California. The almond supply chain can be divided into five main stages: almond growing, almond hulling/shelling, almond handling/processing, almond marketers, and further processing. Other main industries which provide important services to the almond supply chain can be listed as agricultural and financial support, risk management, transportation, storage/warehousing, and other input materials. Using the Sumner et al. (2015) study, we find that the impact of the tariffs will directly impact growers, hullers/shellers, handlers/processors, marketers and transporters between these stages. Other supply chain segments will be indirectly impacted based on the relationships to primary stages (Figure 2).

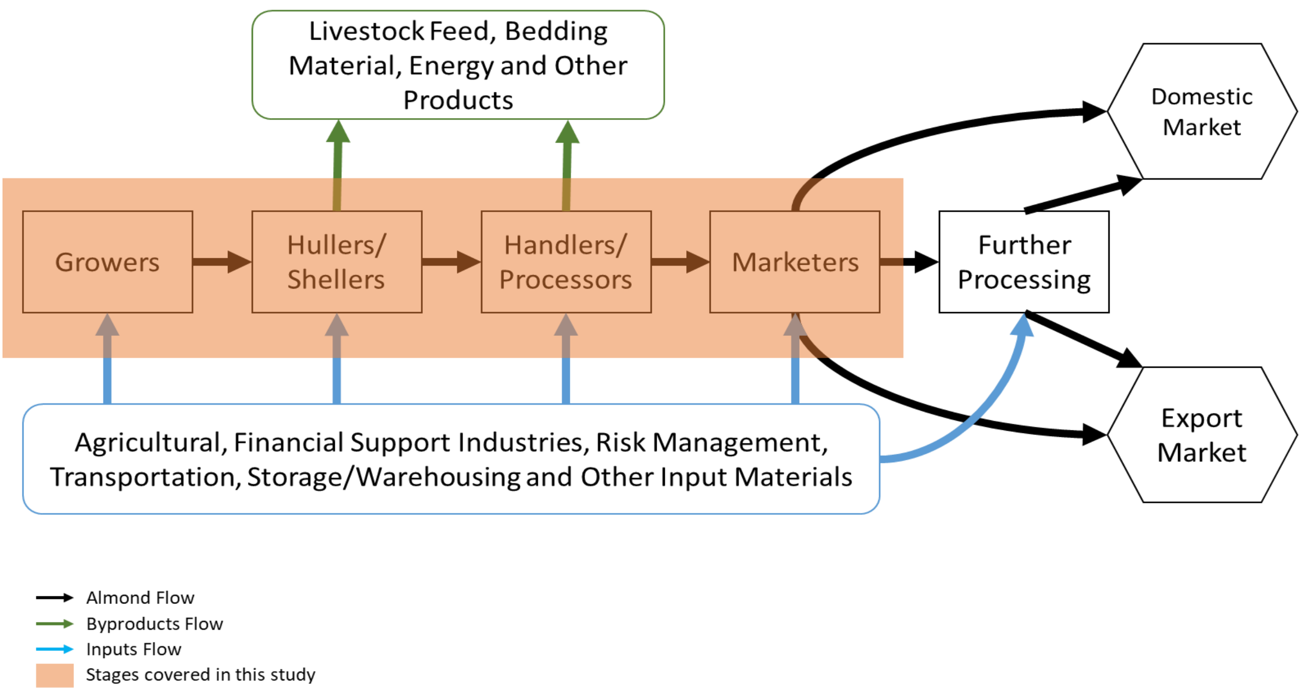

Figure 2. Almond Supply Chain and Flow of the Materials
Source: Sumner et al. (2015) is used as a basis for this diagram

Lastly, we compare our model results to determine the changes may have on the actual trade flow. The paper concludes with suggestions to policy makers, the limitations of this study, and future study opportunities.

Methodology

A spatial equilibrium model (SEM) is constructed and empirically specified in General Algebraic Modelling System (GAMS) for this world almond trade analysis. The SEM developed in this study follows the pioneering work of Samuelson (1952) and the seminal work of Takayama and Judge (1971). SEM has been used extensively to study the impacts of trade policies solved by primal or dual method. Devadoss (2013) exhibits theoretical analysis and empirical illustration to analyze the world agricultural trade using mixed complementarity problem (MCP) approach. Devadoss (2013) suggests that if the modeler knows the equilibrium conditions, the SEM can be solved by a relatively quick and robust method using a MCP approach than traditional primal or dual optimizations.

Bilateral trade among important tree nuts exporting countries (US and Australia), and major importing countries (India, Canada, and China), the European Union (EU), and the rest of the world (ROW) are selected for the analysis. The ROW is included in the SEM to compute the overall trade creation, destruction, or diversion impact of retaliatory tariffs on US almonds. This study contributes to the analysis of the economic impact on tree nut producers, processors, as well as on the overall economy in the Central Valley of California. This study aims to analyze the economic impacts in the Central Valley by using an Input-Output model. GAMS results are incorporated into the county level IMPLAN dataset along with data from USDA FAS, California Department of Food and Agriculture, and County Ag Commissioner's reports.

Programming model

In this study, MCP approach is utilized for SEM using PATH solver. Devadoss (2013) shows that MCP is a relatively simpler, yet powerful approach to solve SEM if the modeler knows the equilibrium conditions. Sabala and Devadoss (2019) advance the SEM to study the impact of Chinese tariffs on world soybean markets between 11 regions. The MCP equations are created for several economic activities: market demand price, supply price, transportation cost between each region, domestic demand, and domestic supply. The market demand and supply equations for the SEM model is expressed as,

Market demand: $P_i^D \geq \alpha_i - \beta_i Q_i^D \qquad \forall\, i,$ (1)

Market supply: $P_i^S \geq \gamma_i - \delta_i Q_i^S \qquad \forall\, i,$ (2)

where, P_i^D is the demand price in the region i, Q_i^D is the domestic consumption in the region i, α_i is the inverse demand intercept for region i, β_i is the inverse demand slope for region i. P_i^S is the supply price in the region i, Q_i^S is the domestic supply in the region i, γ_i is the inverse supply intercept for region i, δ_i is the inverse supply slope for region i.

In this study, we build a closed trade model within seven regions, and all the regions are considered as potential export or import traders of tree nuts. Import regions, j, are denoted interchangeably with exporting regions, i, when the exporting region is importing and vice versa. The price linkage equation constraints the market demand price (with ad valorem tariff) in the importing region to be less than or equal to supply price from the exporting region plus the transportation costs from i to j.

When the demand price in the importing region is greater than the supply price plus the transportation cost in the any exporting region, then opportunity to import from that country exists until the profits opportunities are reached. Finally, the sufficient conditions for quantity demanded and supplied are included in the model. The domestic consumption must be always less than equal to the quantity of domestic production and the imports from the world market.

Similarly, the domestic supply must be at least equal to or greater than the quantity domestic consumption and exports to foreign markets.

IMPLAN model

IMPLAN is an input-output model which uses an inter-industrial accounting system to produce input-output accounts. These accounts link the magnitude of changes in an industry value to all associated industries values throughout the economy. Thus, it is used to estimate the economic impacts of changes in regional economy. However, IMPLAN is price-static model and the results depend on economic characteristics of the recent past to project near-term outcomes. In this study, we analyzed the contraction in the supply for California almonds causing less employment and economic activity in almond industry. Economic linkages provide information to quantify impacts on not only the almond industry and other related industries, but also on other services and industries from groceries to hospitals as "multiplier effects" without leaving out impacted industries or double counting. We summarize our results as direct, indirect and induced effects to show all the key impacts for California economy.

Data

This study includes seven regions, which are Australia, Canada, China, European Union (27 countries), India, USA, and rest of the world (ROW). The model requires six different data sets for in-shell and shelled almonds for each regions included in this study. The data sets are: trade flow quantities and trade value, production and consumption quantities, freight on board (FOB) price and consumer price (retail price), demand and supply own-price elasticities, average ad valorem tariff rates imposed by importing countries, and transportation costs between regions.

We converted all almond trade, consumption, and production quantities to in-shell almonds to be consistent (Almond Board, 2019). The model uses the export and import trade quantities and values for almonds from 2017-2018 and simulates the impact of Chinese retaliatory tariffs on US almond trade by analyzing the industry before and after alternative outcome scenarios.

The trade values and quantities for tree nuts are collected from the World Bank UNSD Commodity Trade Statistics Database (COMTRADE) via World Integrated Trade Solution (WITS 2019). The almond trade data include the aggregation of a six-digit harmonized system (HS) classification under Trade Analysis Information System (TRAINS) of the United Nations Conference on Trade and Development (UNCTAD). WITS software is also used to collect ad valorem import tariff rates transmitted from the UNCTAD and World Trade Organization (databases) (WITS, 2019). Import and export elasticities are collected from the various literature and USDA ERS database (Liu et al., 2003; Seale et al., 2003; Chung, 1992; Murua et al., 1993; Russo et al., 2008). The cost of transportation between two main trade ports for tree nuts trade is collected using an online tool called world freight rates calculator (www.worldfreightrates.com). The transportation cost for the rest of the world is assumed to be the average cost of transportation from exporting countries to other important ports in the Americas, Europe, Africa, and Asia.

Raw data for domestic production of in-shell almonds are collected from the databases of Food and Agriculture Organization (FAO) and USDA Foreign Agricultural Services. The average of in-shell almonds by country for the year 2017 and 2018 is shown in Table 1. The US is the largest almond producer with over 60% of world almond production. The US produces an average of 1,758,086 MT of in-shell almonds per year. Australia is the second major individual country with production capacity of 143,111 MT of almonds per year. The 27 EU countries combined produced 438,895 MT per year. China and India produced 73,259 MT and 7,241 MT respectively. ROW countries combined produces 514,764 MT. Unlike other regions, Canada is sole almond importer since its climate is not suitable for almond production.

Table 1. Domestic production and consumption, and exports and imports of in-shell almonds between seven regions in the world market

Country	Domestic Production (MT)	All Exports (MT)	All Imports (MT)	Domestic Consumption (MT)
Australia	143,111	86,220	4,543	61,434
Canada	0	39	51,179	51,140
China	73,259	630	44,822	117,451
European Union (EU)*	438,895	80,992	727,000	1,084,902
India	7,241	656	162,096	168,681
United States (USA)	1,758,086	1,137,441	15,932	636,578
Rest of World (ROW)*	514,764	253,807	554,213	815,170

Source: FAO STAT and WITS
Note: * European Union member countries in 2018 are considered as a single entity. All the other countries are covered in Rest of World. The trade within EU or ROW countries is not included in the table.

The export value and export quantities are used to determine the export price (supply price). The domestic demand price is determined from the regional markets (Various supermarkets, 2020). Producer prices, consumer prices, demand elasticities, and supply elasticities are shown in Table 2. The bilateral trade flow between each region is collected to determine the realized export and import quantities. The US exports 67% of total almond production to the world market. Australia is the second largest exporter of almonds as it exports 57% of its almond production. EU countries combined exports about 80,992 MT of almonds. ROW combined together exports an average of 252,807 MT of almonds. Canada, China, and India export about 39 MT, 630 MT, and 656 MT, respectively. The data show that some regions re-exports almonds, however, it is not possible to determine exact re-export quantity. EU countries import about 727,000 MT from the world market. The ROW is the second largest importing region in this study. However, according to WITS data, India is the largest single importing country, which imports 162,096 MT of almonds from the world market. Canada imports about 51,179 MT, and China imports 44,822 MT from the world market. The major exporting regions US and Australia imports about 15,932 MT and 4,543 MT, respectively.

Table 2. Freight on board price, consumer price, demand and supply elasticities of almonds for seven regions

Country	FOB price[1] ($/MT)	[2]Consumer price ($/MT)	Demand elasticity	Supply elasticity
Australia	6,473.57	9,067.48	-0.25648	0.2400
Canada	6,068.35	10,294.98	-0.35300	0.2400
China	5,177.62	13,227.72	-0.63300	0.3000
EU	7,483.41	11,760.78	-0.30388	0.3000
India	10,048.54	12,414.98	-0.63300	0.3000
USA	6,106.92	10,273.51	-0.69000	0.2400
ROW	6,893.07	11,173.24	-0.47823	0.2700

Source: [1]WITS and [2]various supermarkets

The realized trade flow between the regions and import tariff rates are shown in appendix Table A1 and Table A2. The estimated transportation costs per metric ton between the regions are shown in appendix Table A3. The transportation costs are calculated based on shipping 11.25 MT of almonds with a value of $85,000 in a full load 20 feet container.

The demand and supply price flexibility forms are developed by using elasticities, quantities and prices. For this study, the demand function for the exporting country can be expressed as, $Q_i = d_i - m_i P_i$, where Q_i is the quantity of demand of region i, d_i is the intercept for region i, m_i is the slope of the demand function, and P_i is the price of region i. Taking the partial derivative with respect to P_i, gives $\frac{\partial Q_i}{\partial P_i} = -m_i$. Own price elasticity for region i is expressed as, $\varepsilon_i = \frac{\partial Q_i}{\partial P_i}\frac{P_i}{Q_i}$ or $\varepsilon_i = -m_i \frac{P_i}{Q_i}$. Thus, the demand slope can be determined using the following equation, $m_i = -\varepsilon_i \frac{Q_i}{P_i}$. The intercept of demand for region i is determined by, $d_i =$

$Q_i + m_i P_i$.

Finally, $Q_i = d_i - m_i P_i$ is constructed for all seven regions. Now to obtain the inverse demand function, the demand equation can be converted to $P_i = \frac{d_i}{m_i} - \frac{Q_i}{m_i}$. A similar approach is used to construct the supply function for each of the seven regions. The demand and supply prices were calibrated manually following Paris et al.'s (2009) study. Table 3 shows the list of calibrated demand and supply equations in price flexibility form used in the SEM to generate supply and demand quantities.

Table 3. Inverse demand and supply function of almond market in seven regions

Country	Demand function	Supply function
Australia	$P^C = 43{,}124 - 0.58Q_d$	$P^P = -19{,}206 + 0.189Q_s$
Canada	$P^C = 39{,}459 - 0.57Q_d$	$P^P = -19{,}216 + 25{,}285Q_s$
China	$P^C = 30{,}100 - 0.18Q_d$	$P^P = -8{,}056 + 0.236Q_s$
EU	$P^C = 48{,}324 - 0.04Q_d$	$P^P = -15{,}323 + 0.057Q_s$
India	$P^C = 30{,}845 - 0.12Q_d$	$P^P = -22{,}263 + 4.626Q_s$
USA	$P^C = 23{,}079 - 0.02Q_d$	$P^P = -17{,}256 + 0.014Q_s$
ROW	$P^C = 32{,}397 - 0.03Q_d$	$P^P = -16{,}497 + 0.050Q_s$

Source: Calculated by Authors.

Results

The demand and supply equations, transportation costs, and ad valorem tariffs were incorporated into the SEM to obtain optimal results for the status quo scenario and the 50% Chinese re tariff on US almonds. The 50% Chinese tariff scenario results are compared with the status quo to identify the domestic consumption and production, equilibrium price, and bilateral trade flows. The examined results are entered into an input-output IMPLAN model to observe the expected economic impact on California's agricultural.

SEM model results

The SEM results suggest that when the Chinese government imposes a 50% import tariff on US almonds, the domestic price in China could increase from $9,990/MT to $10,103/MT, in effect the domestic consumption may reduce from 111,720 MT to 111,090 MT. Increase in the Chinese demand price reduces the domestic consumption in China from 111,720 MT to 111,090 MT and scales up production to 76,946 MT from 76,467 MT.

Results from the 50% Chinese import tariff on US almonds scenario show that the US equilibrium price decreases from $7,924 MT to $7,919 MT. The US almond price drop is not significant because while there is a decline in the production, domestic consumption increases. US production reduced from 1,798,600 MT to 1,798,200 MT, and domestic sales in the US increase from 757,750 MT to 757,980 MT. The results also show that US exports to China discontinues. Furthermore, US exports are diverted to EU, India, and ROW. Similarly, the equilibrium price in all other regions show a decline by $4/MT to $5/MT (compare the columns two and three) with reduction in production and increase in consumption as shown in Table 4.

Table 4. Equilibrium price, domestic demand quantities, domestic supply quantities of seven regions from the SEM model results

	Equilibrium Price ($/MT)		**Quantity Demanded (MT)**		**Quantity Supplied (MT)**	
	Status quo	50% US-China tariff	Status quo	50% US-China tariff	Status quo	50% US-China tariff
Australia	8,014	8,009	60,535	60,543	144,020	144,000
Canada	8,061	8,057	55,084	55,092	0	0
China	9,990	10,103	111,720	111,090	76,467	76,946
EU	8,467	8,463	996,410	996,530	417,380	417,290
India	8,970	8,965	182,290	182,330	6,752	6,751
USA	7,924	7,919	757,750	757,980	1,798,600	1,798,200
ROW	8,823	8,818	785,800	785,970	506,400	506,300

Tables 5 and 6 show the bilateral trade between the regions under a status quo scenario and the 50% Chinese retaliatory tariff on US almonds, respectively. The difference between the two tables gives the expected impact of the 50% Chinese import tariff on the US. The difference shows that China ceases imports from the US and imports all its almonds from Australia for a price $8,009/MT plus the transportation cost of $138.40 with 24% import tariff. However, in status quo scenario, Australia does not export to China. We also observe that Australia diverts 34,148 MT of its exports from EU to China when 50% tariff rate is applied to US almonds. There is no significant change in Australian almond price, supply, and demand since Australia receives a higher margin to export to China than to other regions.

Table 5. Bilateral trade flow results for almond world market from SEM model for the Status quo scenario*

		Imports (MT)							
		AUS	CAN	CHI	EUR	IND	USA	ROW	Total Export
Exports (MT)	AUS	60,535			83,486				83,486
	CAN		0						0
	CHI			76,467					0
	EUR				417,380				0
	IND					6,752			0
	USA		55,084	35,255	495,550	175,540	757,750	279,410	1,040,838
	ROW							506,400	0
Total Import		0	55,084	35,255	579,036	175,540	0	279,410	

Note: The diagonals shows the amount of domestic production consumed in the same country.

Under the current trade agreement (24% Chinese applied tariff on all countries), US has the greatest profit opportunity. Among the exporting regions, Australia has the second highest profit opportunity to ship almonds to China. The marginal cost of shipping a metric ton from Australia to China is calculated $95.73. In the 50% Chinese import tariff on US almonds scenario, US marginal cost to ship a metric ton was $1,317, thus Australia becomes the most profitable country to export almonds to China.

Table 6. Bilateral trade flow results for almond world market from SEM model for the 50% Chinese tariff on US almonds

		Imports ($/MT)							
		AUS	CAN	CHI	EUR	IND	USA	ROW	Total Export
Exports (MT)	AUS	60,543		34,148	49,306				83,454
	CAN		0						0
	CHI			76,946					0
	EUR				417,290				0
	IND					6,751			0
	USA		55,092		529,930	175,580	757,980	279,670	1,040,272
	ROW							506,300	0
Total Import		0	55,092	34,148	579,237	175,580	0	279,670	

Note: The diagonals shows the amount of domestic production consumed in the same country.

GAMS results

SEM results show that value added US almond revenue[3] is reduced by almost 0.43% as a result of the Chinese retaliatory tariffs relative to the status que scenario. We calculated this percentage by calculating US almond export value as the product of equilibrium price and exported quantity. When we use the same method on realized trade and export prices, we found that the value added US almond revenue at the marketers stage is $15.9 billion. Therefore, a 0.43% reduction in California's almond industry results in $68.7 million income decline to the economy. Next, we needed to breakdown which stages would be impacted because of the retaliatory tariff in California. Sumner et al. (2015) shows that total value of the California almond industry is about $21.8 billion. Based on expert inputs and previous studies, we breakdown the values added at each main stage including transportation within these states in the almond supply chain. Table 7 shows that growers are responsible for 25.4% value addition to almond until it reaches to consumers while handlers and marketers added the most value to almonds.

[3] Value added almond revenue is calculated at the marketers stage since FOB export prices shows the almond prices before further processing, individual packaging and added retailer margin.

Table 7. The value addition in the main stages of the almond supply chain

Supply Chain Stages	Value Addition in Percentages
Growers	25.40%
Processing (Hullers/ Shellers/ Initial processing)	8.90%
Transportation (Until marketers)	3.50%
Handlers / Marketers	35.10%
Further Processing/ Retailers/ Others	27.10%

Source: Sumner et al. (2015) and authors' calculations.

Individual income losses are entered into the IMPLAN model to assess the impact of this deviation from the realized production and trade in California. Table 8 describes the annual average job and income losses in California due to the 50% Chinese retaliatory tariff. IMPLAN provides direct, indirect (industry-to-industry-purchases), and induced (households/labor purchases) effects with regards to employment, value added, and output. Total effects are calculated by the addition of direct, indirect, and induced effects.

Table 8. Economic Impacts on California Almond Industry, 2019/2020 (*in $1,000,000*)

Impact Type	Number of Jobs	Labor Income	Total Value Added	Output
Direct Effect	-279	-$23	-$42	-$69
Indirect Effect	-203	-$13	-$18	-$29
Induced Effect	-189	-$11	-$20	-$32
Total Effect	-671	-$47	-$80	-$130

Source: Generated by authors in IMPLAN.

In the table 8, direct effects are the results of a series of production changes or expenditures due to an activity or policy. Indirect effects measure the impact of local industries buying goods and services from other local industries. These impacts are calculated by applying direct effects to the Type I Multipliers[4]. Lastly, induced effects are the responses to an initial change (direct effect) that occurs through re-spending of income received by a component of

[4] Type I multiplier looks only at business to business purchases and describes the direct and supply chain impact within the study region resulting from one direct change (for employment or sale revenue) in the relative industry. For example, if an output multiplier is 2.25, for every extra dollar of production in this industry adds up to $2.25 of activity generated in the local economy.

value added. Based on a more detailed IMPLAN industry-wide breakdown of the results, the industries expected to be significantly impacted by this income reduction are: wholesale trade, tree nut farming, truck transportation, real estate, full/limited-service restaurants, nuts manufacturing, employment services, and warehousing and storage.

Discussion and Conclusion

This study examines the impact of retaliatory tariffs imposed by China on almonds using a SEM modeling on GAMS software combined with the IMPLAN model to assess the impact on California's economy. The results shows that retaliatory tariffs impact almond industry negatively, however, the impact is relatively small compared to the magnitude of the total economic activity created by almond industry. We also observe that retaliatory tariffs resulted in trade diversion, as US exports to China diverted to other buyers in the presence of high almond prices in China's domestic market and low price markets for US almonds. We can summarize the results under three main discussion points.

First, retaliatory tariffs do not change the almond consumption and total exports to China significantly. The reason for this conclusion might be the availability of other almond suppliers like Australia which makes it convenient for trade diversion from the US. Almonds are also a popular gift item in China, and demand price elasticity is inelastic so price increase does not affect the demand much. Demand increase for almonds might also surpass the impact of tariff change since we witness an increase in the awareness about nutritional benefits among health-conscious consumers.

Second, we did not observe much change in total US Exports. The realized trade data also shows that US export has diverted to countries like the EU, India, and other countries. We also expect new opportunities for trade creation because of the increasing demand from ROW which will absorb the impacts of any trade barriers from Chinese market.

Last, the results indicate that the impact on California economy is quite low. It is always advantageous for the Almond Board of California and other almond marketing entities to look for alternate markets as the trade disruption with China is going to persist for some time. We also do not expect a severe impact on employment for almond growing given the permanent nature of the orchard crops.

The results are sensitive to elasticities, transportation costs, structure of the spatial equilibrium model, and the calibration procedure. Overall, this study has a potential to identify discussion points for the current and future trade policies at the AAEA meeting. The audience will be able to comprehend and scientifically discuss the current trade policies and its impact on California agriculture. It would also help researchers to develop new and more comprehensive models that would increase the predictability of future trade policies.

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APPENDIX

Table A1. Average bilateral trade flows between seven regions for the year 2017 and 2018

		Imports (MT)							
		AUS	CAN	CHI	EUR	IND	USA	ROW	Total Export
Exports (MT)	AUS	0	8	8,799	26,372	22,910	2,816	25,314	86,220
	CAN	0	0	3	10	0	13	13	39
	CHI	0	0	0	0	0	0	629	630
	EUR	868	732	73	0	9	12,559	66,752	80,992
	IND	2	0	0	30	0	14	609	656
	USA	2,226	50,377	26,752	464,323	132,867	0	460,895	1,137,441
	ROW	1,446	61	9,194	236,264	6,311	531	0	253,807
	Total Import	4,543	51,179	44,822	727,000	162,096	15,932	554,213	

Source: FAO STAT and WITS

Table A2. The import tariff rates imposed by the importing country on in-shell almonds

		Import tariff (%)						
		AUS	CAN	CHI	EUR	IND	USA	ROW
Exporting countries	AUS	0	0	0.240	0.028	0.103	0.011	0.083
	CAN	0.025	0	0.240	0.012	0.103	0.011	0.159
	CHI	0.025	0	0	0.012	0.082	0.011	0.060
	EUR	0.025	0	0.240	0	0.103	0.015	0.085
	IND	0.025	0	0.240	0.012	0	0.011	0.060
	USA	0	0	0.240	0.028	0.103	0	0.085
	ROW	0.025	0	0.240	0.012	0.082	0.011	0

Source: WITS

Table A3. Transportation cost for shipping a metric ton of almonds between the regions

		Imports ($/MT)						
		AUS	CAN	CHI	EUR	IND	USA	ROW
Exports ($/MT)	AUS	0.00	246.98	138.40	222.96	212.88	236.02	193.15
	CAN	200.49	0.00	128.77	183.93	266.32	139.52	219.70
	CHI	147.40	217.48	0.00	193.25	127.23	198.40	160.79
	EUR	184.99	231.08	127.56	0.00	159.55	244.05	220.50
	IND	128.54	203.98	121.75	161.89	0.00	195.35	211.97
	USA	187.98	137.17	132.49	312.78	210.06	0.00	210.59
	ROW	193.15	219.70	160.79	220.50	211.97	210.59	0.00

Source: World Freight Rates