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RESEARCH ARTICLE

The Imported Challenge: Economic Impact of Fresh Fruit and Vegetable Imports on U.S. Producers

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Abstract
Domestic fruit and vegetable producers contend that rising imports during seasonal harvesting windows have negatively impacted domestic prices and revenue. This study simulates producers' revenue with the removal of above-average imports as defined by the U.S. International Trade Commission. Results indicate significant additional revenues to domestic producers in the simulated scenario. Also, additional revenues to producers by state and season show substantial heterogeneity with robustness checks revealing similar patterns. Options such as risk management and technological improvements are needed to enhance the competitiveness of U.S. fresh produce industries instead of limiting imports in the absence of illegal dumping.

Keywords: Additional revenue; fresh produce and counterfactual imports; producer prices

JEL classifications: Q17; F17

Introduction
In 2021, the United States (U.S.) imported about 60 and 40 percent of the fresh fruits and vegetables consumed, respectively. This marked a substantial increase from 2007, when the corresponding import shares were 50 and 20 percent (U.S. Department of Agriculture, USDA-Economic Research Service, ERS, 2023). Mexico played a central role, supplying 69 percent of the fresh vegetables and 51 percent of the fresh fruit to the U.S. market. While imports play a vital role in U.S. fresh fruits and vegetables consumption, the fresh produce industry is an important segment of national and state economies from value-added and employment perspectives (Huang et al., 2022). For instance, in 2021, there were 2.6 million direct on-farm jobs (1.3 percent of the U.S. employment), and in 2022, the value of utilized production for vegetable and non-citrus fruit crops reached $16.5 billion and $17.2 billion, respectively (USDA National Agricultural Statistics Service, NASS, 2023a, 2023b)

Before 2010, fresh produce imports primarily served consumption during the U.S. winter months. In the last decade, import competition during major harvesting seasons has posed challenges for U.S. growers of fruits and vegetables. Unlike importing countries such as Mexico, where production costs are notably lower, domestic producers face high labor costs, which affects their profitability (Guan et al., 2018). Moreover, recent domestic labor shortages during peak harvesting periods have further aggravated production challenges (Charlton et al., 2019; Guan et al., 2018; Guan, 2018). Not surprisingly, domestic producers have attributed lower market prices and higher revenue losses to increasing competition from imported products during their seasonal windows.[1]

Surging imports from Mexico prompted domestic producers to explore policy options to address price and revenue losses. During the renegotiation of the North American Free Trade Agreement (NAFTA), U.S. negotiators proposed a provision for anti-dumping/ countervailing proceedings of seasonal and perishable products (Zahniser et al., 2023; Office of the U.S. Trade Representative, USTR, 2017). However, the final U.S.-Mexico-Canada Agreement (USMCA) did not include any such provision. Undeterred, domestic producers sought investigations of import injury or threat to harm by the U.S. International Trade Commission (USITC) for specific commodities. Notably, the USITC investigated grapes, cucumbers, squash, and blueberries. In 2021, the USITC concluded that domestic revenue, production, and operating income would increase in the absence of significant increases in imports of cucumbers and squash (USITC, 2021a, 2021c). However, regarding the imports of spring table grapes and blueberries, a different approach was used for impact analysis, distinct from the model used in the cucumber and squash investigations.[2] The USITC determined that the increased imports of blueberries (fresh, chilled, or frozen) and spring table grapes were not harming the domestic industry nor posing a threat of harm (USITC, 2001, 2021b).[3] Furthermore, in 2022, the USTR received a petition from Florida's Congressional delegation, alleging a Mexican "export targeting scheme," i.e., employing lower wage rates, Mexico has gained an unfair advantage in the fresh produce industry (Zahniser et al., 2023). In response, the USTR initiated a collaboration with the USDA to enhance the competitiveness of U.S. fresh produce growers (USTR, 2022; Zahniser et al., 2023).

In this regard, it is critical to understand as well as quantify the economic impacts of imports of fresh fruits and vegetables on the domestic produce industry. This study particularly focuses on the seasonal and monthly impacts of imports on domestic producers' revenue in four major commodities: asparagus and bell pepper among vegetables, and blueberry and strawberry among fruits during 2011–2021/22. It employs the USITC's partial equilibrium framework which assumes that consumers substitute domestically produced commodities with imports. Produce demand and supply elasticities, estimated and cross-checked with prior literature, are used to quantify the revenue that domestic producers would have earned in the absence of above-average growth in imports as defined by the USITC. More specifically, the percentage change in domestic price, import price, domestic supply, foreign supply, and additional revenue upon removing the above-average growth in imports are computed for each season and month. Major producing states considered in the study are the States of California (CA), Washington (WA), Oregon (OR), Michigan (MI), Florida (FL), Georgia (GA), North Carolina (NC) and New Jersey (NJ). The data on monthly imports and annual production are obtained from the U.S. Census Bureau and the

[1]For example, the average price of domestically produced fresh asparagus increased by 39.3 percent from $2,412.56 per metric ton (2011) to $3,361.86 per mt (2022) while the average price of foreign-produced fresh asparagus increased only by around 1 percent from $2,303.45 per mt (2011) to $2,326.9 per mt (2022). Furthermore, the average price of domestically produced fresh bell peppers increased by around 79 percent from $891 per metric ton (2011) to $1,595.16 per mt (2022) while the average price of foreign-produced fresh bell peppers increased only by around 45.2 percent from $1,032.5 per mt (2011) to $1,499.41 per mt (2022) (Census Bureau, 2023; NASS, 2023c). Also, during the major harvesting windows of asparagus, the share of imports increased to 89.2% in 2022 from 68.2% in 2011. Import shares also increased for fresh bell peppers (from 14.9% (2011) to 41.95% (2022)), fresh blueberries (from 14.47% (2011) to 31.76% (2021)) and fresh strawberries (from 10% (2011) to 20 % (2022)) during their major harvesting period (Census Bureau, 2023; NASS, 2023c).

[2]The investigation on spring table grapes pertained to section 732 (b) of the Tariff Act of 1930 while that of blueberries was in accordance with section 202 (b) of the Trade Act of 1974 (USITC, 2021b, 2001). These sections require the investigators to determine if the domestic industry is materially injured or if there is a threat of material injury because of subject imports. The investigation on cucumbers and squash imports was conducted in accordance with section 332(g) of the Tariff Act of 1930. Upon the request of the USTR, a report was prepared that focused on the effect of imports of cucumbers and squash on domestic seasonal markets (USITC, 2021c, USITC, 2021a).

[3]See 19 USC § 1677(7)(A) for the definition of material injury.

USDA NASS, respectively. And, monthly production was estimated based on interviews with growers and members of Commissions of respective commodities.

The four commodities under consideration have important contributions to the domestic economy and their imports have been growing drastically. Strawberries, valued at approximately $3.2 billion in terms of utilized production as of 2022, are the most popular berries in the U.S. (NASS, 2023c; Yeh et al., 2023). Import quantity of fresh strawberries has surged by 132 percent from 2011 to 2022 (Census Bureau, 2023). Similarly, the quantity of fresh blueberries imported, the second most popular berries, has risen by about 194 percent over the same period (Census Bureau, 2023). In addition, imports of fresh asparagus increased by roughly 58 percent, and imports of fresh bell pepper grew by approximately 110 percent during the same time frame (Census Bureau, 2023).

In import injury investigations, it is necessary to define the article under investigation. Seasonality and perishability were important topics of debate in the investigations of spring table grapes and blueberries, yet these factors were not always considered while defining the article under investigation. Unlike the USITC investigation, this study focuses exclusively on fresh or chilled blueberries, motivated by perishability and differences in marketing channels and harvesting methods compared to frozen blueberries.[4] Given the perishable nature of all four commodities under study, distinguishing between fresh and frozen or processed products is essential. Fresh produce, unlike frozen fruits and vegetables, which can be stored for 6-12 months (Attrey, 2017; Blond et al., 2004; Harnkarnsujarit, 2015), has a shorter shelf life and deteriorates rapidly. Consequently, producers of fresh fruits and vegetables face a unique challenge in navigating increasing import competition during narrow harvesting windows.

Following the USITC investigation on blueberry imports, Muhammad and Countryman (2021) used an inverse demand model which mostly supported the USITC ruling. However, Soto-Caro et al. (2023) concluded that Mexican imports are affecting the U.S. market and if imports enter at the same rate as seen in the last decade, the challenges to the U.S. blueberry industry might be significant. Similarly, Li et al. (2022) conclude that the price of domestically produced tomatoes is negatively affected by Mexican imports. Furthermore, Suh et al. (2017) posit that Mexican imports of strawberries will cause a threat to the survival of the domestic strawberry industry. This study builds on the model used in the USITC investigations of cucumber and squash. In contrast to the USITC investigations, this study provides estimates of additional revenue not only on a seasonal but also on a monthly level for the major producing states. Furthermore, the study recognizes the diversity in marketing seasons across different geographical regions within the U.S. Consequently, during periods of import competition, only specific producing states engaged in marketing during that period are impacted. Thus, our analysis sharply focuses on those importing months that coincide with the harvesting months of the corresponding domestic product. The estimates take into account a range of price data, including farm gate price, terminal market price, and shipping

[4]The USITC defined the domestic "like" product to include all blueberries, fresh or frozen. Under optimal storage temperature and humidity conditions, the quality of blueberry deteriorates rapidly (Abugoch et al., 2016; Plesoianu et al., 2020; Sun et al., 2014). They can be stored in a freezer and sold after 10 to 12 months as frozen blueberries. Unlike fresh blueberry producers, therefore, frozen blueberry producers can dodge the period of import competition. In the USITC investigation, the proponents and the parties that opposed safeguard measures made several points that fresh and frozen are not similar products. Although practices of handpicking and machine harvesting prevail for both frozen and fresh blueberries, the former is primarily machine-harvested and the latter is primarily handpicked. Both fresh and frozen blueberries go into cooling to extend their shelf life, but frozen blueberries undergo the additional step of freezing. Also, marketing channels for frozen and fresh blueberries are different (USITC, 2021b). These differences hint that these two blueberries are not necessarily like products, and they should be treated separately while measuring the impact of US imports. Perishability was also a major topic of debate during the investigation of spring table grapes, however, there was no provision in the law to consider it as one of the determining factors in defining the domestic like product (USITC, 2001). However, in 2006, the U.S. proposed amendments to the World Trade Organization's Anti-Dumping Agreement and the Agreement on Subsidies and Countervailing Measures to identify and more effectively tackle the perishability and seasonal nature of agricultural products(World Trade Organization, 2006).

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point price, and they consider re-exports wherever applicable. The results indicate that, for each commodity, domestic revenue and domestic supply would have increased in the absence of above-average growth in imports, echoing conclusions from the USITC investigations of cucumber and squash. Additionally, states with the highest production levels of each commodity would have witnessed more significant additional revenue. These results have implications for domestic support and trade policies to enhance the competitiveness of U.S. producers in the global market.

The paper is organized as follows. The following section presents the background and discusses the events that led to higher imports in each of the four commodities.[5] Section 3 explains the modeling framework and calibration followed by data sources in section 4. Section 5 presents the results, and the final section summarizes the study and draws conclusions.

Background

U.S. agricultural imports have substantially grown between 2007–09 and 2019–21 with a compound annual growth rate of 3.8 percent in terms of real value (Zahniser et al., 2023). Imports from Latin America and the Caribbean grew by 6.9 percent and fresh berries are among the five most imported produce categories. This study uses the case of fresh asparagus, bell pepper, blueberry, and strawberry to examine the impact of imports on respective domestic industries. Figure 1 presents monthly imports by overseas origin during the major harvesting months of these four commodities from 2011 to 2022.

Mexico and Peru take center stage in the context of fresh asparagus imports. In 2022, these two nations collectively contributed to approximately 99 percent of the total volume, with Mexico holding a 62 percent share and Peru at 37 percent. Panel A in Figure 1 shows that both countries exported a substantial volume of fresh asparagus throughout the U.S. harvesting period, spanning from February to June. During the February-April season, imports experienced an almost twofold increase between 2011 and 2021. This period aligns with the early harvesting months in CA, which conducts harvests from February to June, and during the lighter harvesting month of April in WA, where harvests extend from April through June. The May-June season has seen a more than twofold increase in imports between 2011 and 2022. This time frame coincides with the harvesting period of MI (May-June), recognized as the largest U.S. producer of asparagus as of 2022. Additionally, it aligns with the heavy harvesting months of May-June in WA and with the May-June harvests in CA.

Similar to asparagus, Mexico is the primary exporter of fresh bell peppers to the U.S. market (approximately 94 percent in 2021). Imports from Mexico during the July-December season – which has doubled between 2014 and 2021 (Panel B in Figure 1) – coincides with the harvesting months in FL, GA, and CA. These three states accounted for around 77 percent of the U.S. fresh market bell pepper production in 2021. During the July-December season, imports from Mexico dovetail with the overall harvesting window in GA where harvest predominantly unfolds in September, October, and November. Similarly, the harvesting period in CA spans from June to October aligning with the influx of imports from Mexico. As far as FL, the largest producer of fresh bell peppers, the early harvesting months from October to December appear to overlap with the imports during this season. The January-June season has also experienced doubled imports between 2014 and 2021 (Panel B in Figure 1). Imports coming in this season overlap with the peak harvesting period of fresh bell peppers in FL (January to June) as well as with the June harvest in CA.

[5]This section also details the overlap of imports with the harvesting months/seasons of states considered in the individual analysis of the commodities. For example, for asparagus, the states considered in this study are Michigan, Washington, and California (the major producers) and the overlap of imports from Mexico and Peru with each state's harvesting month is discussed.

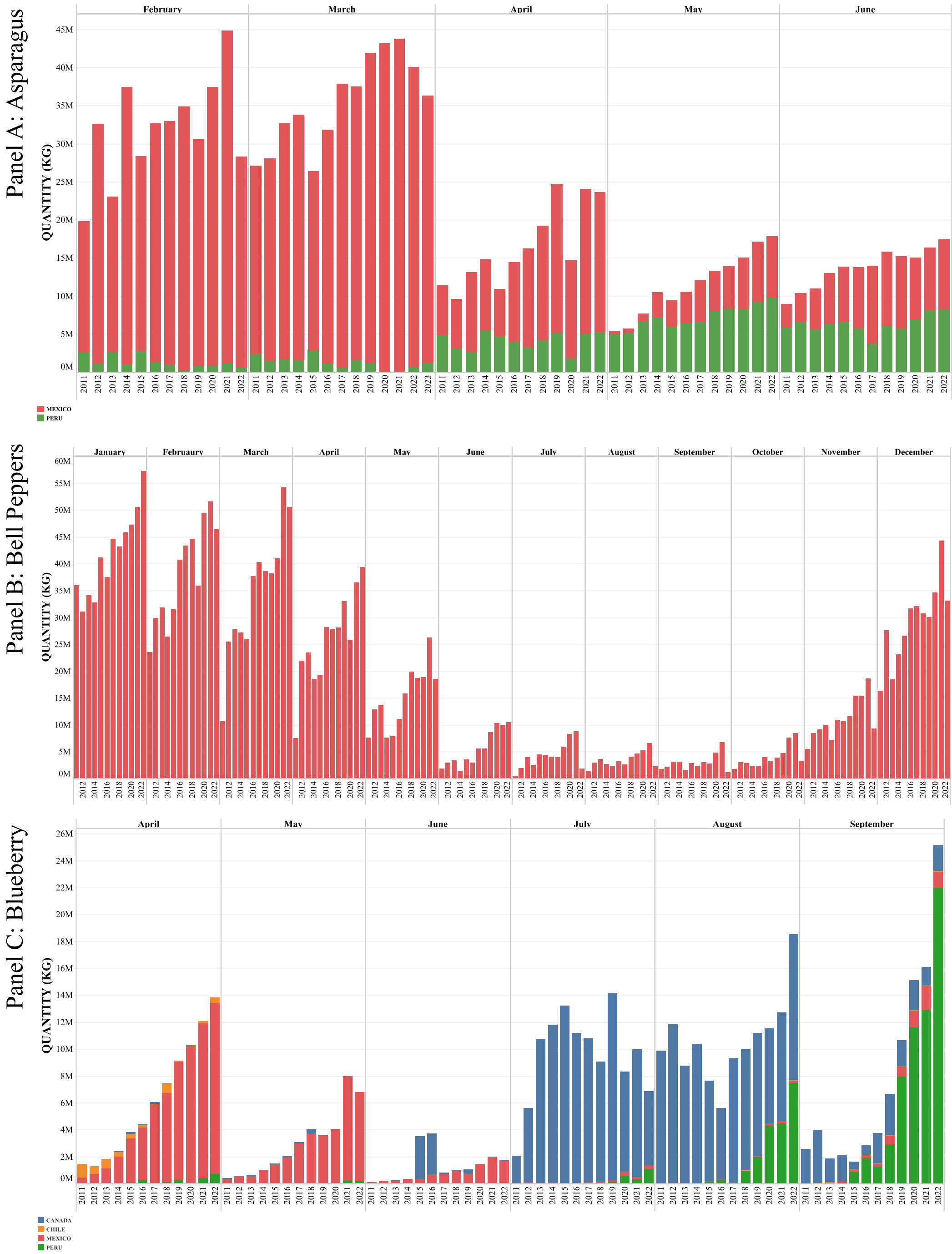

Figure 1. Major imports of fresh vegetables (Asparagus and Bell Peppers) and fruits (blueberry and strawberry) to the United States, 2012-2022.

The primary source of fresh blueberry imports to the U.S. is Peru, claiming the largest share at 46.1 percent in 2022, followed by Mexico at 29.5 percent (Census Bureau, 2023). When combined with Canada and Chile, these countries collectively contributed to approximately 99.7 percent of

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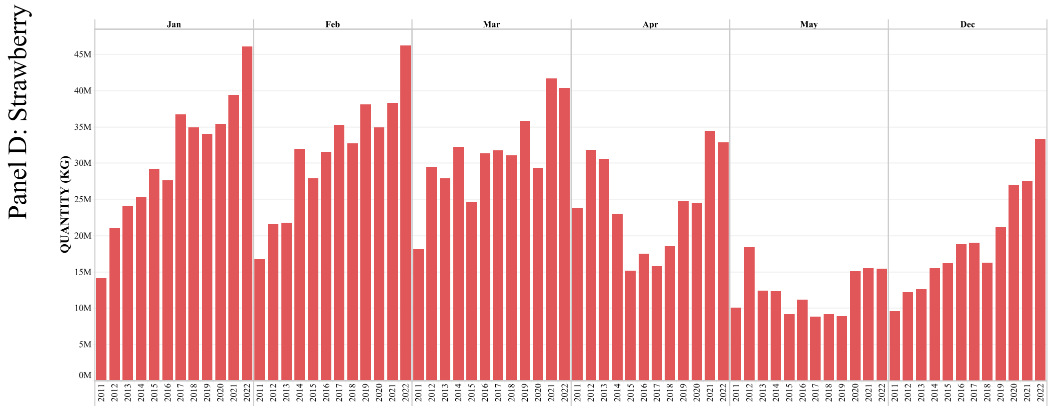

Figure 1. (Continued).

the total fresh blueberry imports by value. The import shares of Canada and Chile have been on the decline, but those of Mexico and Peru have seen an upward trajectory since 2011. Mexican imports, although occurring throughout the entire U.S. harvesting window in recent years, exhibit a concentration during the April to June season (see Panel C in Figure 1). In this season, Mexico has witnessed a more than threefold increase in export volumes to the U.S. since 2016. This surge in Mexican imports aligns with the harvesting periods in key blueberry-producing states: GA (April to June), CA (April to July), NC (May-June), and NJ (June-August). Peru, gaining market share throughout the entire U.S. harvesting period from April to September in recent years, primarily exports fresh blueberries to the U.S. during the July to September season. Interestingly, this timing corresponds with the harvesting window of WA and Oregon (June-September), the two largest blueberry producers in the U.S. as of 2021. Additionally, Peru's exports align with the blueberry harvests in MI (June-August) and NJ during July and August.

In the case of strawberries, Mexico accounted for approximately 98 percent of fresh strawberry imports, including organic varieties. Figure 1 illustrates that imports from Mexico more than doubled between 2011 and 2022 during the December-April season.[6] Imports from Mexico during the May-September season increased by only a few percentage points. In 2022, CA and FL accounted for nearly all of the strawberry production in the United States (NASS, 2023c). FL growers harvest mostly during the December-April season, along with some growers in CA, which overlaps significantly with strawberry imports from Mexico. In 1988, the production volume of fresh strawberries in FL was approximately three times that of imports from Mexico; however, in 2020, the FL production volume declined to less than half of Mexican imports (Huang et al., 2022).

What factors explain the substantial increase in fresh fruit and vegetable imports? Previous studies have identified four likely reasons: (a) climate/weather, (b) labor costs, (c) trade agreements, and (d) subsidies to infrastructure or production. The conducive weather in Mexico and Peru allows for year-round production of asparagus, facilitating multiple harvests annually (Drost, 2023). Furthermore, upon examination of the blueberry varieties brought from Chile, it was discovered that Peru's climate facilitates year-round harvests (World Economic Forum, 2022). This has likely attracted both foreign and domestic investors to the booming asparagus and blueberry industry in Peru, where the "1991 Foreign Investment Promotion Law" treats domestic

[6]Seasons are defined based on the continuation or discontinuation of the harvest month throughout the year for illustrative purposes. For example, strawberries are harvested year-round, but only a negligible amount of imports enter in October and November. Therefore, the months of interest are all months excluding October and November. Harvest typically starts in December, so five months from December will be considered one season (December to April), and the remaining five months another (May-September).

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investors on par with those from overseas (USDA Foreign Agricultural Service, FAS, 2023; Schwarz et al., 2016). Meanwhile, in the U.S., farm labor availability and costs seem to be a major concern for producers with labor's share of total operating expenses at 38.5 percent for fruits and 28.8 percent for vegetables (Calvin et al., 2022) Imported labor, primarily from Mexico, seems to be the major source of farm labor for U.S. fruit and vegetable farms (Ray et al., 2023). However, the decline in the number of farm workers from Mexico has resulted in U.S. farm labor shortages (Charlton and Taylor, 2016; Christiaensen et al., 2021; Ray et al., 2023). The reason for this decline is likely the structural transformation (transitioning out of agriculture due to reduced family sizes) in rural Mexico, rising access to educational attainment, and increasing industrial growth in Mexico (Charlton and Taylor, 2016; Zahniser et al., 2018). This decline in migration along with increasing state minimum wage, and removal of overtime pay exemptions by some states appear to have increased U.S. farm labor costs (Calvin et al., 2022). In 2021, the federal minimum wage stood at $7.25 per hour, with some states aligning their minimum wages with this rate and others surpassing it. Notably, farm wages in the United States often exceed state minimum wages and are considerably higher than the minimum wage of $5.80 per day in Mexico. As far as Peru is concerned, the production of asparagus and blueberries is concentrated in the coastal regions offering not only access to skilled labor but also convenient transportation, logistics, and irrigation resources (FAS, 2023). Specifically, the Chavimochic irrigation project, initiated in the 1960s in La Libertad – a major producing region for both asparagus and blueberries – has played a crucial role in supporting agricultural activities.

The surge in fresh fruit and vegetable imports is further explained by the trade agreements between the U.S., Peru, and Mexico. The U.S.-Mexico-Canada Agreement (USMCA) and the U.S.-Peru Trade Promotion Agreement likely provide Peru and Mexico with streamlined access to the U.S. market. Beyond the aforementioned factors, the support from the Mexican government appears to be playing a pivotal role in enhancing the overall production of fresh fruits and vegetables in Mexico (Wu et al., 2021; Wu et al., 2018; Dorfman et al., 2019). The 2007-2012 National Development Plan featured five agricultural programs, and Strategic Project for Protected Agriculture under the Support Program for Investments in Equipments and Infrastructures administered by Secretariat of Agriculture, Livestock, Rural Development, Fishery, and Food started in 2009 (Wu et al., 2018). Protected agriculture refers to shade houses, plastic tunnels, and greenhouses. In 2014, a subsidy of 200,000 pesos (equivalent to $14,451) per hectare was provided for high tunnels. Furthermore, an individual high tunnel or shade house project can receive a subsidy of up to 2.7 million pesos (or $0.2 million) (Wu and Guan, 2021). In 2019, the maximum amount, for all types of eligible structures, increased to 4 million pesos per project (Feng et al., 2022). These initiatives have boosted the production of blueberry, bell pepper, and strawberry in Mexico (Wu and Guan, 2021; Wu et al., 2018; Biswas et al., 2018). While protected structures can increase yield and quality, most importantly, the off-season production opportunity allows for a year-round supply of fruits and vegetables. Increasing imports of fresh produce, especially during U.S. harvesting windows noted above, have stressed domestic prices and growers' revenue, which are examined in this study.

Modeling Framework

This study uses a partial equilibrium framework from USITC (2021a) and USITC (2021c), which originally investigated the effect of U.S. imports of cucumbers and squash on domestic producers. In this framework, for each commodity under consideration (asparagus, bell pepper, blueberry, and strawberry), consumers can either buy produce originating in their home country (h) or a foreign country (f). They can substitute between the foreign-produced and domestically produced product at a constant rate, the elasticity of substitution (σ).[7] Each source country $i \in \{h, f\}$ has n_i

[7]When $\sigma \rightarrow \infty$, consumption goods are perfect substitutes, and when $\sigma \rightarrow 0$, they are perfect complements.

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firms competing in the market. The number of firms at home and in foreign countries is kept constant to relax the assumption of zero industry profits in the long run.[8] Following Ahmad (2019), consumers maximize the following constant elasticity of substitution utility function given that the foreign and domestic produce are imperfect substitutes:

$$U = \left(\sum_i n_i b_i q_i^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}} \text{s.t.} \sum_i n_i p_i q_i = E \tag{1}$$

where,

- p_i represents the price paid by consumers for varieties produced by firms in country i,
- q_i refers to the quantity demanded from a firm in country i,
- b_i is a parameter capturing asymmetries in consumer preferences, and
- E denotes the level of expenditure for the industry in the home economy.

Solving the utility maximization problem results in Marshallian demands:

$$q_i = E\beta_i p_i^{-\sigma} P^{\sigma-1}, \tag{2}$$

and

$$P = \left[\sum_i n_i \beta_i p_i^{1-\sigma} \right]^{\frac{1}{1-\sigma}} \tag{3}$$

where, P is the industry's aggregate price index and $\beta_i = b_i^{\sigma}$

Let $\theta < 0$ be the price elasticity of total demand (assumed to be constant for a product) and k be an aggregate demand parameter such that the total expenditure can be expressed as:

$$E = kP^{\theta+1}. \tag{4}$$

With this new expression of the industry's expenditure, aggregating demand from all the firms in $i \in \{h, f\}$ and adding the subscript t, equation (2) can be expressed as:

$$Q_{it} = n_{it} k_t \beta_{it} p_{it}^{-\sigma} P_t^{\sigma+\theta}. \tag{5}$$

Here, t can be seasonal or monthly based on the type of analysis being performed. For example, consider the case of analyzing the impact of fresh asparagus imports in the February-April season. In this case, t ={February-April 2011, February-April 2012, ... February-April 2022}.

Equation (5) represents the total quantity demanded from all firms in country i in time t. Multiplying this equation by price (p_{it}), the total sales of all firms for each country V_i in time t is obtained:

$$V_{it} = n_{it} k_t \beta_{it} p_{it}^{1-\sigma} P_t^{\sigma+\theta}. \tag{6}$$

To close the model, the aggregate domestic supply function can be represented as (USITC, 2021a, 2021c):

$$Q_{ht} = a_t \cdot p_{ht}^{\varepsilon_h} \tag{7}$$

where, the parameter a_t is the supply shifter for time t and ε_h is domestic price elasticity of supply which is constant $\forall t$.

It can be discerned from these relations that the elasticities remain constant while other parameters and variables change with time. The elasticity of substitution, σ, is computed based on the trade-cost method that uses variation in international trade costs (freight, tariffs) as explained in USITC (2021a). Likewise, the elasticity of supply, ε_h, is computed using data on prices and

[8]The model does not allow for firm entry and exit; instead, it keeps them constant for each country because, in the short run, the assumption of free entry may not hold. Readers are referred to Ahmad (2019) for more details.

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quantities in the domestic market, and θ is adopted from related literature. All elasticities are cross-checked with previous literature wherever available.

Calibration

In this study, the data available on the total quantity of a specific commodity supplied by domestic producers in the domestic market and the corresponding average price of the produce in a particular season or a particular month are the result of the interaction between demand and supply represented by equations (5) and (7). The data on the total quantity supplied by foreign producers and the average price of foreign produce at time t result from the interaction between the foreign supply function and demand for foreign produce in the home economy represented by equation (5) with a f subscript. It turns out that a foreign supply function is not necessary, given the focus on domestic prices and supply. Furthermore, imports are aggregated, i.e., consumers do not differentiate between produce from different foreign sources, i.e., Peruvian and Chilean blueberries are treated as perfect substitutes. Thus, the price p_{ft} is the average price of the foreign produce at time t. Similarly, on the domestic supply front, since only major producing states are considered, the domestic supply is aggregated and thus, the price of the produce produced in different U.S. states, e.g., Michigan and Washington (for asparagus), is reflected by the average price p_{ht} at time t.

Using the data on price and quantity of both foreign and domestically produced produce at time t, the next step is to calibrate the unknown parameters: number of firms (n_{it}), β_{it}, and the aggregate demand parameter k_t for each t. For calibration, normalize $n_{ht}\beta_{ht} = 1 \forall t$. Recall that $i \in \{h, f\}$, thus, from equation (6), the ratio of total sales of all firms in the home economy by domestic producers and foreign producers at time (t) is given by:

$$\frac{V_{ht}}{V_{ft}} = \frac{p_{ht}^{1-\sigma}}{n_{ft}\beta_{ft}p_{ft}^{1-\sigma}} \tag{8}$$

$$n_{ft}\beta_{ft} = \frac{V_{ht}p_{ft}^{1-\sigma}}{V_{ft}p_{ht}^{1-\sigma}} = z_t \tag{9}$$

Moreover, the aggregate demand parameter k_t can be calibrated using equation 6:

$$k_t = \frac{V_{ht}}{P_t^{\sigma+\theta}p_{ht}^{1-\sigma}} \tag{10}$$

Recall that the study aims to analyze the economic impacts of imports on the domestic industry. The impact is quantified by calculating the revenue that domestic producers would have earned in the absence of above-average growth in imports (2021c, USITC, 2021a).In the absence of above-average growth, U.S. imports are lower than the actual volume. For example, in Panel A of Figure 2, the average growth rate of asparagus import in the February-April season from 2011-22 is 5 percent. Whichever year between 2011 and 2022 reports higher growth rate than the average (i.e., >5 percent), the growth rate is reduced by the average value (i.e., 5 percent). This scenario where imports are reduced is referred to as the *hypothetical/simulated scenario* as shown in line graphs in Panel A of Figures 2–5 along with seasonal import patterns (from 2011 to 2021/22) for the four commodities of interest. Therefore, the next step is to incorporate this information on reduced imports, also referred to as the counterfactual imports in the model.

New Equilibrium Calculation

The model assumes that the calibrated parameters remain constant in the actual and hypothetical scenarios in time (t). For example, the calibrated parameters for the analysis of blueberries in the

April-June season of 2013 remain constant in the hypothetical scenario of the 2013 April-June season. The counterfactual imports coming in time t represented as Q_{ct} is set equal to the demand of foreign produce in the home economy in time (t). The counterfactual import is actually the equilibrium quantity of foreign produce for a new equilibrium price (p_{ft}^*) for foreign-produced produce in time t.

$$Q_{ct} = k_t z_t p_{ft}^{*-\sigma} \iota_t^{\sigma+\theta}, \tag{11}$$

where

- $z_t = n_{ft}\beta_{ft}$
- ι_t is the price index in the hypothetical scenario in time t and can be represented as:

$$\iota_t = \left[z_t p_{ft}^{*\,1-\sigma} + p_{ht}^{*\,1-\sigma} \right]^{\frac{1}{1-\sigma}} \tag{12}$$

where, p_{ht}^* is the equilibrium price for domestically produced produce in time t.

Note that the representation of the demand for foreign produce in the hypothetical scenario – the right-hand side of equation (11) – and the representation of the price index (equation 12) in the hypothetical scenario are similar to those in the actual scenario equations (5 and 3).

Furthermore, as in the actual scenario, the hypothetical case's new equilibrium quantity and equilibrium price of domestic produce (represented by μ_{ht}^* and p_{ht}^*, respectively) in time t are obtained by equating the demand and supply equations:

$$a_t p_{ht}^{*\,\varepsilon_h} = k_t p_{ht}^{*\,-\sigma} \iota_t^{\sigma+\theta}, \tag{13}$$

where $a_t p_{ht}^{*\varepsilon_h} = \mu_{ht}^*$ is the new equilibrium quantity of domestic produce.

Now we have three equations, namely equations 11–13, with a total of three unknowns (ι_t, p_{ht}^*, and p_{ft}^*) in these equations. Unknowns can be determined by solving these three equations. Finally, additional revenue (R_t) that domestic farmers would have earned in the absence of above-average import growth at time t can be calculated using equation (14).

$$R_t = (p_{ht}^* \cdot \mu_{ht}^*) - (Q_{ht} \cdot p_{ht}). \tag{14}$$

Counterfactual Imports

The methodology used to calculate the counterfactual level of imports in this study is similar to the one employed by USITC (2021a, 2021c) for most seasons, but differs slightly in certain respects for a few other seasons as noted below. First, years from 2011 through 2021/22 (2021 for blueberry) were divided into low- and high-growth years; 2011 to 2016 as low-growth years and 2017 through 2021/22 as high-growth years. Then growth rates for each harvesting season (or month) from 2011 to 2021/22 are calculated separately. Following, Pillai (2003), the average growth rate from 2011 to 2021/22, and the average growth rate for high-growth years are calculated. In cases where the growth rate of a given period exceeded the average growth rate recorded between 2011 and 2021/22, the growth rate was reduced. Since, the average growth of high-growth years was lower than the average growth rate, for asparagus and bell peppers, growth rates higher than the average growth from 2011-2022 were reduced by the average growth from 2011-2022 as depicted in Panel A in Figures 2 and 3. The growth rate was reduced by the difference between the average growth rate of high-growth years and the average growth from 2011 to 2021/22 for both seasons for fresh fruits – blueberries and strawberries as depicted in Panel A in Figures 4 and 5. Despite the lower growth rate of high-growth years (19%) compared to the average growth from 2011 to 2021 (28%) for the April-June season, the reduction procedure was done by the difference between the average growth rate and the growth rate during high-growth years. This approach was adopted because, for the July to December season, the growth rates were reduced by 7.8%, and recognizing that

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additional revenues are influenced by the extent of reduction, for consistency, the reduction was carried out based on the difference.

Data

Trade

The data on monthly U.S. imports – including quantity (kilogram) and customs value (US$) based on 10-digit Harmonized Tariff Schedule (HTS) codes – from major origins during 2011–22 are compiled from the U.S. Census Bureau's USA Trade Online portal (Census Bureau, 2023).

a. The United States receives most of the fresh asparagus from Peru and Mexico, and these are reported under HTS codes 0709209090 (after July 2006) and 070920900 (before July 2006).
b. Imports of fresh bell peppers are mostly from Mexico and were reported under HTS Code 0709604085 before July 2022. Since then six different HTS Codes were aggregated to compute imports: 0709604078 (green sweet bell peppers), 0709604081 (red sweet bell peppers), 0709604084 (yellow sweet bell peppers), 0709604087 (orange sweet bell peppers), 0709604091 (other), and 0709604074 (In St Nt 3, fresh/chilled).
c. Imports of fresh blueberries are reported under HTS code 0810400029, and imports from Canada, Mexico, Peru, and Chile are considered.
d. Most of the fresh strawberries come from Mexico. The HTS codes 0810102000 and 0810104000 included both fresh organic and non-organic strawberries. The former reported imports between June 15 and September 15 while the latter reported imports for the rest of the year (ROY). Both of them were discontinued in July 2021. Now, 0810102090 (June 15 and September 15) and 0810104090 (ROY) report imports of fresh non-organic strawberries to the U.S. Furthermore, organic strawberries are now reported under 0810102010 (entered June 15 to September 15) and 0810104010 (ROY). Therefore, to remain consistent even after 2021, the study on strawberries includes organic strawberries.

Domestic and foreign exports of fresh blueberries are reported under 0810400029, and fresh asparagus are reported under 0709200000 and 0709205000. Export and re-exports of certified organic strawberries are reported under HTS Code 0810100010 and non-organic strawberries are under 0810100050.

Production and Prices

Yearly state-level production data (both volume and value) from 2011 to 22 for all four commodities are compiled from USDA National Agricultural Statistics Service (NASS, 2023c). Only production intended for fresh consumption is taken into account. To impute missing values, data as far as 1998 are used. Missing values are imputed by fitting trends from available data and/or using fresh market shares from U.S. fresh market annual production data. When feasible, imputed values are cross-validated using data obtained from respective Growers' Commission.

Since monthly state-level production data were not available, monthly production estimates were calculated from annual production data based on interviews with growers and members of Commissions of the respective commodities. Specifically, information on monthly harvest share is collected from interviews.

While the primary analysis is based on farmgate and customs unit value, terminal market price and shipping point price were utilized for robustness checks. Monthly terminal market price and shipping point price for both domestically produced and imported produce were extracted from the Custom Average Tool of the USDA Agriculture Marketing Service (AMS, 2023).

As with monthly production data, imputation of missing values was necessary for farmgate price, terminal market price, and shipping point price. Depending on the nature of the missing values, mean imputation, temporal imputation, linear regression imputation, and random forest imputation were done to fill in the missing values. The two critical cases where imputed values account for nearly 50 percent of the data are asparagus and bell peppers, and readers are cautioned (as detailed below) in interpreting results specific to those scenarios.

For asparagus, data on production amounts and farm gate prices for Washington were missing for all years of interest, while all the required data for California were available. The missing values for Michigan's asparagus production, both volume and value, were imputed using the share of Michigan's fresh market production in U.S. fresh asparagus production. The difference between the total fresh market production and the sum of the production of California and Michigan was then employed to estimate production volume and value for Washington. Consequently, results for Washington should be approached cautiously in the analysis of asparagus imports. Concerning bell peppers, most of the missing values for Florida were filled using data available from the University of Florida IFAS (Wade et al., 2020). However, data before 2016 were unavailable for California and Georgia. In this scenario, the relationship between total bell pepper production (all kinds including fresh) value/volume and fresh market production value/volume was utilized to impute the missing values.

Farm gate prices (along with state and time dummies whenever applicable) were employed for imputing terminal market prices. Subsequently, these terminal market prices were in turn used to impute missing values for shipping point prices.

Results

Recall that this study aims to measure the economic impact of imports on the domestic industry by quantifying the additional revenue that domestic producers would have earned in the absence of above-average growth in imports. The next sub-section presents computed elasticities, and sub-section 5.2 discusses commodity-wise seasonal economic effects (including additional revenue) for each state noted in section 2. The primary focus below is on seasonal analysis with customs unit value and farmgate price. Robustness checks, placed in the appendix, are conducted using terminal market and shipping point prices, and after reducing re-exports wherever applicable. Monthly analyses are also presented in the appendix.

Elasticities

The point estimates of parameters – elasticity of substitution (σ), domestic price elasticity of supply (ε_h), and the price elasticity of total demand (θ) – used in the revenue analysis are presented in Table 1. The domestic price elasticity of supply is relatively lower in all the commodities (asparagus: 1.610, bell pepper: 0.074, blueberry:1.000, strawberry: 0.300) under consideration because producers cannot easily adjust their production capacity in a short time frame. The estimate of θ is around -1 implying the annual expenditure does not change with price (cucumbers). The estimated σ is largest for strawberry (9.650) and lowest for bell pepper (2.588). There are very few strawberry choices available in the market, which means consumers can flexibly substitute domestic and imported strawberries. In contrast, there are numerous varieties of bell pepper in domestic and foreign markets; consumers can have a preference for specific tastes and origins, leading to lower substitution possibilities. These elasticities, estimated and cross-checked with prior literature, are used below to estimate the effects of imports on the domestic fresh produce industry (USITC, 1996; Sobekova et al., 2013; Arnade and Kuchler, 2015; Ferrier et al., 2023).

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Table 1. Commodity-wise elasticity estimates

	σ	ϵ_d	θ
Asparagus	7.783	1.610	−1.408
Bell Peppers	2.588	0.074	−1.000
Blueberry	4.000	1.000	−1.000
Strawberry	9.650	0.300	−1.458

State-level seasonal economic effects (2011-22)

Tables 2 and 3 present the estimated seasonal economic effects for all commodities and states during 2011-2022, and state-wise additional revenue, respectively. Columns labeled 1, 2, 3, and 4 of Table 2 present the percentage change in domestic price, import price, domestic supply, and foreign supply (imports), respectively, upon removing above-average growth in imports. Column 5, also illustrated as bar graphs in Panel B of Figures 2–5, presents the additional revenue that the domestic producers would have earned in the absence of above-average growth in imports.[9] Columns 1 through 7 in Table 3 show the disaggregated additional revenue for the States of California (CA), Washington (WA), Michigan (MI), Florida (FL), Georgia (GA), North Carolina (NC), and New Jersey (NJ), respectively.

Asparagus

Three states – CA, MI, and WA – which accounted for 76 percent of U.S. fresh market asparagus production in 2022, are considered to be the major producers, and February-April and May-June are classified as two seasons for asparagus in this study (NASS, 2023c) Based on the findings in Table 2, upon removing the above-average import growth, in 2022, domestic and import prices respectively increased by 13.90 and 21.55 percent (9.06 and 16.20 percent) in the February-April (May-June) season. Likewise, columns 3 and 4 show that the domestic supply increased by 23.32 (14.99) percent, while imports decreased by 25.65 (29.77) percent in the February-April (May-June) season in 2022. In all the commodities, the economic effect is higher whenever there is a higher import reduction because it provides opportunities for domestic producers to replenish the residual demand stemming from import reduction. Also, in a commodity like asparagus, where import dominates the market supply, even a small change in import triggers larger effects on how domestic producers respond (USITC, 2021c, USITC, 2021a).

The larger additional revenue each year (column 5 of Table 2) during the May-June season than the February-April season can be explained by two reasons: (a) import penetration – the market share of imports in a particular year – and (b) the magnitude of import reduction (values in column 4, Table 2) (USITC, 2021c, USITC, 2021a). Whenever import penetration is high, change in imports will have a larger effect on the domestic price and domestic supply resulting in a higher impact on additional revenue. The above effect will be further higher if there exists a higher deviation between counterfactual and actual level of imports (i.e., higher magnitude of import reduction). In the case of asparagus, the imports made up around 87 percent of the market in the February-April season in 2012, increasing to around 98 percent in 2022. In the May-June season, imports were around 43 percent in 2012, which increased to around 73 percent in 2022. This means, that each year, import penetration is higher in February-April than in the May-June season, but the deviation between counterfactual and actual import or percentage change in import is consistently higher in the May-June season (column 4). This led to higher additional revenue in the May-June season each year. In addition, the U.S. producers are most active during

[9]The baseline value of imports and domestic use are available upon request.

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Table 2. Estimated seasonal economic effect for four commodities (for all states)

Commodity	Season	Year	Column (1) Dom. Price Change (%)	Column (2) Imp. Price Change (%)	Column (3) Dom. Supply Change (%)	Column (4) Imp. Change (%)	Column (5) Revenue Addition (All States) (million $)
ASPARAGUS	**Feb-Apr**	2011	0	0	0	0	0
		2012	1.45	2.28	2.35	−3.94	1.01
		2013	1.61	2.48	2.61	−3.94	1.28
		2014	3.12	4.84	5.07	−7.59	1.78
		2015	3.3	5.06	5.37	−7.59	1.59
		2016	5.11	7.84	8.36	−11.25	2.49
		2017	7.06	10.89	11.61	−15.07	3.99
		2018	8.98	13.97	14.86	−18.91	4.1
		2019	11.15	17.4	18.56	−22.53	6.36
		2020	11.51	17.86	19.18	−22.53	4.02
		2021	13.78	21.39	23.09	−25.65	4.37
		2022	13.9	21.55	23.32	−25.65	3.71
	May-June	2011	0	0	0	0	0
		2012	1.23	2.43	1.98	−6.97	1.45
		2013	2.25	4.62	3.65	−13.29	2.99
		2014	4.24	7.97	6.91	−18.72	4.19
		2015	4.54	8.35	7.41	−18.72	4.31
		2016	4.08	7.77	6.64	−18.72	5.18
		2017	3.92	7.57	6.38	−18.72	5.63
		2018	5.58	10.69	9.14	−24.43	7.25
		2019	5.27	10.29	8.62	−24.43	7.75

(*Continued*)

Table 2. (*Continued*)

Commodity	Season	Year	Column (1) Dom. Price Change (%)	Column (2) Imp. Price Change (%)	Column (3) Dom. Supply Change (%)	Column (4) Imp. Change (%)	Column (5) Revenue Addition (All States) (million $)
		2020	6.12	11.37	10.04	−24.43	7.61
		2021	9.08	16.22	15.02	−29.77	8.89
		2022	9.06	16.2	14.99	−29.77	9.3
BELL PEPPERS	**Jan-June**	2012	1.77	4.09	0.13	−5.53	2.45
		2013	4.44	10.07	0.32	−12.42	6.25
		2014	4.06	9.65	0.29	−12.42	6.6
		2015	5.34	14.18	0.39	−18.5	11.2
		2016	11.36	24.05	0.8	−23.76	13.8
		2017	10.93	27.08	0.77	−29.12	19.5
		2018	11.9	28.23	0.84	−29.12	19.97
		2019	11.34	27.57	0.8	−29.12	23.77
		2020	12.27	28.66	0.86	−29.12	25.9
		2021	15.37	35.88	1.06	−33.83	34.18
		2022	14.14	34.38	0.98	−33.83	34.55
	July-Dec	2012	0.32	2.05	0.02	−4.31	1.28
		2021	5.2	18.03	0.38	−25.48	16.65
		2013	0.27	2	0.02	−4.31	1.17
		2014	0.23	1.96	0.02	−4.31	1.17
		2015	0.22	1.94	0.02	−4.31	1.07
		2016	1.18	5.31	0.09	−9.77	3.76
		2017	0.82	4.93	0.06	−9.77	3.15

(*Continued*)

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Table 2. (*Continued*)

Commodity	Season	Year	Column (1) Dom. Price Change (%)	Column (2) Imp. Price Change (%)	Column (3) Dom. Supply Change (%)	Column (4) Imp. Change (%)	Column (5) Revenue Addition (All States) (million $)
		2018	0.94	5.06	0.07	−9.77	3.25
		2019	1.94	8.93	0.14	−15.65	6
		2020	3.02	12.83	0.22	−20.8	11.43
		2022	2.79	15.26	0.2	−25.48	11.6
BLUEBERRY	**Apr-June**	2011	0	0	0	0	0
		2012	0	0	0	0	0
		2013	0.11	1.77	0.11	−6.27	0.61
		2014	0.42	3.74	0.42	−11.81	2.45
		2015	1.13	5.59	1.13	−14.9	5.97
		2016	1.32	5.83	1.32	−14.9	5.56
		2017	1.01	5.43	1.01	−14.9	5.39
		2018	1.48	6.05	1.48	−14.9	7.47
		2019	0.95	5.36	0.95	−14.9	7.06
		2020	1.46	6.01	1.46	−14.9	9.5
		2021	2.75	9.35	2.75	−19.9	18.03
	July-Sept	2011	0	0	0	0	0
		2012	0.54	1.65	0.54	−3.75	2.23
		2013	0.71	1.86	0.71	−3.75	2.66
		2014	1.79	4.52	1.79	−8.41	7.96
		2015	1.92	4.68	1.92	−8.41	7.29
		2016	1.54	4.2	1.54	−8.41	6.74

(*Continued*)

Table 2. (*Continued*)

Commodity	Season	Year	Column (1) Dom. Price Change (%)	Column (2) Imp. Price Change (%)	Column (3) Dom. Supply Change (%)	Column (4) Imp. Change (%)	Column (5) Revenue Addition (All States) (million $)
		2017	1.99	5.99	1.99	−12.57	10.76
		2018	2.71	6.94	2.71	−12.57	13.55
		2019	3.27	8.75	3.27	−16.03	18.93
		2020	3.09	8.52	3.09	−16.03	17.61
		2021	4.09	11.24	4.09	−20.2	24.39
STRAWBERRY	**May-Sept**	2012	0.11	0.93	0.03	−7.56	1.95
		2013	0.09	0.91	0.03	−7.56	1.65
		2014	0.06	0.88	0.02	−7.56	1.27
		2015	0.05	0.86	0.01	−7.56	0.69
		2016	0.12	1.97	0.04	−16.11	2.91
		2017	0.2	2.05	0.06	−16.11	4.18
		2018	0.29	3.4	0.09	−25.45	4.74
		2019	0.38	3.49	0.11	−25.45	6.93
		2020	0.44	4.83	0.13	−33.75	8.25
		2021	0.57	6	0.17	−39.7	14.33
		2022	0.53	5.96	0.16	−39.7	12.16
	Dec-April	2012	0.22	0.37	0.07	−1.37	1.84
		2013	0.17	0.32	0.05	−1.37	1.88
		2014	0.45	0.79	0.13	−3.1	4.86
		2015	0.49	0.83	0.15	−3.1	4.4
		2016	0.8	1.34	0.24	−4.77	9.27

(*Continued*)

Table 2. (*Continued*)

Commodity	Season	Year	Column (1) Dom. Price Change (%)	Column (2) Imp. Price Change (%)	Column (3) Dom. Supply Change (%)	Column (4) Imp. Change (%)	Column (5) Revenue Addition (All States) (million $)
		2017	1.44	2.19	0.43	−6.45	13.71
		2018	1.58	2.33	0.47	−6.45	12.3
		2019	2.23	3.19	0.66	−8.02	19.98
		2020	1.94	2.89	0.58	−8.02	20.15
		2021	2.48	3.62	0.74	−9.5	29.28
		2022	2.74	4.08	0.81	−11.09	35.98

Note: Dom. Price Change means the percentage change in domestic price upon removing above-average growth in imports; Imp. Price Change means the percentage change in import price upon removing above-average growth in imports; Dom. Supply Change means the percentage change in domestic supply; Imp. Change is the percentage change in import quantity.

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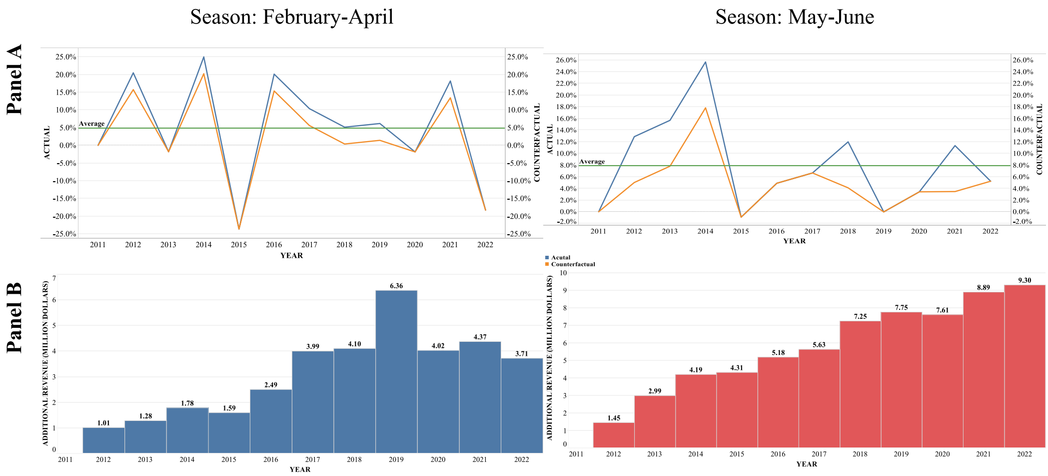

Figure 2. Seasonal analysis for asparagus; panel a: actual and counterfactual growth; panel b: revenue additions to growers.

the May-June season and very low production happens during the February-April season. This means, that while imports are reduced, the ability of U.S. producers to scale up production is higher in the May-June season leading to higher additional revenues. The additional revenue, in the absence of above-average import growth, to fresh asparagus growers during the February-April season is $3.71 million in 2022, with the highest additional revenue estimated in 2019 ($6.36 million). Similarly, during the May-June season, it is $9.30 million in 2022 (Panel B of Figure 2 and column 5 of Table 2). Upon adding, overall estimated additional revenue from February through June was valued at $13.01 million in 2022.

MI and WA, the two largest U.S. producers of fresh asparagus, harvest mostly in the May-June season, while CA harvests around 48 percent in this season (CA season starts in February). The additional revenue appropriated to each state is a function of their supply in a given period. Most of the additional revenue in the February-April season is attributed to CA and some to WA because CA has consistently been the largest supplier in the U.S. market in the February-April season (columns 1 and 2 in Table 3). However, in the May-June season, the largest producer, MI, accounted for most of the additional revenue. Interestingly, before 2016, CA got the largest share of the pie, since it was supplying more to the market during the May-June seasons then.[10]

Bell pepper

Three states – CA, GA, and FL – which accounted for 77 percent of the total fresh market bell pepper production in 2021, are considered the major producers (NASS, 2023c), and January-June and July-December are classified as the two seasons for bell pepper in this study. Based on the findings in Table 2, upon removing the above-average import growth, in 2022, the domestic and import prices increased by 14.14 and 34.38 percent (2.79 and 15.26 percent), respectively, in the January-June (July-December) season (columns 1 and 2). Likewise, columns 3 and 4 show that the

[10]While there are limited studies on asparagus, Ferrier and Zhen (2014)producer quantified the effect of NAFTA and ATPA (Andean Trade Promotion and Drug Eradication Act) on U.S. asparagus producers due to imports. They found that, while imports have decreased producer welfare, consumer welfare resulting from the availability of asparagus in the off-season offsets (i) 64 percent of the loss of $1.24 million due to NAFTA, and (ii) 100 percent of the loss of approximately $0.39 million due to ATPA.

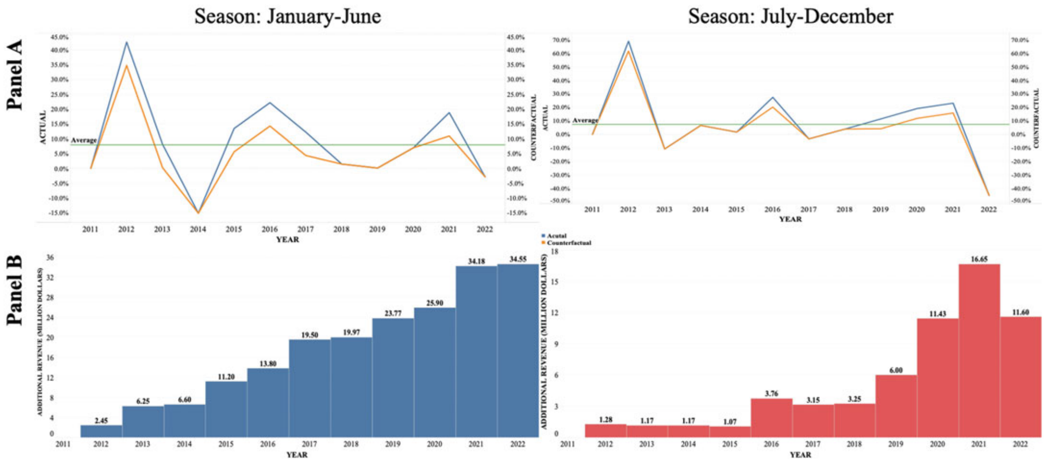

Figure 3. Seasonal analysis for bell peppers; panel a: actual and counterfactual growth; panel b: revenue additions to growers.

domestic supply increased by 0.98 (0.20) percent, while imports decreased by 33.83 (25.48) percent in the January-June (July-December) season in 2022.

Each year (2011–22), additional revenue is larger in the January-June season than in the July-December season (column 5 of Table 2). It stems from the consistently larger magnitude of import reduction (column 4) in January-June compared to the July-December season. This reduction has grown larger over time for both seasons, but the absolute percentage change is higher in January-June. Another reason for early season higher additional revenue is consistently higher import penetration rate. During the early season of 2012, the share of imports was around 49 percent in the U.S. market which increased to 60 percent later in 2022. When a period of larger import reduction overlaps with a season with higher import penetration, the effect gets multiplied (USITC, 2021c, USITC, 2021a). This explains why the additional revenue is higher in the January-June season.[11]

In the case of fresh bell peppers, additional revenue in the absence of above-average import growth is $34.55 million during the January-June season and $11.60 million in the July-December season of 2022. Overall additional revenue, upon adding from January through December, was valued at $46.15 million in 2022.

At the state level (Table 3 and Figure 3), the largest producer, FL, has the highest additional revenue share during the January-June season because it is mostly active during the first season compared to the latter season. In the January-June season, while FL contributes around 72 percent of their production, CA only contributes around 5 percent. As far as the July-December season is concerned, all three states under consideration – FL, GA, and CA – share harvests. In this season, CA has consistently been supplying more than FL followed by GA; therefore, most of the additional revenue is attributed to CA followed by FL. More specifically, CA's share is double that of FL and GA.

Blueberry

The seven states – CA, GA, MI, NJ, NC, WA (which includes Oregon) – that accounted for 94 percent of U.S. fresh market blueberry production in 2021 are the major producers

[11]Domestically produced bell pepper dominates the U.S. market in the July-December season. Imports were only around 9 percent in 2012 which increased to around 30 percent in 2021, and eventually reduced to around 18 percent in 2022.

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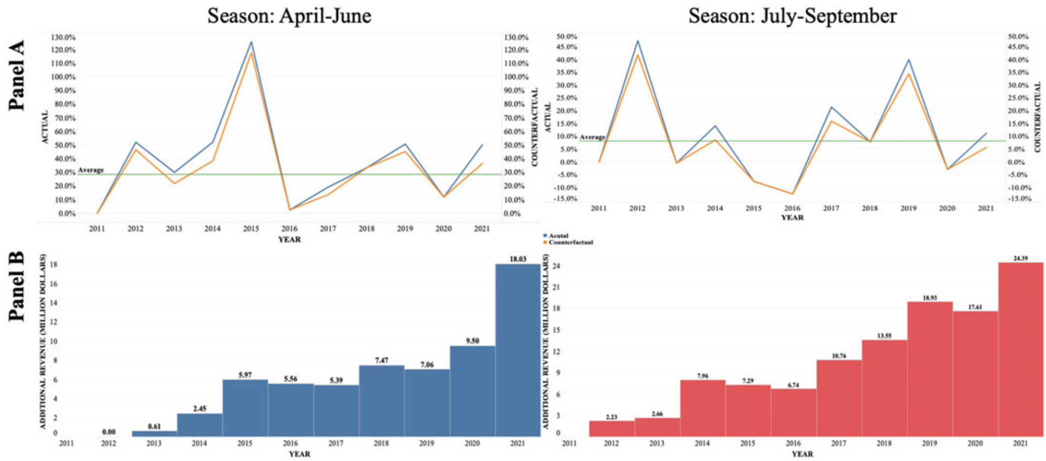

Figure 4. Seasonal analysis for blueberries; panel a: actual and counterfactual growth; panel b: revenue additions to growers.

(NASS, 2023c).[12] This study considers two seasons for blueberries: April-June and July-September. Based on Table 2 (columns 1 and 2), upon removing the above-average import growth, in 2021, the domestic and import prices increased by 2.75 and 9.35 percent (4.09 and 11.24 percent), respectively, in the April-June (July-December) season. Likewise, columns 3 and 4 show that the domestic supply increased by 2.75 (4.09) percent, while imports decreased by 19.90 (20.20) percent in the April-June (July-September) season in 2021.

The seasonal analysis reveals that U.S. fresh blueberry growers would have earned additional revenue of $18.03 million in the April-June season and $24.39 million in the July-September season of 2021, respectively (Panel B of Figure 4 and column 5 of Table 2). Note that overall additional revenue from April through September would have been $42.42 million in 2021. The consistently higher additional revenue in the July-September season is likely due to higher import penetration. In this season, the import share has increased from 31 percent in 2012 to around 36 percent in 2021. But, in the April-June season, the import penetration has been relatively low, i.e., around 4 percent in 2012 and 27 percent in 2021. Another contributing factor to the higher additional revenue is higher import reduction in the counterfactual scenario. Although the magnitude of import reduction looks similar in both seasons across the board (column 4 of Table 2), when import reduction overlaps the period of higher import penetration rate, the final effect becomes larger (July-September season). During this season, WA (including OR), the largest producer, is active meaning they can scale up production to replenish the shortage garnering a higher share of the additional revenue (column 2 of Table 3). In this season, NJ and MI also supply a bulk of fresh blueberries to the U.S. market. In terms of total additional revenue share, WA is followed by MI and NJ in this season. In comparison to MI, the additional revenue for NJ is lower, even for years before 2016, when the production was higher than that of MI. This is because 40 percent of NJ's harvest occurs in the April-June season while Michigan only harvests around 5 percent of its yearly production in this season.

On the other hand, in the April-June season, CA, GA, and NC harvest most of their blueberries and, thus, are the major domestic suppliers to the U.S. market. Among these three states, from 2011 to 2021, CA has been the largest producer for most years, followed by GA and NC. Hence, for most years, the additional revenue is the largest for CA, followed by GA and NC (Table 3).

[12]In the USDA Agricultural Marketing Services (AMS) data, shipping point prices for fresh market blueberries originating in Oregon and Washington are not individually reported; instead, they are combined under the category "Oregon and Washington." Consequently, the additional revenue is calculated collectively.

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However, some exceptions exist, for example, GA surpassed CA in 2014 and 2019, and also NC overtook GA in 2016.

The study by Soto-Caro et al. (2023) using a nested synthetic inverse demand model concludes similar welfare losses to domestic producers. According to their study, an increase in imports of blueberries from Mexico by 100 percent could result in a $20 million loss in domestic revenue especially affecting CA and southeastern states FL, GA, and NC because they operate in the production window when imports are higher. The results of this study confirm the significant challenges to the U.S. fresh blueberry industry from exponential import growth from Mexico and South American countries.[13]

Strawberry

Two states – CA and FL – accounting for almost all of the fresh market strawberry production in 2022 are considered the major producers in the United States (NASS, 2023c), and December-April and May-September are the two seasons for strawberries in this study. Based on Table 2 (columns 1 and 2), upon removing above-average import growth, in 2022, the domestic and import prices respectively increased by 2.74 and 4.08 percent (0.53 and 5.96 percent) in the December-April (May-September) season. Likewise, columns 3 and 4 show that the domestic supply increased by 0.81 (0.16) percent, while imports decreased by 11.09 (39.7) percent in the December-April (May-September) season of 2022.

The additional revenue for strawberries is higher in the December-April season than in the May-September season (column 5 of Table 2 and Panel B of Figure 5). While imports made only around 4-5 percent of the market in the May-September season (which has not increased significantly over time), the December-April season is when Mexico – which accounted for around 98 percent of fresh strawberry imports (including organic) in 2022 – sends fresh strawberries to the U.S. market. In terms of market share, imports made up around 30 percent of the market in 2012, which increased to around 41 percent in 2022. Due to higher import

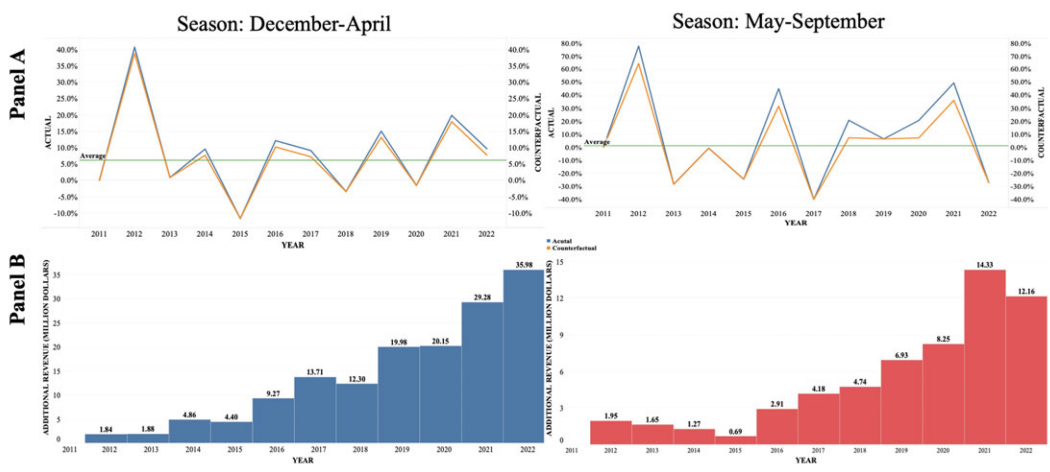

Figure 5. Seasonal analysis for strawberries; panel a: actual and counterfactual growth; panel b: revenue additions to growers.

[13]The rationale for presenting losses exclusively for CA, FL, GA, and NC stems from findings by Huang et al. (2022), which indicate that only the harvesting windows of these states coincide with Mexico's peak season. There is no overlap observed in the harvesting windows of the northern states.

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Table 3. Estimated state-level seasonal economic effect for four commodities

Commodity	Season	Year	Additional Revenue (Million Dollars)						
			Column (1)	Column (2)	Column (3)	Column (4)	Column (5)	Column (6)	Column (7)
			CA	WA	MI	FL	GA	NC	NJ
ASPARAGUS	**Feb-Apr**	2011	0	0	–	–	–	–	–
		2012	0.93	0.08	–	–	–	–	–
		2013	1.19	0.09	–	–	–	–	–
		2014	1.65	0.13	–	–	–	–	–
		2015	1.44	0.15	–	–	–	–	–
		2016	2.10	0.40	–	–	–	–	–
		2017	3.33	0.66	–	–	–	–	–
		2018	3.34	0.75	–	–	–	–	–
		2019	5.32	1.04	–	–	–	–	–
		2020	3.16	0.86	–	–	–	–	–
		2021	3.62	0.75	–	–	–	–	–
		2022	2.86	0.86	–	–	–	–	–
	May-June	2011	0	0	0	–	–	–	–
		2012	0.59	0.50	0.36	–	–	–	–
		2013	1.23	0.97	0.79	–	–	–	–
		2014	1.71	1.33	1.16	–	–	–	–
		2015	1.49	1.52	1.30	–	–	–	–
		2016	1.22	2.29	1.67	–	–	–	–
		2017	1.25	2.46	1.92	–	–	–	–
		2018	1.51	3.37	2.37	–	–	–	–
		2019	1.61	3.13	3.01	–	–	–	–

(*Continued*)

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Table 3. (*Continued*)

			Additional Revenue (Million Dollars)						
			Column (1)	Column (2)	Column (3)	Column (4)	Column (5)	Column (6)	Column (7)
Commodity	Season	Year	CA	WA	MI	FL	GA	NC	NJ
		2020	1.19	3.22	3.20	–	–	–	–
		2021	1.68	3.44	3.78	–	–	–	–
		2022	1.18	3.53	4.60	–	–	–	–
BELL PEPPERS	**Jan-June**	2012	0.33	–	–	2.12	–	–	–
		2013	0.83	–	–	5.42	–	–	–
		2014	0.98	–	–	5.62	–	–	–
		2015	0.95	–	–	10.24	–	–	–
		2016	1.39	–	–	12.41	–	–	–
		2017	1.41	–	–	18.09	–	–	–
		2018	1.73	–	–	18.25	–	–	–
		2019	1.21	–	–	22.56	–	–	–
		2020	1.29	–	–	24.62	–	–	–
		2021	1.46	–	–	32.72	–	–	–
		2022	1.39	–	–	33.16	–	–	–
	July-Dec	2012	0.97	–	–	0.13	0.19	–	–
		2021	9.15	–	–	4.29	3.21	–	–
		2013	0.95	–	–	0.13	0.09	–	–
		2014	0.95	–	–	0.11	0.1	–	–
		2015	0.76	–	–	0.17	0.14	–	–
		2016	2.78	–	–	0.52	0.46	–	–
		2017	2.1	–	–	0.56	0.49	–	–
		2018	2.31	–	–	0.51	0.43	–	–
		2019	3.29	–	–	1.28	1.43	–	–
		2020	6.47	–	–	2.58	2.37	–	–
		2022	5.86	–	–	2.92	2.81	–	–

(*Continued*)

Table 3. (*Continued*)

Commodity	Season	Year	Additional Revenue (Million Dollars) Column (1) CA	Column (2) WA	Column (3) MI	Column (4) FL	Column (5) GA	Column (6) NC	Column (7) NJ
BLUEBERRY	**Apr-June**	2011	0.00	0.00	0.00	–	0.00	0.00	0.00
		2012	0.00	0.00	0.00	–	0.00	0.00	0.00
		2013	0.18	0.03	0.01	–	0.15	0.14	0.09
		2014	0.67	0.1	0.04	–	0.78	0.57	0.3
		2015	1.82	0.23	0.08	–	1.76	1.43	0.64
		2016	1.93	0.34	0.12	–	1.08	1.46	0.63
		2017	2.11	0.41	0.12	–	1.15	0.96	0.65
		2018	2.66	0.58	0.1	–	1.81	1.5	0.81
		2019	2.12	0.5	0.09	–	2.52	1.18	0.63
		2020	3.35	0.69	0.12	–	2.91	1.53	0.9
		2021	6.13	1.5	0.21	–	5.45	3.21	1.52
	July-Sept	2011	0.00	0.00	0.00	–	–	–	0.00
		2012	0.07	1.15	0.55	–	–	–	0.46
		2013	0.09	1.11	0.89	–	–	–	0.57
		2014	0.28	3.44	2.57	–	–	–	1.68
		2015	0.31	3.21	2.31	–	–	–	1.46
		2016	0.23	3.20	2.32	–	–	–	1.00
		2017	0.35	5.52	3.42	–	–	–	1.46
		2018	0.46	8.10	3.09	–	–	–	1.90
		2019	0.60	11.42	4.51	–	–	–	2.40
		2020	0.64	10.63	4.04	–	–	–	2.30
		2021	0.81	16.04	4.81	–	–	–	2.72

(*Continued*)

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Table 3. (*Continued*)

			Additional Revenue (Million Dollars)						
			Column (1)	Column (2)	Column (3)	Column (4)	Column (5)	Column (6)	Column (7)
Commodity	Season	Year	CA	WA	MI	FL	GA	NC	NJ
STRAWBERRY	**May-Sept**	2012	1.93	–	–	0.01	–	–	–
		2013	1.64	–	–	0.01	–	–	–
		2014	1.27	–	–	0.01	–	–	–
		2015	0.69	–	–	0	–	–	–
		2016	2.89	–	–	0.02	–	–	–
		2017	4.15	–	–	0.03	–	–	–
		2018	4.7	–	–	0.04	–	–	–
		2019	6.88	–	–	0.06	–	–	–
		2020	8.17	–	–	0.08	–	–	–
		2021	14.21	–	–	0.12	–	–	–
		2022	12.04	–	–	0.12	–	–	–
	Dec-April	2012	1.28	–	–	0.56	–	–	–
		2013	1.3	–	–	0.58	–	–	–
		2014	3.46	–	–	1.4	–	–	–
		2015	2.96	–	–	1.44	–	–	–
		2016	6.61	–	–	2.67	–	–	–
		2017	9.23	–	–	4.48	–	–	–
		2018	7.72	–	–	4.58	–	–	–
		2019	12.93	–	–	7.05	–	–	–
		2020	12.11	–	–	8.04	–	–	–
		2021	18.68	–	–	10.6	–	–	–
		2022	21.58	–	–	14.39	–	–	–

Note: For Blueberries, the additional revenue for WA also comprises additional revenue for Oregon since they were calculated together.

penetration during the December-April season, the reduction in imports has a higher effect on the additional revenue. In this season, although the magnitude of import reduction is lower compared to the May-September season (column 4 of Table 2), the effect of import penetration is way higher to outweigh the counter-effect arising from import reduction. Here, the total additional revenue in the absence of above-average import growth to fresh strawberry growers in all states during the December-April season was $35.98 million, and it was $12.16 million in the May-September season of 2022. Upon adding, overall additional revenue from January through December was $48.14 million in 2022.

Between the two major producers, CA and FL, CA has consistently been accounting for about 90 percent of the total national production. FL harvests around 95 percent of its production in the December-April season. Even though most of CA's harvest occurs through May and September, its supplies during the December-April season still surpass those of FL. This contributed to the larger share of additional revenue to CA growers in both seasons (Table 3). In the May-September season, CA almost supplies alone, which is why, the additional revenue of CA is much larger than that of FL.[14]

In addition to the factors mentioned above, other factors also affect the magnitude of the additional revenue. For instance, if consumers are more willing to shift to domestic varieties after a relative increase in the price of imported varieties, i.e., if the elasticity of substitution is higher, the effect will be larger. Another factor is the ability of the growers to increase their supply in response to the prices, i.e., the price elasticity of supply. While the results of this study are sensitive to elasticities of demand and substitution, the direction of change in additional revenues is straightforward (2021c, USITC, 2021a).

Robustness Checks

Results of robustness checks, conducted using terminal market and shipping point prices, and after reducing re-exports, for seven states and respective seasons are presented in Appendix 1, 2, and 3. Columns 1 through 7 in all appendices show state-wise seasonal additional revenue for each commodity. Upon comparing with Tables 2 and 3, the seasonal additional revenue using terminal market prices is consistently higher (column 8 in Appendix 1). Additionally, additional revenue was typically higher with the shipping point price, compared to the farm gate and customs unit value prices (column 8 in Appendix 2). These findings are consistent with the fact that the terminal market price is higher than the shipping point price followed by the farm gate or customs unit value due to the additional costs and services involved at each stage of the distribution process. When comparing the revenue change with and without re-exports (column 8 in Appendix 3), it is important to note that the calculation of average growth rates, identification of above-average growth rates, and removal of above-average growth rates were performed separately. Furthermore, terminal market price was utilized while estimating additional revenue upon reducing re-exports.[15]

These results show sizable economic impacts of fruit and vegetable imports on U.S. producers because imports increasingly coincide with domestic seasonal windows. In 2021, the USITC found no "national injury" to growers from all (fresh and frozen) blueberry imports. However, the USITC studies on cucumber and squash found grower revenue losses of $66.93 million and $32.34 million, respectively, from "above-average" import growth. Extending the USITC framework, this study found that fresh vegetable and fruit growers would have earned seasonal additional revenue of $13.01 million (asparagus 2022), $46.15 million (bell peppers 2022), $42.42 million (blueberry

[14]Similar study by Suh et al. (2017) utilized a synthetic inverse demand system to quantify the effect of fresh strawberry imports from Mexico on the U.S. industry. They found that a 100 percent increase in Mexican imports can incur a loss of $145 million for FL and $50 million for CA.

[15]Results from state-level monthly analysis are placed in appendices 4–7.

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2021), and $48.14 million (strawberry 2022) when “above-average” growth in these commodity imports were absent. Every state under consideration is found to have benefited in the counterfactual world (i.e., absence of above-average import growth). The larger the market share of a particular state, the larger its share in the additional revenue, and with higher import penetration, changes in imports create larger economic effects because of their impacts on domestic price and supply.

Limiting imports (in the hypothetical scenario) increased the prices of the respective commodities as depicted in columns 1 and 2 of Table 2. Though producers are benefiting, consumers are facing higher prices. The welfare of consumers is an important area of discussion since off-season produce availability in the U.S. has increased consumer welfare (Kuchler and Arnade, 2016). The different directions of gains for producers and consumers call for policies to maximize both producer and consumer welfare.

Conclusion and Policy Suggestions

Import of fresh fruits and vegetables into the United States has increased dramatically in recent years. Domestic farmers are facing declining market shares and have expressed concerns about exporting countries’ advantages due to low labor cost, production climate, and support policies. In response, the U.S. International Trade Commission (USITC) investigated if imports were harming domestic growers of fruits and vegetables. In 2021, the USITC concluded that domestic revenue and production would increase in the absence of above-average increases in imports of cucumbers and squash using a trade model. In contrast, with a different methodology, the USITC reported that imports were not harming or threatening the domestic table grape and blueberry industries.

This study employs the model used in the USITC study of cucumbers and squash to analyze the economic effect of imports on four fresh produce industries: asparagus, bell pepper, blueberry, and strawberry. The distinguishing features of these commodities include their significant import growth in recent years, and their perishability and seasonality, unlike their frozen counterparts. Higher import, increasingly during the seasonal harvesting window of domestic producers, is challenging domestic production, prices, and revenue.

To calculate the economic effects of imports on the major producing states of each commodity, this study uses farm gate price and customs unit value data from 2011 to 2022. Along with data from the USDA NASS and the Census Bureau on production and trade, respectively, this study simulates state-level monthly and seasonal additional revenue that farmers would have earned in the absence of above-average import growth, as defined by the USITC studies. Results from this counterfactual analysis show substantial changes in domestic prices, supply, and additional revenue for eight major producing states (CA, WA, OR, MI, FL, GA, NC, and NJ). Using farm gate price and customs unit value, domestic farmers would have gained higher seasonal additional revenue of $13.01 million (asparagus 2022), $46.15 million (bell peppers 2022), $42.42 million (blueberry 2021), and $48.14 million (strawberry 2022) if the counterfactual scenario (no above-average import growth) had played out. Additionally, robustness checks using terminal market prices, shipping point prices, and adjusted import quantities that account for re-exports (wherever applicable) yield similar results. The additional revenue calculations acknowledge that only those states facing import competition for a certain month/season are considered.

The model and data limitations of this study provide avenues for further research as well as documentation. The model does not identify any specific events that led to the above-average growth increase in imports; rather it identifies above-average growth based on import trends and reduces them (2021c, USITC, 2021a). On the data end, monthly state-level production data were estimated based on interviews with growers and board members of Commissions of respective commodities. However, this way of distributing production does not consider the possibility that

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farmers can shift some harvest to later months due to labor availability, and market and weather fluctuations.

Nevertheless, the findings of this research provide valuable insights to growers of fresh produce and policymakers concerned with the competitiveness of the domestic industry. Liberalized trade offers economic benefits and promotes welfare. In this context, U.S. consumers appear to be the primary beneficiaries of lower prices and year-round availability of fresh produce. Moreover, there has been opposition from consumer groups as well as U.S. producers with Mexican operations to limit imports in any form, except in the case of illegal dumping. While some regions, e.g., the South-East, demonstrated significant domestic producer losses from imports, regional injuries do not have a recourse in U.S. trade laws. That is, the evidence provided to date does not justify the imposition of anti-dumping or countervailing duties. The recent revision to NAFTA, i.e., USMCA, also did not address safeguards on significant import growth in fresh produce. This study identified additional revenue to domestic producers of fresh produce from limiting imports, albeit it came with price increases to consumers. As noted above, limiting imports is easier said than done, given recent reciprocal trade sanctions, e.g., U.S.-China, Russia-Western countries, and others. What options can help domestic growers without limiting import and raising consumer prices (distorting markets)? The balancing of gains and losses from trade is a decades-old problem and has been at the core of recent U.S. presidential elections. Economists often suggested income support or transitions to greater competitiveness of the industry in concern. The conversations with grower associations, for data assistance in this study, pointed to improved risk management, and technological investments (labor-saving machinery) as priorities to enhance U.S. competitiveness. Many such examples can be found in the Farm Bill – crop insurance, revenue protection, research and development, and others. The choice of support will depend on how costs, including any market distortion, weigh against the benefits documented here, a potential topic for intramural economic research at USDA. Finally, addressing inequities arising from agricultural trade may be useful elsewhere in the economy to build consensus towards future economic partnerships with the rest of the world.

Supplementary material. The supplementary material for this article can be found at https://doi.org/10.1017/aae.2024.17.

Data availability statement. All the data used in the research are publicly available. The data sources are mentioned explicitly in the data section of the paper.

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Authors contribution. Conceptualization, M.G. and A.K.; Methodology, A.K. and M.G.; Formal Analysis, A.K., M.G. and D.P.; Data Curation, A.K. and D.P.; Writing – Original Draft, A.K., M.G. and D.P.; Writing – Review and Editing, A.K., M.G. and D.P.; Supervision, M.G.; Funding Acquisition, M.G.

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