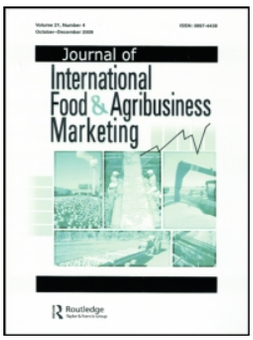

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The National Economic Benefits of Food Imports: The Case of U.S. Imports of Hass Avocados From Mexico

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ABSTRACT

Imports of food products are often seen primarily as a threat to domestic producers while the broader economic impacts are ignored. Research on rapidly growing U.S. avocado imports has focused on the consequences for the U.S. avocado industry. This study conducts an economic impact analysis to measure the level and industry distribution of any benefits of U.S. imports of avocados from Mexico that may accrue to the U.S. national economy. We find that the US$1.5 billion in U.S. imports of Mexican avocados in 2015 had a positive and statistically significant effect on the U.S. economy in that year. Every dollar of avocado imports from Mexico in 2015 generated US$2.31 in U.S. output, US$1.41 in U.S. GDP, and US$0.79 in U.S. labor income. About 12.3 jobs were generated per US$1 million of imports. A separate econometric analysis corroborates the result. We conclude that imports of Mexican avocados are pro-growth for the U.S. economy.

KEYWORDS

Avocado; IMPLAN; imports; Mexico

Economists have long understood that imports do not reduce or slow economic growth but lead directly to faster economic growth and improved standards of living in both exporting and importing countries by fostering specialization and the transfer of technology. In the process, jobs are created in both countries and both enjoy higher standards of living. For many products like food, however, imports are often seen primarily as a threat to domestic producers. The role of imports in expanding consumer food availability and choices as well as potentially contributing positively to the U.S. economy as they stimulate economic activity all along their respective supply chains is often ignored.

Avocados, a rapidly growing U.S. food import, have received increasing attention for both expanding nutritional food choices for U.S. consumers (see Huang, 2013 and Wien, Haddad, Oda, & Sabaté, 2013, for example) and at the same time impacting the California and Florida avocado industries (see, Peterson, Evangelou, Orden, & Bakshi, 2004 and Nalampang, Tantiwongampai, & Evans, 2006, for example). Between 1990 and 2015, U.S.

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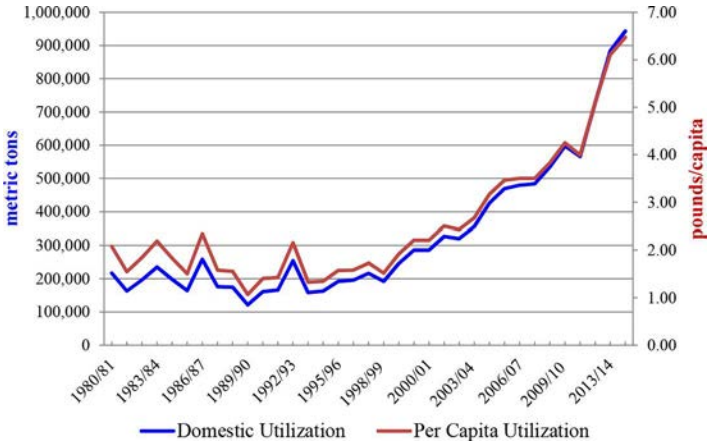


Figure 1. U.S. domestic utilization of avocados, total and per capita, 1980/1981 to 2014/2015.

avocado imports grew from nearly 13,400 metric tons (mt) to greater than 867,000 mt, which has supported a 675% expansion in U.S. avocado utilization and a 6-fold increase in U.S. annual per capita consumption of avocados during that period from 1.1 lb to 6.5 lb (Figure 1). Imports now account for about 82% of U.S. avocado consumption compared with 11% in 1990 (U.S. Department of Agriculture [USDA], 2015a). More tha 93% of avocado imports now come from Mexico.

If international trade theory holds true, the rapidly growing avocado imports should have consequences beyond U.S. avocado markets to the broader U.S. economy. This study examines the level and industry distribution of any benefits of U.S. imports of avocados from Mexico that may extend to the overall U.S. national economy. After providing some background on the economic dimensions of U.S. avocado imports, the analytical methodology is explained. The analytical results are then discussed with a focus on the aggregate, economy-wide impacts as well as the industry breakdown of those impacts. Salient conclusions and implications of the analysis are then highlighted.

Economic dimensions of U.S. avocado imports

Between 1989 and 2004, U.S. imports of avocados increased steadily from about 4,700 mt to about 145,300 mt, mostly from Chile (Figure 2). Between 2004/2005 and 2005/2006, however, a spike in Mexican avocado imports from just under 39,000 mt to greater than 134,000 mt boosted total U.S. imports by 80% to greater than 264,000 mt. Imports from Mexico accelerated at a blistering average annual rate of nearly 30% between 2007 through 2013, steadily crowding out imports from Chile. Total U.S. avocado imports reached almost 870,000 mt in 2015 (about US$1.5 billion) with Mexico accounting for 93% of those imports compared with less than 1% in 1990 and only 27% in 2004.

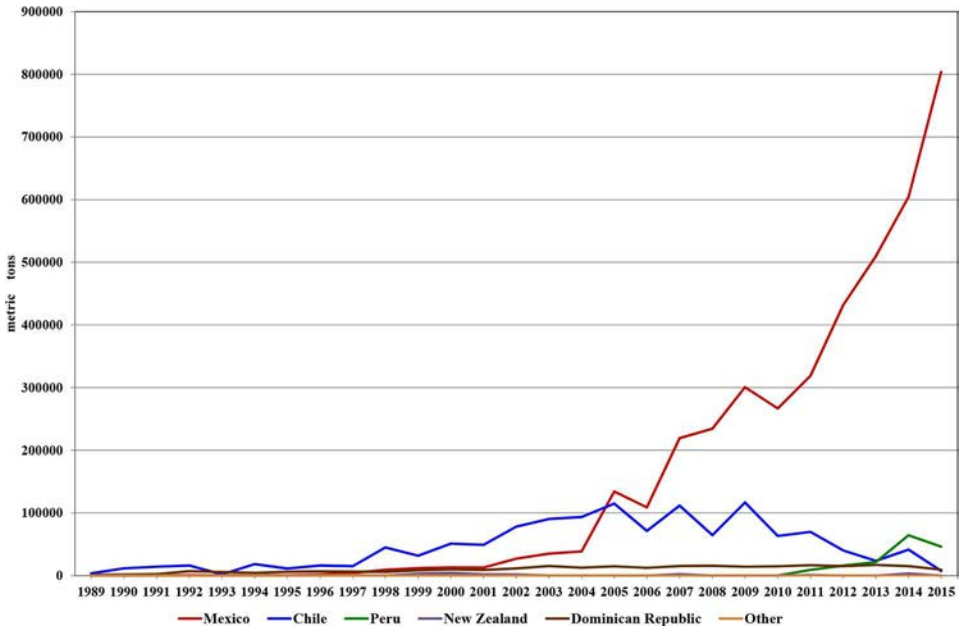


Figure 2. U.S. imports of Mexican avocados by country of origin, 1989–2015.

The growing U.S. demand for avocados is the result of various forces, including the growth of the U.S. Hispanic and Caribbean population, a rapidly spreading consumer trend toward ethnic as well as health-promoting foods, and intensifying promotion efforts by domestic avocado producers and importers through the Hass Avocado Board established in 2002 under the Hass Avocado Promotion, Research and Information Order and by Mexican Hass avocado producer and importer associations (Khazan, 2015; USDA, 2015b). The favorable demand conditions coupled with the sequential issuance of USDA rules in 1997 and 2001 to lift a ban on imports from the state of Mexico into the United States facilitated the sharp increase in avocado imports that began during that period (Carman, Saitone, & Sexton, 2013; Carman & Sexton, 2011; Huang, 2013; Roberts & Perez, 2006).

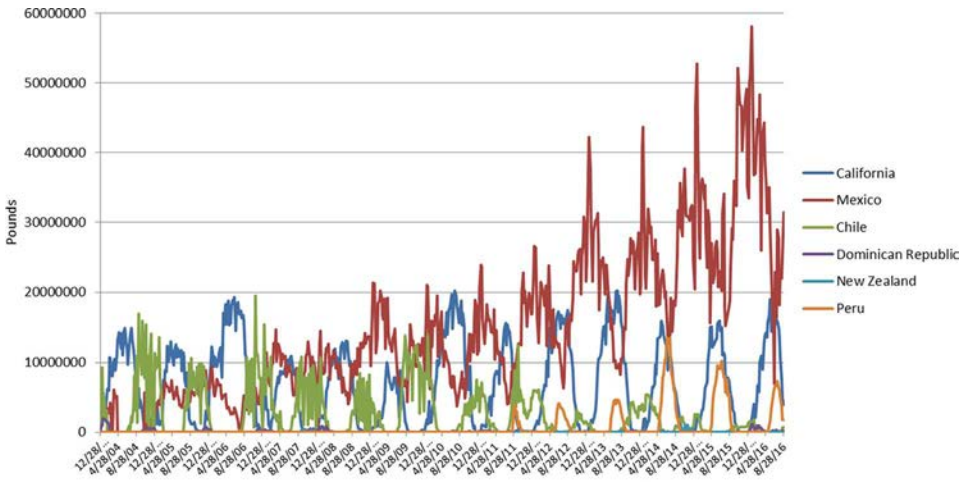
The ban on avocados from Mexico was implemented in 1914 to prevent entry of avocado seed weevils into the United States. After a series of appeals, the state of Michoacán was allowed to begin exporting Hass avocados to the United States in 1997 on a limited basis. While the ban was gradually lifted during the years, no Mexican state other than Michoacán had been allowed access of their avocados to the United States until 2016. Effective June 27, 2016, Hass avocados from any state in Mexico are allowed into the continental United States, Hawaii, and Puerto Rico provided those states meet the same requirements placed on imports from Michoacán (USDA, 2016). The first Mexican state to benefit will likely be Jalisco, which produces about 3% of Mexican avocados (Linden, 2016). Although Michoacán produces 85% of

Mexican avocados, there is mature commercial production in Jalisco with some packers already shipping to other export markets, including Canada, Japan, and Europe (Linden, 2016). Several U.S. avocado distributors already have working relationships with Jalisco producers.

The growth in Mexican import volume has been accompanied by a broadening of the seasonal pattern of Mexican imports to almost consistent year-round availability (Carman, Li, & Sexton, 2009; Huang, 2013). Weekly volumes of Hass avocados arriving into the U.S. market from all country suppliers are exhibited in Figure 3. An obvious seasonal pattern exists in the volume of those shipments throughout each year. Note that avocado imports, particularly from Mexico, tend to peak in the winter and spring months when California avocados are out of season.

Imports of avocados from Peru generally provide a boost to summer supplies, while imports from Chile and the Dominican Republic provide a winter enhancement of domestic supplies. Occasional inflows from New Zealand are also common. California, the only domestic supplier of Hass avocados, has seen its share of U.S. avocado consumption drop from nearly 100% in the 1980s and 1990s to about 15% in 2014 and 2015 (USDA, 2015a).

In the United States, avocados are traditionally consumed fresh in salads, as a side dish, or as guacamole. The growth of the U.S. Hispanic and Caribbean population, however, has spurred the demand for avocados as ingredients in



Weekly Descriptive Statistics (pounds)						
	Mexico	California	Chile	Dominican Republic	New Zealand	Peru
mean	14,740,319	6,871,671	2,626,842	85,004	16,071	672,991
median	12,094,174	6,182,001	912,600	0	0	0
std	11,130,554	5,952,604	3,531,193	219,222	88,754	2,048,026
min	0	0	0	0	0	0
max	58,151,125	20,183,825	19,503,350	1,939,350	1,020,000	13,517,070

Figure 3. Weekly shipment by volume of avocados arriving into the U.S. market from all suppliers, 2004 to September 2016. *Source*: Graphics by authors using data from Hass Avocado Board (2016).

their own traditional dishes. At the same time, an explosion of fusion foods featuring Hispanic and Caribbean cuisine in the United States has integrated avocados solidly into U.S. diets in a growing range of dishes. The fast food industry has increasingly added avocados to their menus as the growth in avocado imports now allow these food chains to keep avocados on the menu year-round (Polis, 2012).

Avocados have been touted as one of the so-called super foods, enhancing its demand among increasingly health conscious U.S. consumers. Avocados are a nutrient-dense food and are high in insoluble fiber as well as potassium, the B vitamins, vitamin E, magnesium, and folate. Health claims for the avocado abound, including the ability to regulate blood pressure, prevent heart disease, encourage healthy bones, support cardiovascular health, and stave off migraines. While avocados are high in fat content, most of it is of the healthy monounsaturated type, reported to reduce "bad" cholesterol (low-density lipoprotein [LDL]) and to help increase "good" cholesterol (high-density lipoprotein [HDL]).

Avocados consumed in the western region of the United States, and particularly California where greater than one-third of the U.S. Hispanic population lives, are primarily of the Hass variety (Pollack & Perez, 2006). Although more than two dozen varieties of avocados are grown commercially in the United States, Hass avocados compose 96% of U.S. avocado consumption and, hence, are the most widely available. Hass avocados have a thick, leathery skin that turns dark green-to-black as the fruit matures. With the second largest U.S. Hispanic population, Texas is also a large market for Hass avocados. Mexico produces Hass avocados almost exclusively so most U.S. avocado imports are of the Hass variety. Retail and food service markets reportedly prefer Hass avocados for consistency (Pollack & Perez, 2006). Also, Hass is the variety most heavily promoted as a result of the Hass Avocado Promotion and Research Order and the efforts of Mexican Hass avocado importer and producer associations.

Green-skinned avocados are common in the eastern half of the United States, where the larger populations of Caribbean immigrants are found. The Florida avocado industry is the primary supplier of green-skinned avocados to these markets. Green-skinned avocados are generally larger than Hass avocados and have less fat and more moisture (Pollack & Perez, 2006). Green-skinned varieties are also thinner skinned than the Hass and tend to bruise more easily during shipment, which tends to limit the range of their market.

Imported avocados are packed in the country of origin and shipped to various U.S. buyers. Avocados from Michoacán are trucked to the United States primarily through Texas border crossings (Pavlakovich-Kochi, 2016). The imported avocados may be shipped to wholesalers or directly to supermarkets, restaurants, fast-food establishments, or other retailers.

As avocados move from U.S. ports of entry to wholesalers, distributors, supermarkets, restaurants, fast-food establishments, and elsewhere along the supply chain, they generate economic growth by stimulating economic activity within the avocado supply chain itself and, as a result, economic activity along associated supply chains with which the avocado import supply chain intersects. For example, shipments of avocados passing through U.S. land or water ports require services from port officials such as the U.S. Customs and Border Protection and other federal inspection agencies responsible for the enforcement of federal laws pertaining to such activities. Avocados passing through maritime ports require a large range of services related to the transfer of goods from water to land transportation. As the avocados move inland from the ports, the shipments of imported avocados stimulate a large number of other economic activities related to transportation, wholesale and retail trade, advertising, construction, finance, manufacturing, infrastructure, and numerous after-market services.

The economic activities stimulated at each point in the supply chain generate not only services and jobs at those points but also services and jobs along the supply chains that intersect at those points. For example, the transport of avocados requires fuel. That demand for fuel generated by the transport of imported avocados generates a demand by fuel retailers for fuel from their suppliers, who then must demand more fuel from refiners who demand more oil from oil suppliers, and so on. At each point on the fuel supply chain, the additional demand for fuel initiated by the shipments of imported avocados contributes to profits and employment. In addition, the suppliers of fuel equipment, transportation services, repair services, and other fuel support services are also all benefited by the additional demand for fuel generated by avocado imports. The same process holds true at each point in the avocado import supply chain resulting in additional economic activity along transportation, wholesaling, retailing, and other supply chains that intersect with the avocado import supply chain.

Methodology

We first use an economic impact analysis, focusing on the contribution of the US$1.5 billion of avocado imports from Mexico in 2015 to the value of U.S. output, value-added, employment, labor income, and taxes paid (federal, local, and state level)s in that year. We then employ a quantitative, econometric procedure to directly measure the statistical relationship between the U.S. economy and avocado imports from Mexico over time. In this procedure, we focus on the extent to which changes in U.S. employment can be explained by the avocado imports.

The econometric analysis serves as a check on the results of the economic impact analysis providing an independent measure of the effects of avocado

imports specifically on U.S. employment levels. If the results of the econometric analysis are similar to those of the input–output analysis with respect to the employment impact of avocado imports from Mexico, then the level of confidence that can be placed in the results of the economic impact analysis increases. If the results of the two methodologies are dissimilar in their conclusions regarding the U.S. employment effects of avocado imports but are of the same order of magnitude, then they provide a useful range of likely impacts. If the results are highly dissimilar, then the level of confidence that can be placed in the measured impacts decreases.

Economic impact analysis methodology

To determine the extent of the contribution that imports of Mexican avocados have on the U.S. economy, this study first measures the *direct, indirect*, and *induced* effects of avocado imports on the U.S. economy. The *direct effects* on the economy are the initial economic activities measured that are impacted by imports. The direct effects result in two types of secondary effects. The *indirect effects* result from the purchase of inputs among local industries as a result of the imports. The *induced effects* result from the expenditure of institutions such as households and governments benefitting from increased activity among local businesses (IMPLAN Group, LLC, 2013a).

The general methodology used is referred to as "economic contribution analysis" and is based on the idea that a dollar spent in a region or country stimulates additional economic activity or multiplies as it circulates through the economy. To estimate the national- and state-level economic contribution of the sale of imported avocados from Mexico through the import supply chain, we use the IMPLAN (IMpact analysis for PLANning) input–output system (IMPLAN Group, LLC, 2013b). Input–output analysis is based on the idea that a change in one sector of the economy has effects on other sectors of the economy. Input–output analysis captures the relationships between industries and estimates the change in each sector's sales due to an initial change in final demand for a given industry's output. The sum of these changes is the industry's multiplier.

To measure impacts, the IMPLAN model produces multipliers that estimate the total economic contribution of expenditures within an economy. Multipliers are calculated based on the purchasing patterns of industries and institutions in the regional economy. Each industry and region combination has a unique spending pattern and a unique multiplier relating to the direct, indirect, and induced effects of the spending.

Four types of economic effects are reported in IMPLAN analyses. The *employment* contribution measures the number of jobs (both full-time and part-time) attributable to the direct economic activity stimulated. The contribution to *labor income* measures the effect of spending by businesses on

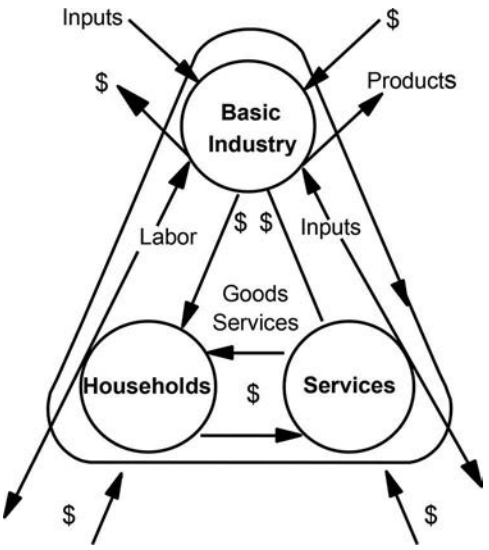


Figure 4. Overview of any community economic system.

the incomes of households and indicates a benefit to local residents. The *value-added* measures the contribution to gross domestic product and indicates the return to resources used by the business. The *output* contribution measures economic activity (total spending) generated. Labor income is a subset of value-added, which is part of output. These four effects provide a better perspective of the contribution of an economic activity like avocado imports but they are three separate views and not meant to be summed.

The foundation of a community's economy consists of those businesses that sell some or all of their goods and services to buyers outside of the community (Woods, McCorkle, & Niemeyer, 2007). Such a business is a considered to be a "basic industry." The flows of products out of, and dollars into, a community are represented by the two arrows in the upper right portion of Figure 4. To produce these goods and services for "export" outside the community, the basic industry purchases inputs from outside the community, labor from the residents or "households" of the community, and inputs from service industries located within the community. The flow of labor, goods, and services in the community is completed by households using their earnings to purchase goods and services from the community's service industries. A depicted Figure 4, a change in any one segment of a community's economy will have reverberations throughout the entire economic system of the community (Woods et al., 2007).

Econometric analysis methodology

As a check on the reasonableness of the IMPLAN analysis results, we also conduct a quantitative, econometric analysis of the impact of U.S. avocado

imports (shipments) from Mexico on U.S. nonfarm employment. In this analysis, we hypothesize that shipments of Mexican avocados into the U.S. market have affected the number of total U.S. nonfarm workers over time, controlling for all other factors. Specifically, we examine the statistical relationship between changes in monthly imports of avocados from Mexico and changes in the level of U.S. employment during the January 2004 through March 2016 period controlling for the effect of recessions. Through this procedure, we statistically estimate both the short-run and long-run impacts of avocado imports from Mexico on U.S. employment and associated elasticities. The elasticities are measures of the percentage change in U.S. employment that occurs from each 1% change in U.S. avocado imports from Mexico in either the short-run or long-run.

Analysis of the benefits to the U.S. economy from imports of avocados from Mexico

In this section, the results of the economic impact analysis using the IMPLAN model are first discussed. Then the results of the econometric analysis are discussed and compared with those of the economic impact analysis.

Economic impact analysis

After reviewing the procedures followed in using the IMPLAN model for this specific analysis, a summary of the aggregate economic impacts of U.S. imports of Mexican avocados in 2015 on the U.S. economy is discussed with an emphasis on the contribution of avocado imports to the value of U.S. output, U.S. value-added, U.S. employment, U.S. labor income, and U.S. taxes paid (federal, state, and local) in that year. Then the avocado import contribution multipliers are presented. The multipliers demonstrate the dollar value of the contribution of imports of Mexican avocados to U.S. output, U.S. value-added, and U.S. labor income per dollar of avocado imports. An employment multiplier is also presented that reflects the number of U.S. jobs generated per US$1 million of avocado imports from Mexico. Finally, a tax multiplier is presented which shows the value of all taxes generated at the federal, state, and local levels as a result of all activities stimulated by avocado imports from Mexico as a share of the value of imports. The aggregate economy-wide impacts are then broken down by industry to provide some indication of the industry distribution of the contribution of avocado imports from Mexico to the U.S. economy.

Procedures followed in the analysis

Before the economic impact analysis of avocado imports from Mexico to the United States could begin, an IMPLAN input–output model of the United

States had to be constructed. Using 2010 data for the United States, the IMPLAN software was used to write component information; add structural matrices; create regional absorption tables, commodity balances, market shares, and interinternational transfers; and compute and create multipliers for the U.S. model. By constructing social accounts that describe the structure and function of the U.S. economy, IMPLAN creates a localized model to investigate the consequences of changes in U.S. economic transactions (IMPLAN Group, LLC, 2013b).

With the U.S. model constructed, the next step was to determine what sector in IMPLAN to use for the analysis of the avocado imports. IMPLAN consists of 440 different sectors from production to transportation, wholesale, manufacturing, retail, services and others. For this analysis, industry sector 319 (wholesale trade businesses) was used because this industry sector best reflects the impact that avocado imports from Mexico would have on the U.S economy.

The production function for the U.S. wholesale trade businesses industry sector was edited to reflect sales of avocados by adjusting the calculated IMPLAN coefficients for the various commodities associated with the 440 sectors that contribute to the production function of sector 319. First, the coefficients calculated by IMPLAN for those associated commodities not directly needed for the operations of the wholesale trade businesses sector, specifically things that are cost of goods sold, were summed up and added to the current IMPLAN coefficient for "commodity code 3436–non-comparable foreign imports." Then, the selected commodity coefficients (production function) for sector 319 were set to zero and the model's coefficients were rebalanced and saved. Finally, the model's multipliers were then re-constructed to reflect the coefficients changes.

The reason for modifying the coefficients (production function) in the wholesale trade businesses industry (sector 319) was to enable the results of the model to best reflect the impact of importing rather than domestic production of avocados, thus helping to reduce any potential substitution effects between avocado imports from Mexico and avocados produced in United States. Further, these adjustments allow backward leakages in the model associated with avocado farming/production to be stopped and not included in the impact analysis while still allowing for the impacts for the other backward leakages to be reflected for the other associated industry sectors (transportation, warehousing, storage, etc.).

Following the reconstruction of the multipliers, the next step was to select an "industry change" activity with an event for the wholesale trade business industry. An activity is a grouping of one or more events that represents a related change within the study area (IMPLAN Group, LLC, 2013a). The value of avocado imports from Mexico to the United States for 2015 (US$1.5 billion) was then entered as the industry sales for the wholesale trade businesses sector

event within the U.S. model. For this analysis, gross retail margin was used to best reflect the producer price and not the purchase price. Producer prices are received by the producer for the goods and services that are sold or the prices paid by the store to its suppliers (IMPLAN Group, LLC, 2013a). With the avocado import value entered in the model, the analysis of this industry change to the U.S. economy was conducted in which direct, indirect, and induced impacts were calculated with IMPLAN.

Finally, summary and industry sector results for the direct, indirect, induced, and total effects for output (total spending), employment (full- and part-time jobs), value-added (contribution to GDP), labor income (employee compensation), and taxes (local, state, and federal) were reported within the IMPLAN model for this particular industry change activity.

Summary of aggregate results

The analysis provides clear evidence that avocado imports from Mexico make a substantial contribution to the U.S. economy along the avocado import supply chain that has a multiplier effect along intersecting supply chains, generating output, value-added, income, jobs, and taxes as a result. The total of all the direct, indirect, and induced effects of the US$1.5 billion of imports of Mexican avocados in 2015 on U.S. output or total spending amounted to US$3.52 billion (Table 1). That is, the US$1.5 billion of U.S. imports of Mexican avocados in 2015 stimulated economic activity in the United States that generated a total of US$3.52 billion in output or total spending. At the same time, the total economic activity stimulated by those imports added US$2.16 billion in 2015 to the U.S. GDP (value-added), created US$1.21 billion in U.S. labor income, US$593.9 million in taxes (federal, state, and local), and added 18,695 jobs.

Implied contribution multipliers

Every dollar of Mexican avocados imported in 2015 generated US$2.31 in gross output, US$1.41 in GDP (value-added), and US$0.79 in labor income (Table 2). Every US$1 million of imports generated 12.3 jobs in the U.S. economy. Taxes generated by the imports amounted to 38.9% of the value of the imported avocados (Table 2). Stated in this way, these contributions

Table 1. Summary economic impact of 2015 avocado imports.

Output (US$ million)	Value-added (US$ million)	Employment (no. of jobs)	Labor income (US$ million)	Taxes* (US$ million)
$3,524.3 (0.02% of GDP)	$2,161.3 (0.008% of GDP)	18,695 (0.0085% of U.S.)	$1,206.4	$593.9

*Federal, state, and local.

Table 2. Impact multipliers of 2015 avocado imports.

Output multiplier (US$ output/US$ imports)	Value-added multiplier (US$ VA/US$ imports)	Employment multiplier (jobs added/US$ million imports)	Labor income multiplier (US$ income/US$ imports)	Tax multiplier (% of import value)
2.31	1.41	12.3	0.79	38.9

measure the multiplier effect of the imports. That is, they indicate how much additional output, GDP, etc. is generated by each dollar of imports. For example, for every US$100 million increase in imports of Mexican avocados, U.S. output or spending increases by US$231 million while GDP increases by US$141 million, labor income by US$79 million, and employment by 1,230 jobs.

Industry by industry breakdown of the results

An industry breakdown of the economic contributions reveals that the wholesale/retail and service industries account for much of the contribution of imports of Mexican avocados to U.S. economic activity as might be expected (Table 3). Together, those two industries account for 83% of the contribution of imports of Mexican avocados to U.S. gross output, 88% of the contribution to U.S. GDP (value-added), U.S. employment, and U.S. labor income, and 95% of the contribution to U.S. taxes. The manufacturing industry is also a major beneficiary of the avocado imports, accounting for nearly 8% of their contribution to gross output and 1% to 4% of the contribution made to GDP, labor income, employment, and taxes. Transportation and warehousing and a large number of miscellaneous services (e.g., advertising, insurance, accounting and legal service, repair services, and more) account for much of the remaining contribution of U.S. imports of avocados to the U.S. economy.

Table 3. Economic impact of 2015 avocado imports by industry.

Industry	Output (US$ million)	Value-added (US$ million)	Employment (no. of jobs)	Labor income (US$ million)	Taxes* (US$ million)
Wholesale/retail	$1,706.2	$1,150.5	7,931.6	$613.2	$225.3
Manufacturing	$281.9	$80.9	529.0	$38.1	$3.4
Transportation and warehousing	$121.4	$65.5	852.3	$46.2	$2.8
Services	$1,229.1	$769.8	8,472.2	$447.3	$46.1
Food and accommodation	$67.5	$38.2	1,047.9	$27.2	$4.8
Other	$1,161.6	$731.6	7,424.3	$420.1	$41.3
Agriculture	$20.5	$10.2	157.2	$6.3	$0.2
Other	$165.2	$84.3	753.0	$55.2	$6.5
Total**	$3,524.3	$2,161.3	18,695.3	$1,206.4	$284.2

*Indirect business taxes. **Totals may not add due to rounding.

Econometric analysis

As a check on the IMPLAN results, we also conducted an econometric analysis of the impact of Mexican avocado imports (A) on U.S. nonfarm employment (E) using monthly data such that:

$$E_t = f(A_t,\ E_{t-1},\ R_t) \tag{1}$$

where R is a 0–1 indicator variable representing the recessionary period of December 2007 through June 2009. R takes on the value of 1 for the months of December 2007 through June 2009 and 0 otherwise.

The dependent variable (E) is monthly U.S. nonfarm employment, seasonally adjusted, expressed in thousands of workers and is a measure of the number of workers in the U.S. economy excluding proprietors, private household employees, unpaid volunteers, farm employees, and the unincorporated self-employed (U.S. Department of Labor, 2016). This measure accounts for approximately 80% of the workers who contribute to the GDP of the U.S. economy. Between January 1990 to March 2016, the number of workers ranged from approximately 109 million to 144 million (Figure 5).

The avocado import variable (A) in equation (1) is a monthly aggregate of the weekly avocado shipment data in pounds (see Figure 3) available from the Hass Avocado Board (2016) to match the dependent variable data. We use a polynomial distributed lag (Almon lag) model in equation (1) to capture potential dynamics in the relationship between employment (E) and avocado imports (A). We also allow for a nonlinear as well as a dynamic relationship between E and A. The nonlinearity of the functional representation is accomplished with the use of the logarithm of the dependent variable (E) and the square root of the explanatory variable (A). The dynamics of this relationship are represented through the use of a second-degree polynomial

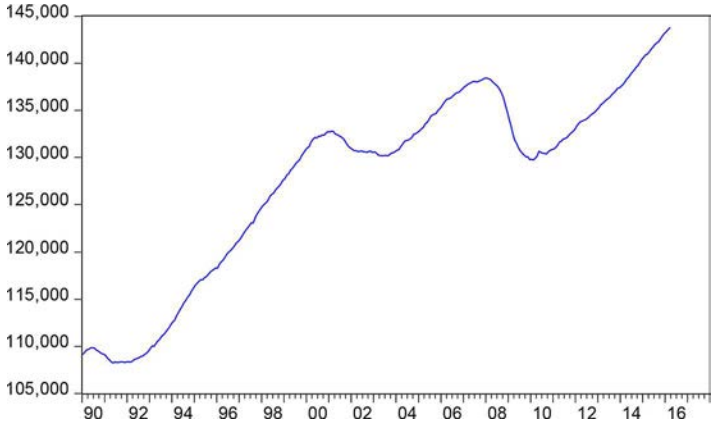


Figure 5. Total nonfarm payroll, seasonally adjusted, January 1990 to March 2016. *Source*: U.S. Department of Labor (2016).

distributed lag with two lags and the use of endpoint restrictions. The optimal lag length and the degree of polynomial were determined by examining various combinations of polynomial degrees (2 and 3) and various lag lengths (1 through 12) via the use of model selection criteria (Akaike information criterion, Schwarz information criterion, and Hannan–Quinn information criterion).

We also postulate that adjustment of nonfarm employment to changes in the explanatory variables is not instantaneous but rather takes time due to rigidities in the economy resulting from adjustment costs, incomplete information, and other factors. Consequently, lagged nonfarm employment (E_{t-1}) is included as an explanatory variable in a partial adjustment model.

The results of estimating the parameters of equation (1) are presented in Table 4. To minimize issues associated with restrictions on Mexican imports and structural change issues in the quantitative analysis, we estimate the parameters of equation (1) during the sample period. More than 99% of the variability in total nonfarm employment (E) is accounted for by the 10-month lag of the recessionary period (R), lagged nonfarm employment (E_{t-1}) and the 2-month polynomial distributed lag of the square root of Mexican imports of Hass avocados (A). A serial correlation correction for the systematic pattern in the error term of the model was necessary. This pattern is represented by the AR(1) and MA(1) terms in Table 4, that is, the error term follows an

Table 4. Econometric analysis of the impact of Mexican imports of avocados on the number of workers in the U.S. economy.

Dependent variable: LOG(US_EMPLOYMENT_SA_FRED)				
Method: ARMA maximum likelihood (OPG - BHHH)				
Sample: 2004M01 2016M03				
Included observations: 145				
Variable	Coefficient	Std. Error	*t*-Statistic	Prob.
C	0.426684	0.654851	0.651574	0.5158
US_RECESSIONS(-10)	−0.001775	0.000479	−3.704890	0.0003
LOG(US_EMPLOYMENT_SA_FRED(-1))	0.963890	0.055390	17.40175	0.0000
PDL01	5.93E−08	4.32E−08	1.372232	0.1722
AR(1)	0.944062	0.090086	10.47956	0.0000
MA(1)	−0.422939	0.098946	−4.274452	0.0000
SIGMASQ	7.72E−07	7.48E−08	10.32678	0.0000
R^2	0.998902	Mean dependent var		11.81590
Adjusted R^2	0.998854	S.D. dependent var		0.026605
S.E. of regression	0.000901	Akaike info criterion		−11.13030
Sum squared resid	0.000112	Schwarz criterion		−10.98659
Log likelihood	813.9466	Hannan-Quinn criter.		−11.07191
F-statistic	20921.73	Durbin-Watson stat		2.013009
Prob(*F*-statistic)	0.000000			
Lag distribution of SQRT_MEXICO_IMPORTS	*i*	Coefficient	Std. Error	*t*-Statistic
. * |	0	4.4E−08	3.2E−08	1.37223
. * |	1	5.9E−08	4.3E−08	1.37223
. * |	2	4.4E−08	3.2E−08	1.37223
	Sum of Lags	1.5E−07	1.1E−07	1.37223

Source: Computations by the authors using EVIEWS 8.0.

autoregressive-moving average (ARMA) process consisting of two parts, autoregressive process of order 1 and a moving average process of order 1.

Without question, a statistically significant and positive relationship exists between Mexican imports of Hass avocados and the level of U.S. employment. Because of the use of the second-degree polynomial distributed lag with endpoint restrictions as well as the optimal lag length of 2 months, both the contemporaneous or short-run impact of U.S. imports of Mexican Hass avocados on U.S. employment are estimated as well as the long-run or cumulative impact on U.S. employment. Changes in the level of Mexican imports of avocados affect U.S. employment not only immediately but up to 2 months later.

The econometric results also indicate that the U.S. recession from December 2007 to June 2009 negatively affected the total nonfarm payroll (Table 4). We considered contemporaneous and lagged impacts of the recession indicator variable. On the basis of model selection criteria, the optimal lag for this variable (R) was 10 months. Thus, the results indicate that U.S. employment was lower by 0.18% at 10 months following the period of recession relative to the nonrecessionary period.

Using the estimated parameters from Table 4, the year-to-year (short-run) average impact of 1 million pound change in shipments of Mexican avocados on total nonfarm payroll (non-farm workers) for calendar years 2004 through 2015 were calculated (Table 5). Over the entire period of 2004 through 2015, the short-run incremental (marginal) impact of 1 million pound increase in shipments of Mexican avocados on U.S. employment has generally declined from a high of 1,866 in 2004 to a low of 517 n 2015. The long-run incremental impact declined from a high of 6,362 to a low of 1,761 during that same period. These marginal effects depend on three factors: (a) the estimated coefficients associated with the level of U.S. imports of Mexican avocados,

Table 5. Short-run and long-run impacts of a million pound increase in U.S. imports of Mexican avocados on the number of workers in the U.S. economy, 2004–2015.

Year	Short-run impact	Long-run impact
2004	1,866	6,362
2005	1,208	4,117
2006	1,432	4,883
2007	968	3,301
2008	940	3,203
2009	803	2,736
2010	856	2,919
2011	799	2,723
2012	682	2,326
2013	653	2,226
2014	593	2,021
2015	517	1,761
Mean	910	3,102

Source: Calculations by authors.

(b) the number of workers in the U.S. economy, and (c) the level of U.S. imports of Mexican avocados. That is, the marginal effects vary by calendar year due to variations in U.S. imports of Mexican avocados and in the number of U.S. workers.

The elasticities (both short-run and long-run) of U.S. nonfarm employment relative to shipments of Mexican avocados for each calendar year were calculated from the marginal effects and, thus, vary by year due to the non-linear relationship between avocado imports from Mexico and total nonfarm payroll (Table 6). Note that the elasticities are quite small (inelastic) as would be expected. For example, for calendar year 2015, the (short-run) elasticity of total nonfarm employment with respect to imports of Mexican avocados is 0.00027. On average during the full period of 2004 to 2015, a 1% increment in the volume of Mexican avocados entering the U.S. market leads to a short-run increase of 0.000165% in total nonfarm employment (the short-run elasticity) and to a cumulative (during 2 months) impact of 0.00056% (the long-run elasticity). Hence, during the period, a 1% change in the U.S. import volume of Mexican avocados (equivalent to 1,114,662 pounds on average) translates into an immediate change (one-month) of roughly 910 workers in the U.S. economy and into a cumulative change of about 3,102 workers in the U.S. economy (during 3 months).

To compare these results with those from those of the IMPLAN model for the calendar year 2015, the elasticities are used to calculate the change in U.S. employment in 2015 from the change in Mexican shipments of avocados over the previous year. The volume of U.S. shipments of Mexican avocados grew by 33% (36,799,742 pounds) between 2014 and 2015. Given the short-run elasticity of U.S. nonfarm employment with respect to U.S. imports of Mexican avocados for calendar year 2015 is 0.00027, the U.S. nonfarm employment increased by an estimated 12,510 workers between 2014 and 2015 (short-run) as a result of the avocado imports.

Instead of the elasticities, we also used the calculated marginal effects provided in Table 5 to determine the effects of the same change in shipments of Mexican avocados on U.S. employment. In this case, the results were quite similar to those obtained using elasticities. In this case, the increase of U.S. shipments of Mexican avocados by 36,799,742 pounds between 2014 and 2015 resulted in an estimated increase of 19,012 U.S. workers (short-run).

Our estimate of the number of jobs attributable to U.S. imports of Mexican avocados in 2015 from the IMPLAN model was 18,695, which falls in the interval of 12,510 to 19,012 additional workers calculated in the short-run based on the estimated elasticities and marginal effects, respectively, from the econometric model previously discussed. The robustness of the IMPLAN results are apparent given the remarkably close correspondence of the IMPLAN impacts of avocado imports on U.S. employment and those calculated from a distinctly different methodology (econometrics).

Table 6. Short-run and long-run elasticities for total nonfarm payroll due to unit percentage changes in the level of U.S. imports of Mexican avocados, 2004 to 2015.

Year	Short-run elasticities	Long-run elasticities
2004	0.00004117	0.00014034
2005	0.00010831	0.00036925
2006	0.00009692	0.00033040
2007	0.00013921	0.00047456
2008	0.00014365	0.00048971
2009	0.00016169	0.00055123
2010	0.00015209	0.00051849
2011	0.00016615	0.00056643
2012	0.00019507	0.00066502
2013	0.00020990	0.00071555
2014	0.00023053	0.00078590
2015	0.00026716	0.00091078
Mean	0.00016505	0.00056268

Source: Calculations by authors.

Conclusions and implications

In general, this study provides evidence of the impact of food imports on the overall U.S. economy. Specifically, the study concludes that U.S. imports of Mexican avocados have a positive and statistically significant effect on the U.S. economy. The study found that those imports contributed the following to the U.S. economy in 2015:

- US$3.5 billion in output or spending
- US$2.1 billion to the U.S. GDP (value-added)
- 18,695 jobs;
- US$1.2 billion in labor income
- US$594 million in taxes (federal, state, and local)

In addition, the study found that every dollar of avocado imports from Mexico generates US$2.31 in output, US$1.41 in U.S. GDP, and US$0.79 in labor income. Also, US$1 million of avocado imports was found to generate 12.3 U.S. jobs.

A separate econometric analysis of the impact of shipments of avocados from Mexico corroborated these results. The econometric analysis found that shipments of Mexican avocados in 2015 added between about 12,510 to 19,012 workers to the U.S. economy in that year, a result consistent with the 18,695 jobs added found in the IMPLAN analysis.

The primary implication of this study is straight forward. Imports of Mexican avocados are pro-growth for the U.S. economy. Given their rapid and increasing rate of growth, imports of Mexican avocados will continue to make substantial and increasing contributions to the U.S. economy. When aggregated over time, the contributions of those imports to the U.S. economy are not only impressive but economically important for the U.S. economy.

Given the steep predicted growth path of imports of Mexican avocados, their current positive contribution to the U.S. economy will only intensify

during the years. The sequential easing of phytosanitary restrictions on avocado imports from Mexico in place since 1914 not only has supported the growth of the Mexican avocado industry during the years but has boosted the U.S. economy as a whole. Thus, any trade policy or other actions to reduce the level of U.S. avocado imports would have a substantial and growing negative impact on the U.S. economy.

Concerns about the possibility that the imports may be depressing U.S. avocado prices and production may be unwarranted given the large and expanding demand push for avocados that is driving both the domestic and Mexican production of avocados. Previous research (Nalampang et al., 2006; Peterson et al., 2004) supports such a conclusion. Given the weather, water, land, and other resource limitations that challenge California avocado producers, imports continue to fill the gap for the rapidly growing domestic avocado demand left unfilled by domestic producers. This study measures the downstream contributions of those imports to the U.S. economy.

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