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Economic Benefits of the Expansion of Avocado Imports from Mexico

Research Report to the Mexican Hass Avocado Import Association (MHAIA)

Forecasting and Business Analytics, LLC.

Dr. Gary W. Williams,
FABA Team and Professor,
Texas A&M University

Dr. Oral Capps, Jr.,
FABA Managing Partner and Executive Professor,
Texas A&M University

Dan Hanselka
FABA Team and Extension Associate,
Texas A&M University

Forecasting and Business Analytics, LLC
9409 Whitney Lane
College Station, TX 77845

Phone: 979-255-7081
Email: capps@faba-llc.com
Webpage: http://www.faba-llc.com

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Gary W. Williams, Oral Capps, Jr., and Daniel Hanselka
Forecasting and Business Analytics, LLC

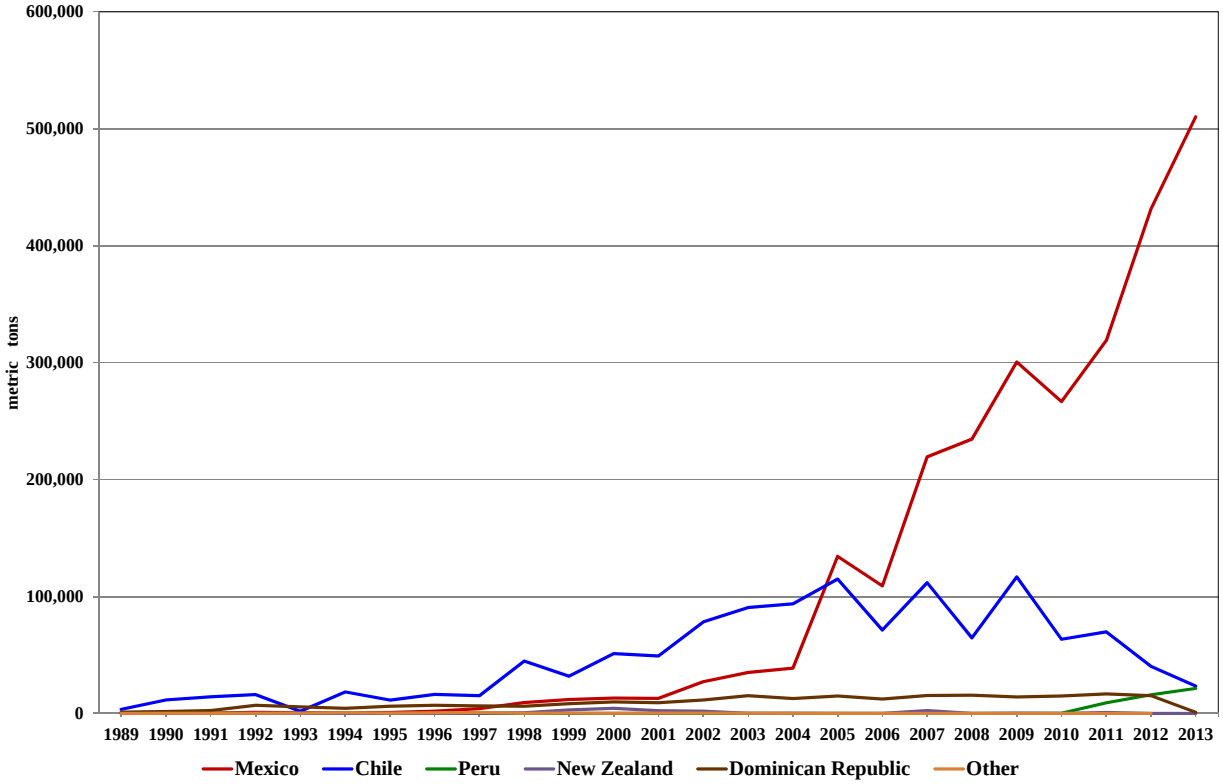
Since Adam Smith wrote his treatise on *The Wealth of Nations* in 1776, economists have understood that imports do not reduce or slow economic growth but lead directly to faster economic growth and improved standards of living in both the exporting and importing countries by fostering specialization and the transfer of technology. In the process, jobs are created in both countries and both enjoy higher standards of living.

In recent years, U.S. imports of avocados, particularly from Mexico, have increased dramatically. The growing imports not only are expanding consumer food availability and choices but also, according to the economic theory of international trade, should be contributing positively to the U.S. economy. Imports of avocados from Mexico stimulate market activities along the avocado import supply chain and much beyond as the economic impact of those activities multiply through the economy. The question, however, is whether or not imports of Mexican avocados have actually contributed to the growth of the U.S. economy as might be expected. If so, then what is the level and industry distribution of the economic contribution of those imports? This study addresses these and related questions. After providing some background on the economic dimensions of U.S. avocado imports, this report then lays out the methodology used to analyze the impact of imports of Mexican avocados on the U.S. economy. Then, the analytical results are discussed with a focus on the aggregate, economy-wide impacts as well as industry breakdown of those impacts. Finally, the report reviews the major conclusions and implications of the analysis.

Economic Dimensions of Avocado Imports

U.S. imports of avocados, particularly from Mexico, increased steadily between 1989 and 2004 from just under 5,000 metric tons (mt) to about 145,000 mt in 2004, mostly as a result of growing imports from Chile (Figure 1). In 2005, however, a huge jump in avocado imports from Mexico from almost 39,000 mt to over 134,000 mt in 2006 boosted total U.S. imports by 80% to over 264,000 mt. Imports from Mexico have continued to accelerate at a blistering average annual rate of 150%, reaching over half a million mt in 2013. As a consequence, imports from Chile have steadily declined from a high of 114,892 mt in 2005 to only 23,298 mt last year. Total U.S. avocado imports reached almost 556,000 mt in 2013 with Mexico accounting for 92% of those imports compared to less than 1% in 1990 and only 27% in 2004.

Figure 1: U.S. imports of Mexican Avocados by Country of Origin, 1989-2013



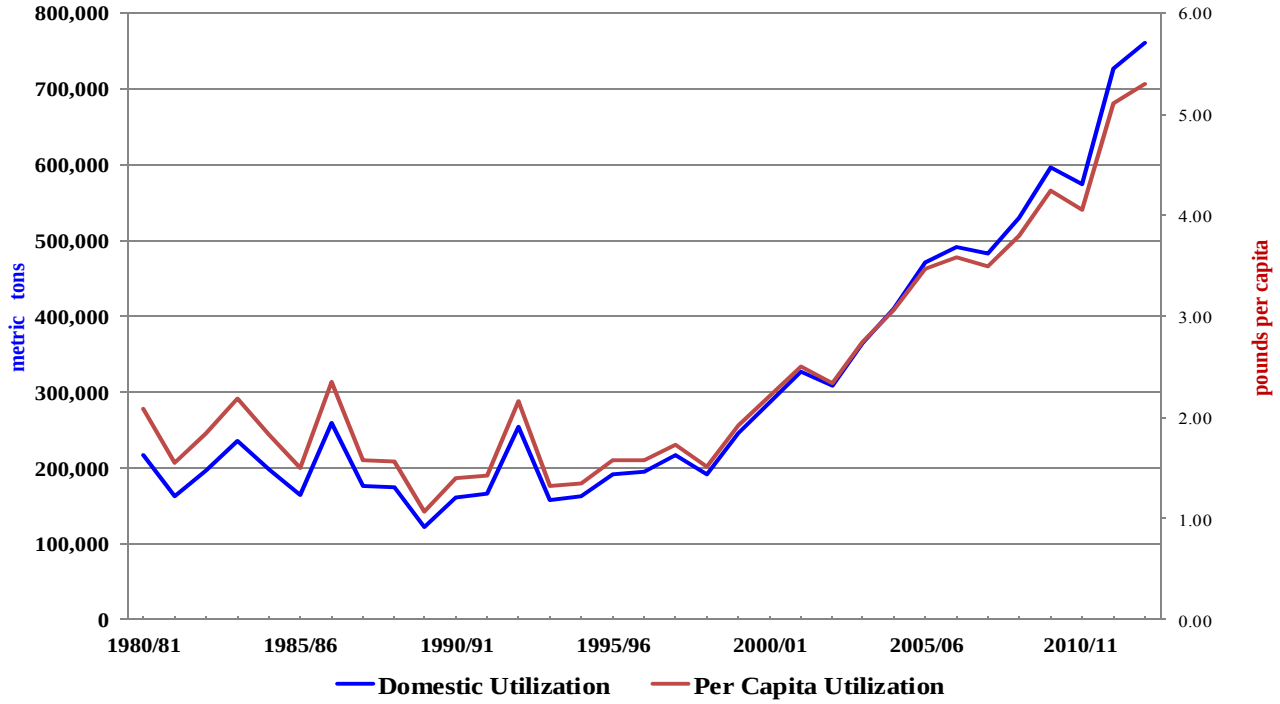
Along with the growth in volume of Mexican imports, the seasonal pattern of imports from Mexico has also broadened so that Mexican avocados are now consistently available year-round. Imports of avocados from Peru generally provide a boost to summer supplies while imports from Chile and the Dominican Republic provide a winter enhancement of domestic supplies. Occasional inflows come from New Zealand are also common.

The growth of U.S. avocado imports in recent years, particularly from Mexico, is mainly the result of two interrelated key forces – growth in U.S. consumer demand for avocados and the easing of U.S. import bans on Mexican avocados as a result of NAFTA negotiations. As imports grow, the U.S. avocado supply chain expands and multiplies the effects of the growing imports throughout the economy.

U.S. Avocado Consumption

Despite growing imports from Chile, annual U.S. avocado consumption varied only slightly between about 200,000 mt and 300,00 mt (about 1 lb to 2 lb per capita) through the 1980s into the early 2000s (Figure 2). Then in about 2002/03, consumption began to take off, more than doubling to 761,537 mt by 2013 with per capita consumption hitting a record 5.3 lb. The growth of imports from Mexico greatly facilitated that growth. The growing U.S. demand for

Figure 2: U.S. Domestic Utilization of Avocados, Total and Per Capita, 1980/81-2012/13



avocados is the result of various forces, including the growth of the U.S. Hispanic and Caribbean population, a rapidly spreading consumer trend towards ethnic as well as health-promoting foods, and intensifying promotion efforts by the U.S. avocado industry under the Hass Avocado Promotion, Research and Information Order established in 2002.

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 their own traditional dishes. At the same time, an explosion of fusion foods featuring Hispanic and Caribbean cuisine in the U.S. 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 lipoproteins or LDLs) and to help increase "good" cholesterol (high-density lipoproteins or HDL).

Avocados consumed in the western region of the U.S., and particularly California where over a third of the U.S. Hispanic population lives, are primarily of the Hass variety (Pollack and Perez, 2006). Although more than two dozen varieties of avocados are grown commercially in the United States, Hass avocados comprise 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 and Perez, 2006). Also, Hass is the variety most heavily promoted by the industry through the Hass Avocado Promotion and Research Order.

Green-skinned avocados are common in the eastern half of the U.S. 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 in size than Hass avocados and have less fat and more moisture (Pollack and 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

U.S. Import Bans on Avocado Imports

U.S. avocado consumption growth was constrained for many years by a USDA ban on imports of Mexican avocados implemented in 1914 to prevent entry of avocado seed weevils into the United States. The ban was partially lifted in 1993 when USDA allowed Mexican avocados to be shipped to Alaska under strict production and shipping requirements. The NAFTA agreement facilitated the easing of geographical and seasonal restrictions on Mexican avocado imports on three subsequent occasions leading to year-round access to all U.S. States except California, Florida, and Hawaii in 2005. Full access of Mexican avocados to all U.S. States was granted in 2007 although certain safeguards like annual field surveys and packinghouse requirements remain to protect against the entry of avocado pests. The easing of the U.S. import ban on Mexican avocados was undertaken as part of a systems approach to risk management in which sequential safeguards were put in place to progressively reduce risk. The idea was to insure that if one safeguard failed, other safeguards would be in place to help minimize the risk of pests or diseases (Roberts and Perez 2006).

The Avocado Import Supply Chain

Imported avocados are packed in the country of origin and shipped to U.S. markets to various buyers. A large majority of Mexican avocados come from Michoacán and Jalisco in Mexico by truck through Texas border crossings. The imported avocados may be shipped to wholesalers who distribute them to supermarkets and other retail establishments or processors.

Alternatively, imports may be shipped directly to supermarkets or to processors for value-added processing for sales to restaurants, fast-food establishments, and other retailers.

As avocados move from U.S. ports of entry to wholesalers, distributors, processors, 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 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 not only generate services and jobs at those points but also services and jobs along the supply chains that intersect at those points. For example, overland transportation 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 benefitted 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

In this study, we use two competing yet independent methodologies to measure the relationship between U.S. imports of avocados from Mexico and the U.S. economy. We first employ economic impact analysis and focus particularly on the contribution of avocado imports from Mexico in 2012 to the value of U.S. output, U.S. value-added, employment, labor income, and taxes paid (federal, local, and state-level) in that year. Then we 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 imports. The two

methodologies serve as checks on each other, providing independent measures 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 economic impact 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 impact that imports of Mexican avocado 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.

The general methodology employed is referred to as "economic impact analysis" (or 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 economic impact of the sale of imported avocados from Mexico through the import supply chain, we use the IMPLAN input-output system. 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 which estimate the total economic impact 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 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. Together, these different effects help to give 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 is those businesses which sell some or all of their goods and services to buyers outside of the community (Woods et al., 2007). Such a business is a considered to be a "basic industry". Figure 3 illustrates the major flows of goods, services, and dollars of any economy. The flows of products out of, and dollars into, a community are represented by the two arrows in the upper right portion of Figure 3. To produce these goods and services for "export" outside the community, the basic industry purchases inputs from outside of 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 3, 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).

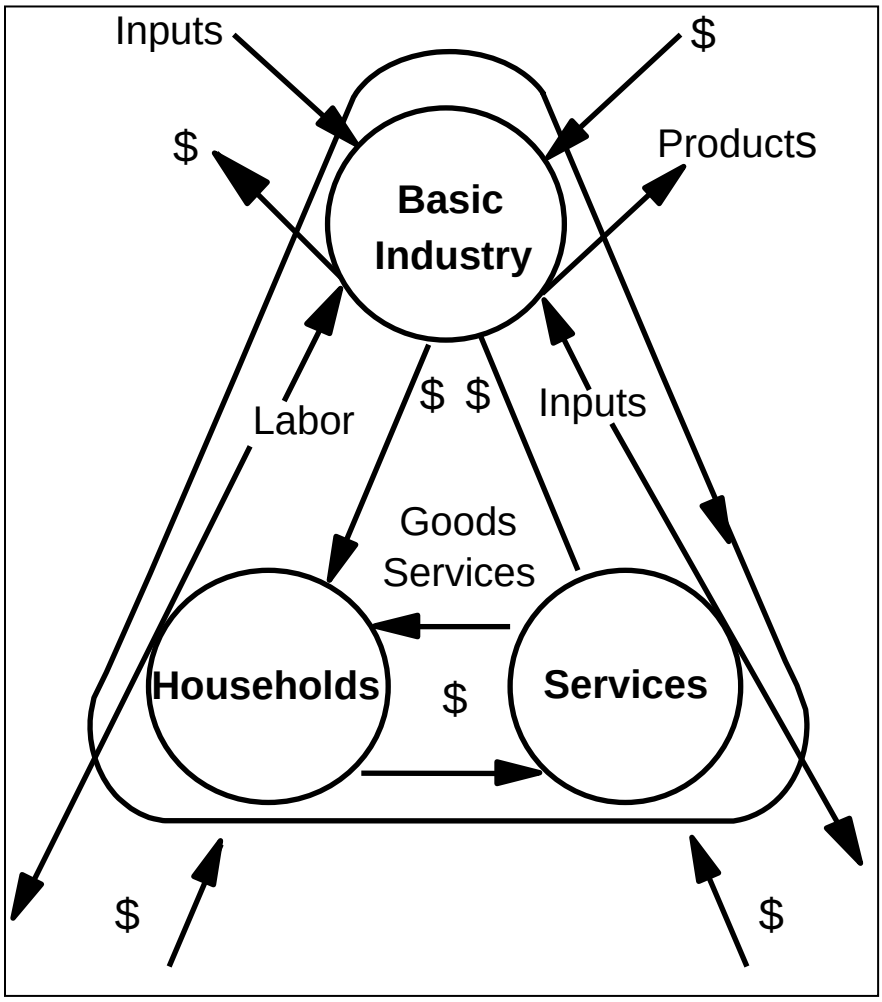
Econometric Analysis Methodology

In addition to the use of the IMPLAN analysis, we also conduct a quantitative, econometric analysis of the impact of Mexican avocado imports (shipments) on U.S. non-farm employment. In this analysis, we hypothesize that Mexican avocado shipments into the U.S. market have affected the number of total U.S. non-farm 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 over the January 2004 to December 2013 period. Through this procedure, we statistically estimate both the short-run and long-run impacts of avocado imports on U.S. employment. We use those statistical results to calculate the short-run and long-run elasticities of U.S. employment with respect to avocado imports from Mexico. The elasticities are measures of the percentage change in U.S. employment that occurs from each 1% change in avocado imports 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.

Figure 3: Overview of Community Economic System



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 avocado imports on the U.S. economy are 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). Then the avocado import impact 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 which reflects the number of U.S. jobs generated per million dollars 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 U.S. 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 inter-international transfers, and compute and create multipliers for the U.S. model. By constructing social accounts that describe the structure and function of a specific economy, IMPLAN creates a localized model to investigate the consequences of projected economic transactions in a geographic region (IMPLAN, 2013b).

With the U.S. model constructed, the next step in the analysis process was to determine what sector in IMPLAN to use in conducting the analysis of the avocado imports. IMPLAN consists of 440 different sectors from production to transportation, wholesale, manufacturing, retail, services and others. For this particular 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.

Within the U.S. model, the production function for the 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. 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 3436 – Noncomparable foreign imports". After modifying the coefficient for "Noncomparable foreign imports," the above mentioned selected commodity coefficients were set to zero, and the model's coefficients were re-balanced and saved. With the adjustments made to these coefficients, the model's multipliers were then re-constructed to reflect these coefficients changes. The reason for modifying these 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 domestically producing avocados. Further, with these adjustments it allows the backward leakages 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, 2013a). The value of avocado imports from Mexico to the U.S. for 2012 was then entered as the industry sales for the wholesale trade businesses sector event within the U.S. model. At this point in the analysis, IMPLAN requests whether gross retail sales or gross retail margin be selected. For this analysis, gross retail margin was selected in order to best reflect the producer price and not the purchase price. Producer prices are the prices received by the producer for the goods and services that are sold or the prices paid by the store to its suppliers (IMPLAN, 2013a). With the avocado import value entered in the model, the analysis of this industry change to the U.S. economy was conducted which entailed selecting and naming a scenario for the given "industry change" activity, analyzing a single region, whereby IMPLAN conducted direct, indirect, and induced impacts.

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 have a substantial impact on the U.S. economy along the avocado import supply chain which 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 $762.311 million of imports of Mexican avocados in 2012 on U.S. output or total spending amounted to $1.734 billion (Table 1). That is, the $762.311 million of U.S. imports of Mexican avocados in 2012 stimulated economic activity in the United States that generated a total of $1.734 billion in output or total spending. At the same time, the total economic activity stimulated by those imports added $1.231 billion in 2012 to the U.S. GDP (value-added), created $690.2 in U.S. labor income, $165.3 million in taxes (federal, state, and local), and added 11,248 jobs.

Implied Impact Multipliers

Every dollar of Mexican avocados imported in 2012 generated $2.27 in gross output, $1.59 in GDP (value-added), and $0.91 in labor income (Table 2). Every million dollars of imports generated 14.8 jobs in the U.S. economy. Taxes generated by the imports amounted to 21.3% of the value of the imported avocados (Table 2). Stated in this way, these impacts 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 $100 million increase in

Table 1: Summary Economic Impact of 2012 Avocado Imports

Output ($ million)	Value-added ($ million)	Employment (no. of jobs)	Labor Income ($ million)	Taxes* ($ million)
$1,734.0	$1,213.1	11,248	$690.2	$165.3
(0.01% of GDP)		(0.008% of U.S.)		

* federal, state, local.

Table 2: Impact Multipliers of 2012 Avocado Imports

Output Multiplier ($output/ $imports)	Value-added Multiplier ($VA/$imports)	Employment Multiplier (jobs added/$milllion imports)	Labor Income Multiplier ($income/ $imports)	Tax Multiplier (% of import value)
$2.27	$1.59	14.8	$0.91	21.3%

imports of Mexican avocados, U.S. output or spending increases by $227 million while GDP increases by $159 million, labor income by $91 million, and employment by 1,480 jobs.

Industry by Industry Breakdown of the Results

An industry breakdown of the economic impacts reveals that the wholesale/retail and service industries account for much of the contribution of imports of Mexican imports to U.S. economic activity as might be expected (Table 3). Together those two industries account for 86% of the contribution of imports of Mexican avocados to U.S. gross output, 92% of the contribution to the U.S. GDP (value-added), U.S. employment, and U.S. labor income, and 96% of the contribution to U.S. taxes. The manufacturing industry is also a major beneficiary of U.S. imports of Mexican avocados, accounting for nearly 9% of their contribution to gross output and 2-3% of the contribution made to GDP, labor income, employment, and taxes. Transportation and warehousing and a large number of miscellaneous services (such as 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 2012 Avocado Imports by Industry

Industry	Output ($ million)	Value-added ($ million)	Employment (no. of jobs)	Labor Income ($ million)	Taxes* ($ million)
Wholesale/Retail	$855.6	$707.8	5,615	$403.4	$146.5
Manufacturing	$151.0	$43.8	311	$22.3	$2.0
Transportation & Warehousing	$43.7	$26.9	383	$19.3	$1.3
Services	$636.3	$406.1	4,716	$232.1	$24.5
- Food & accommodation	$35.8	$19.5	571	$12.3	$2.6
- Other	$600.5	$386.6	4,145	$219.8	$21.9
Agriculture	$12.5	$4.9	111	$3.1	$0.2
Other	$35.0	$23.5	113	$10.0	$3.7
Total**	$1,734.0	$1,213.1	11,248	$690.2	$178.1

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

Econometric Analysis

As a check on the IMPLAN results, we also conducted a quantitative analysis of the impact of Mexican avocado imports (shipments) on U.S. non-farm employment. In this econometric analysis, the dependent variable corresponds to U.S. non-farm employment, seasonally adjusted, expressed in thousands of persons. We hypothesize that Mexican avocado shipments into the U.S. market positively affect the level of total non-farm workers, controlling for all other factors. In order to capture potential dynamics in this relationship, we posit a polynomial distributed lag (Almon lag) model.

Mathematically, the econometric model hypothesized is as follows:

(1) $US\_EMPLOYMENT\_SA\_FRED_t = f(MEXICO\_IMPORTS\_WQ_t, MEXICO\_IMPORTS\_WQ_{t-1}) + \text{random error}$

In equation (1), $US\_EMPLOYMENT\_SA\_FRED_t$, the dependent variable, is total non-farm payroll on a seasonally-adjusted basis in a given time period t. These data are collected on a monthly frequency by the U.S. Department of Labor, Bureau of Labor Statistics (BLS). Specifically, total non-farm payroll 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. This measure accounts for approximately

80% of the workers who contribute to the gross domestic product (GDP) of the U.S. economy. Generally, this level of employment, measured in thousands of persons, is subject to fluctuations due to seasonal changes in weather, major holidays, and other forces. The BLS adjusts the data to offset the seasonal effects. Between January 1990 to December 2013, the number of workers ranged from approximately 105 million to 140 million (Figure 4).

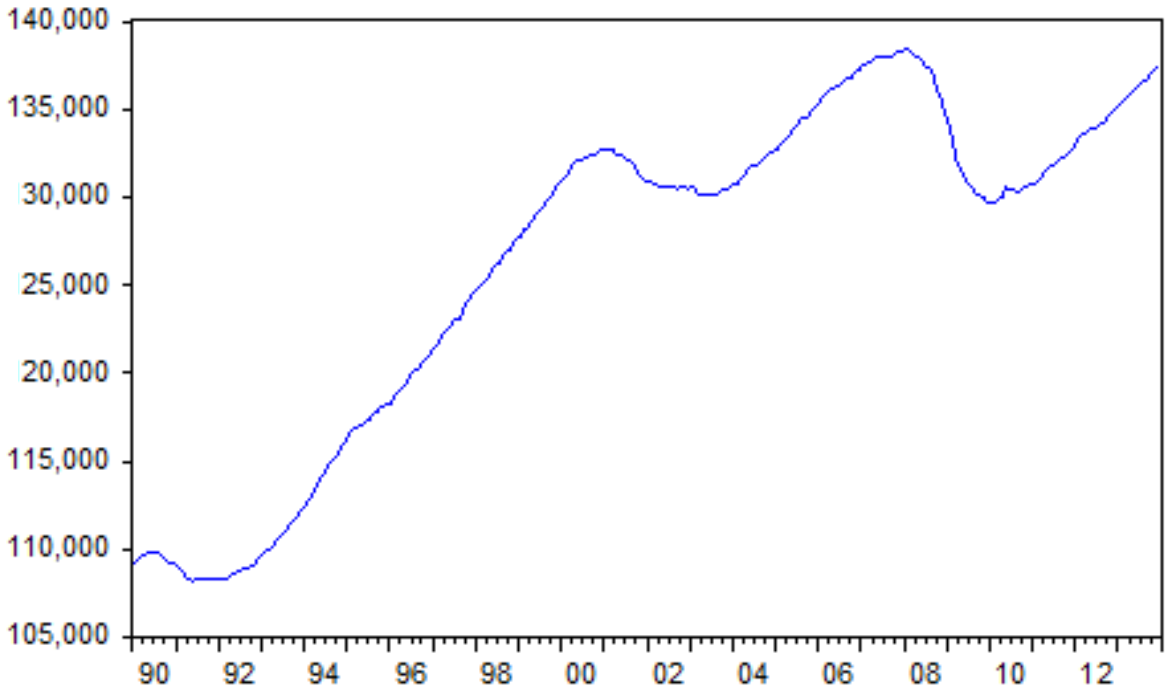
On the right-hand side of equation (1), $MEXICO\_IMPORTS\_WQ_t$ is an explanatory variable representing the volume of Hass avocados arriving into the U.S. market from Mexico in a given period t. Hass avocados also may arrive into the U.S. market internationally from Chile, the Dominican Republic, New Zealand, and Peru as well as domestically from California. The frequency of the volume of shipments from these respective suppliers is weekly. The data are available on the Hass Avocado Board website (www.hassavocadoboard.com). To minimize issues associated with restrictions on Mexican imports as well as to minimize structural change issues in the quantitative analysis, we employ data over the last ten years from 2004 to 2013.

Weekly volumes of Hass avocados arriving into the U.S. market from all suppliers (California, Mexico, Chile, the Dominican Republic, New Zealand, and Peru) are exhibited in Figure 5. Several observations are worth noting. First, the major suppliers of Hass avocados are California, Mexico, and Chile. On average, roughly two-thirds of the shipments originate from international suppliers and one-third from California. Second, the weekly volume of shipments from particular suppliers depends on the week in the calendar year. That is to say, a seasonal pattern exists in the volume of shipments from various suppliers. Third, Mexico commands the largest share of weekly shipments of Hass avocados, accounting for 48.7% of the shipments, followed by California at 33.4%, Chile at 16.5%, Peru at 0.7%, the Dominican Republic at 0.6%, and New Zealand at 0.05% (Figure 6). Obviously, New Zealand has not been a primary source of Hass avocados arriving into the U.S. market over the past decade.

To investigate the impact of Mexican avocado imports on the number of workers in the U.S. economy, the weekly shipment data was first aggregated to form compatible monthly data. Monthly volumes of Hass avocados arriving into the U.S. market from all suppliers (California, Mexico, Chile, the Dominican Republic, New Zealand, and Peru) are exhibited in Figure 6. Mexico supplied the largest average monthly volume of Hass avocados to the U.S. market over the period of January 2004 to December 2013 at 47.2 million pounds (48.3%) followed by California at 30.1 million pounds (33.2%), Chile at 13.4 million pounds (17.2%), Peru at 864,132 pounds (0.7%), the Dominican Republic at 353,490 pounds (0.5%), and New Zealand at only 33,795 pounds (0.04%) (Figures 7 and 8).

A seasonal pattern in the volume of shipments from the various suppliers is apparent. Avocado imports from Mexico arrive predominantly in January, March, April, and December while California and Chile are key suppliers in other months. Correlations among the volume

Figure 4: Total Non-Farm Payroll, Seasonally Adjusted, January 1990 to December 2013

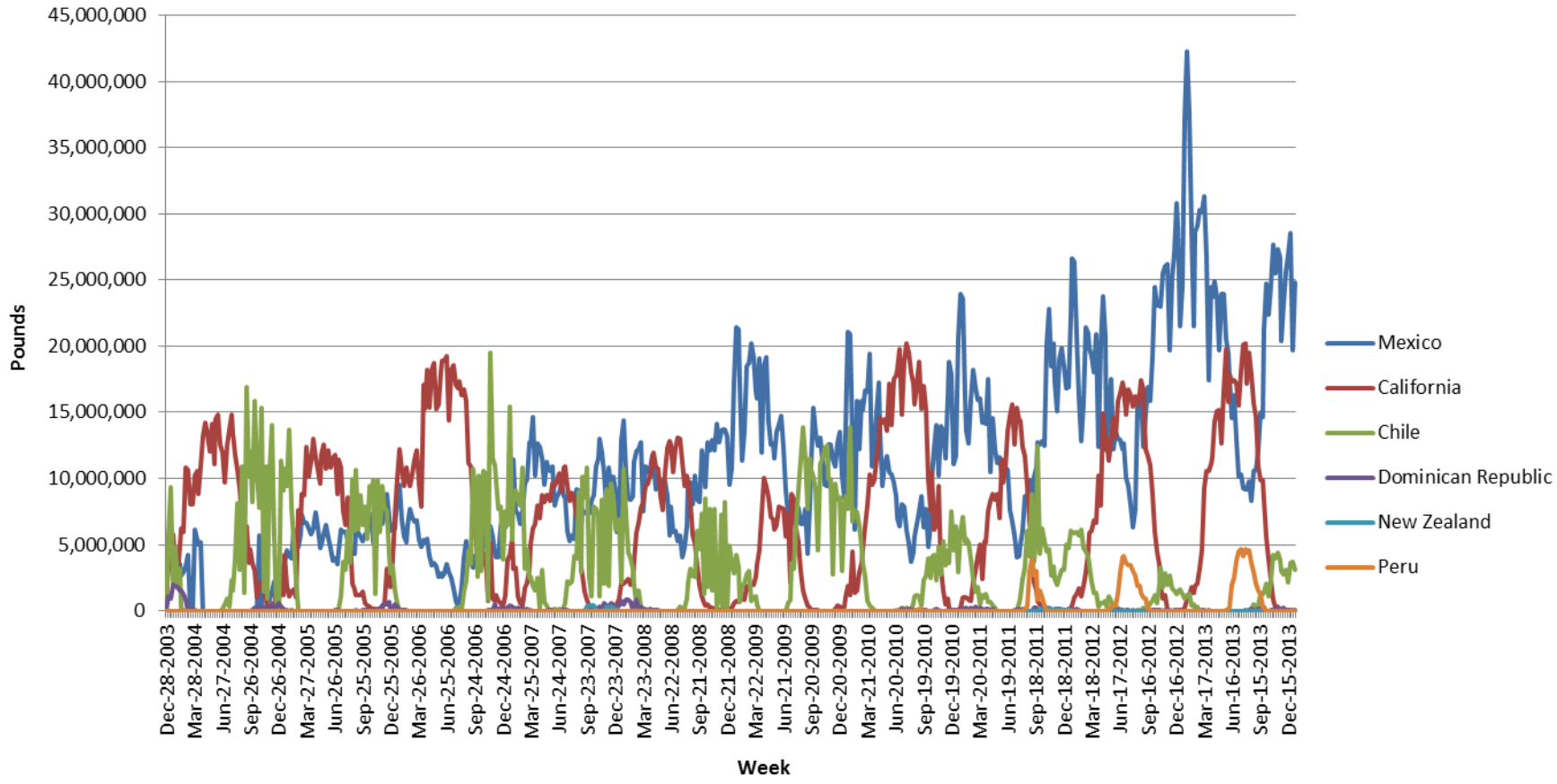


Source: U.S. Department of Labor, Bureau of Labor Statistics

of shipments from suppliers entering the U.S. market are modest. Except for California and Chile with a correlation of their monthly shipments of -0.68 and California and Peru with a correlation of 0.37, the remaining pair-wise correlations for monthly shipments by supplier ranged from -0.29 (Mexico and California) to 0.19 (New Zealand and Chile).

In statistical terms, about 92% of the monthly changes in the level of Mexican imports of Hass avocados coming into the U.S. market over the ten year period of January 2004 through December 2013 can be explained by seasonality, trend, and cyclical factors as shown in Table 4. The variables @SEAS(1) through @SEAS(11) in Table 4 refer to monthly dummy variables (@SEAS(1) representing the month of January, @SEAS(2) representing the months of February and so on through @SEAS(11) representing the month of November). The base or reference month is arbitrarily selected to be December. The variable @TREND is a time trend where January 2004 is 0, February 2004 is 1, March 2004 is 3, and so on to 120 for December 2013. The variables AR(1) and AR(6) refer to the cyclical pattern of monthly imports from Mexico. The seasonality variables indicate that Hass avocado shipments from Mexico are significantly higher in January and March relative to December but significantly lower in June, July, August, and September relative to December over this ten-year period. An upward trend is evident in imports from Mexico as well over this ten-year period. The month-to-month growth in the level of Mexican shipments is roughly 726,505 pounds.

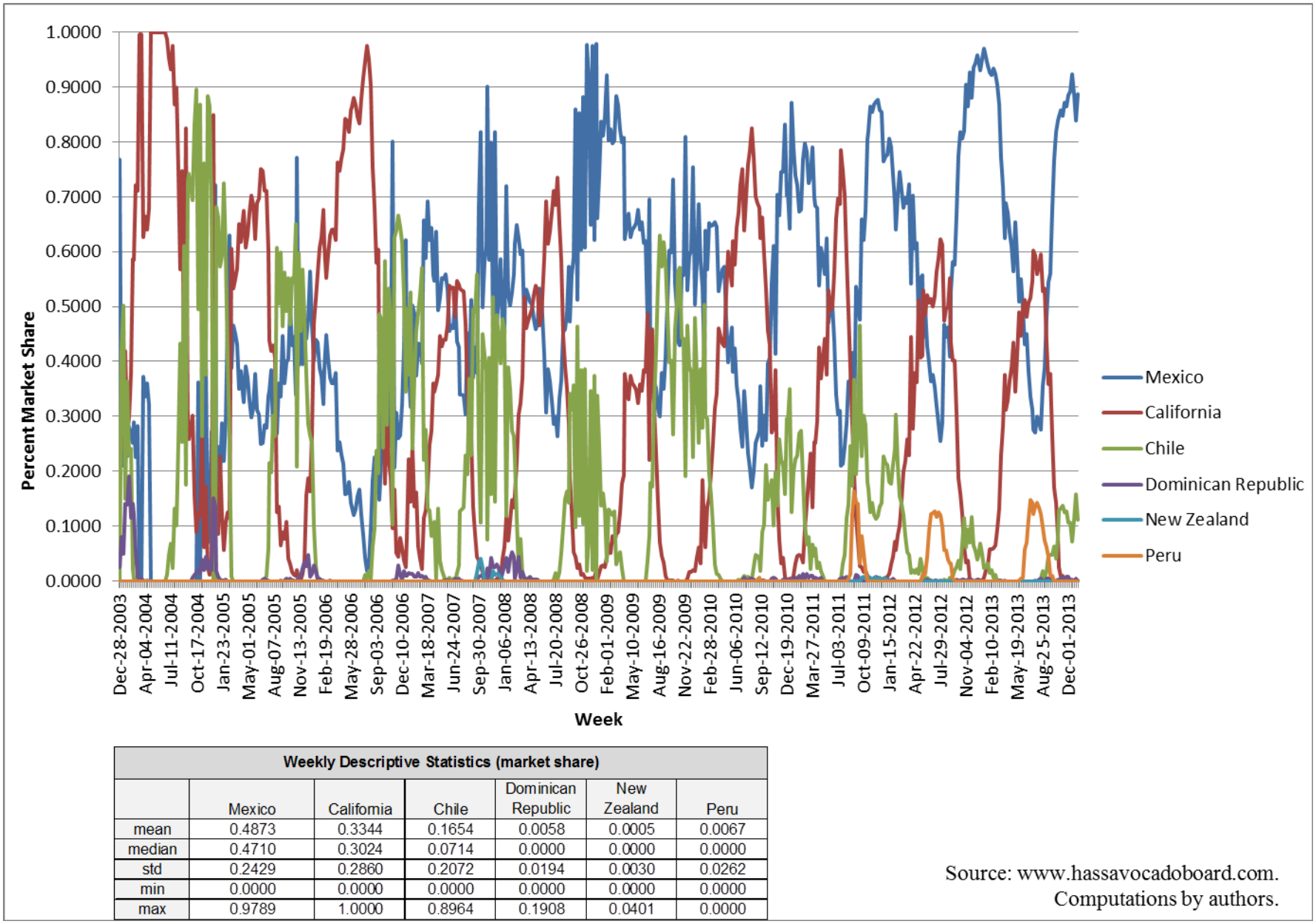
Figure 5: Weekly Shipment by Volume of Avocados Arriving into the U.S. Market from All Suppliers, 2004 to 2013



Weekly Descriptive Statistics (pounds)						
	Mexico	California	Chile	Dominican Republic	New Zealand	Peru
mean	10,835,302	6,861,449	3,088,383	81,980	7,739	192,859
median	9,564,324	6,200,513	1,427,356	0	0	0
std	7,246,232	5,961,887	3,784,708	221,333	43,228	765,163
min	0	0	0	0	0	0
max	42,272,704	20,183,825	19,503,350	1,939,350	415,025	4,694,452

Source: www.hassavocadoboard.com.
Computations by authors.

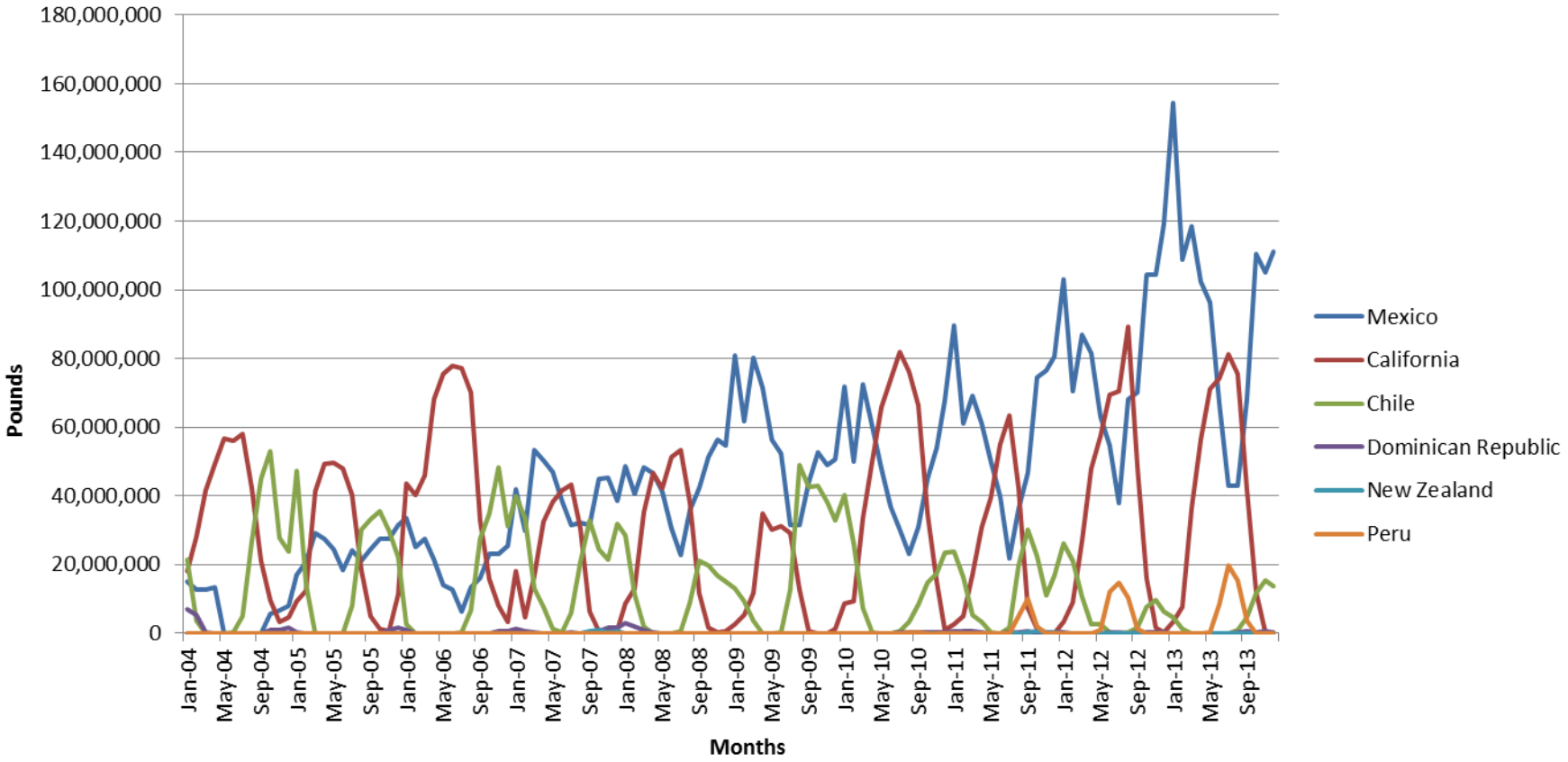
Figure 6: Weekly Market Share of Avocados into the U.S. Market from All Suppliers, 2004 to 2013



Weekly Descriptive Statistics (market share)						
	Mexico	California	Chile	Dominican Republic	New Zealand	Peru
mean	0.4873	0.3344	0.1654	0.0058	0.0005	0.0067
median	0.4710	0.3024	0.0714	0.0000	0.0000	0.0000
std	0.2429	0.2860	0.2072	0.0194	0.0030	0.0262
min	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
max	0.9789	1.0000	0.8964	0.1908	0.0401	0.0000

Source: www.hassavocadoboard.com.
Computations by authors.

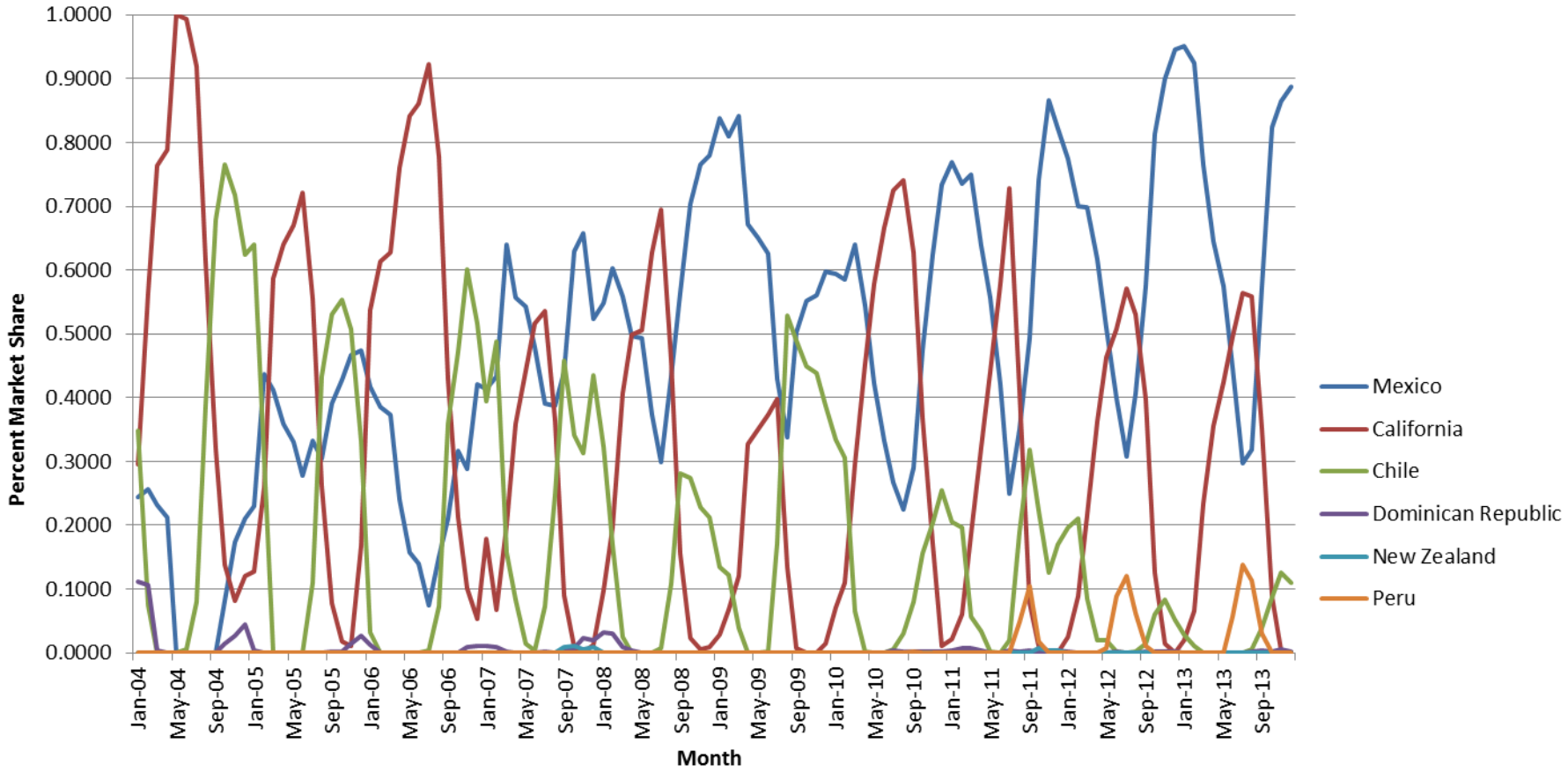
Figure 7: Monthly Shipment by Volume of Avocados Arriving into the U.S. Market from All Suppliers, 2004 to 2013



Monthly Descriptive Statistics (pounds)						
	Mexico	California	Chile	Dominican Republic	New Zealand	Peru
mean	47,200,777	30,079,252	13,446,746	353,490	33,795	864,132
median	42,916,968	29,767,468	8,189,523	40,157	0	0
std	30,234,497	25,585,571	14,367,285	884,308	138,330	3,187,858
min	0	11,571	0	0	0	0
max	154,503,836	89,272,832	53,025,282	6,812,368	836,275	19,735,272

Source: www.hassavocadoboard.com;
Computations by authors.

Figure 8: Monthly Market Share of Avocados into the U.S. Market from All Suppliers, 2004 to 2013



Monthly Descriptive Statistics (market share)						
	Mexico	California	Chile	Dominican Republic	New Zealand	Peru
mean	0.4833	0.3320	0.1723	0.0052	0.0004	0.0067
median	0.4742	0.3214	0.0836	0.0005	0.0000	0.0000
std	0.2306	0.2772	0.1998	0.0154	0.0018	0.0243
min	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000
max	0.9510	1.0000	0.7657	0.1112	0.0117	0.1372

Source: www.hassavocadoboard.com.
Computations by authors.

Table 4: Econometric Model of Mexican Imports of Hass Avocados Entering the U.S. Market, January 2004 to December 2013

Dependent Variable: MEXICO_IMPORTS_WQ
Sample (adjusted): 2004M07 2013M12
Included observations: 114 after adjustments
Convergence achieved after 12 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.11E+08	13751842	-8.092923	0.0000
@SEAS(1)	17950989	3079203.	5.829752	0.0000
@SEAS(2)	-1472089.	4179243.	-0.352238	0.7254
@SEAS(3)	10765483	4913764.	2.190883	0.0308
@SEAS(4)	2514704.	5426884.	0.463379	0.6441
@SEAS(5)	-7539092.	5796255.	-1.300683	0.1964
@SEAS(6)	-18581085	6010335.	-3.091522	0.0026
@SEAS(7)	-29959044	5707741.	-5.248845	0.0000
@SEAS(8)	-25199389	5285682.	-4.767481	0.0000
@SEAS(9)	-19347380	4729561.	-4.090735	0.0001
@SEAS(10)	-3475482.	3996960.	-0.869531	0.3867
@SEAS(11)	-3458944.	2936240.	-1.178018	0.2416
@TREND	726504.9	57359.46	12.66583	0.0000
AR(1)	0.771957	0.062013	12.44835	0.0000
AR(6)	-0.191352	0.064656	-2.959552	0.0039

R-squared	0.930091	Mean dependent var	49213839
Adjusted R-squared	0.920204	S.D. dependent var	29779644
S.E. of regression	8412190.	Akaike info criterion	34.85034
Sum squared resid	7.01E+15	Schwarz criterion	35.21037
Log likelihood	-1971.469	Hannan-Quinn criter.	34.99646
F-statistic	94.07981	Durbin-Watson stat	1.914094
Prob(F-statistic)	0.000000		

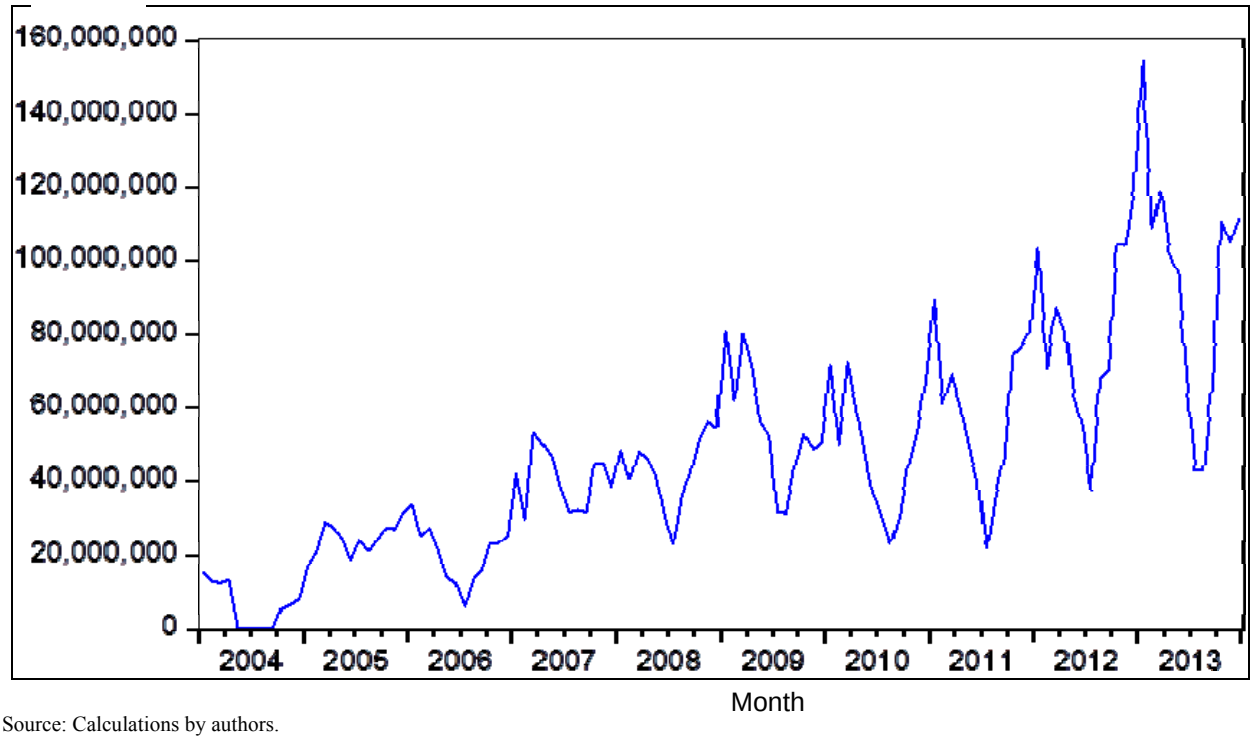
Inverted AR Roots	.84+.32i	.84-.32i	.11+.71i	.11-.71i
	-.56-.37i	-.56+.37i		

Source: Computations by the authors using EVIEWS 8.0.

A graphical depiction of the monthly level of only Mexican avocados arriving into the U.S. market is given in Figure 9. This figure clearly demonstrates the upward trend in the level of Mexican avocados, the seasonal pattern, and the cyclical pattern. The corresponding monthly number of workers in the U.S. economy (total non-farm payroll) is exhibited in Figure 10. This measure of unemployment ranges from 129.6 million to 138.3 million over the period January 2004 to December 2013.

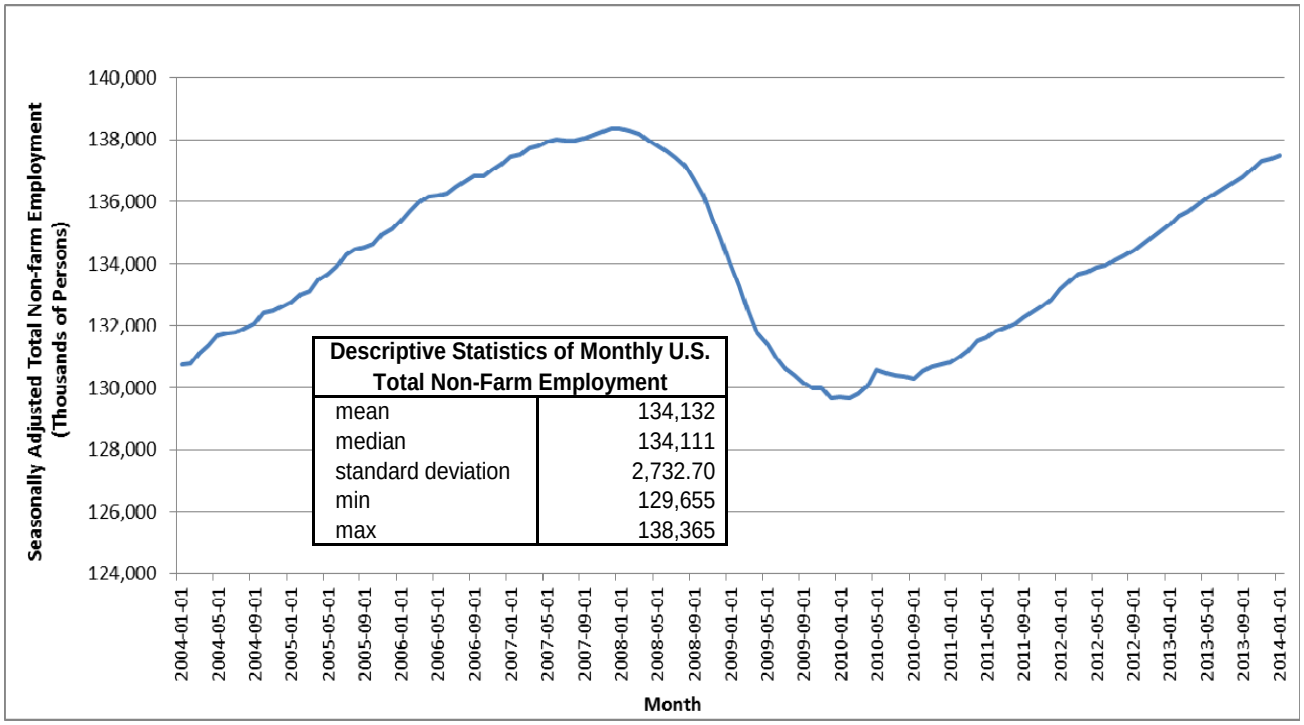
Figure 11 is a scatter diagram of the relationship between total non-farm payroll and Mexican imports of Hass avocados. Note the positive relationship between our measure of U.S. employment and the level of Mexican imports of Hass avocados.

Figure 9: Volume of Mexican Avocados Arriving into the U.S. Market, January 2004 to December 2013



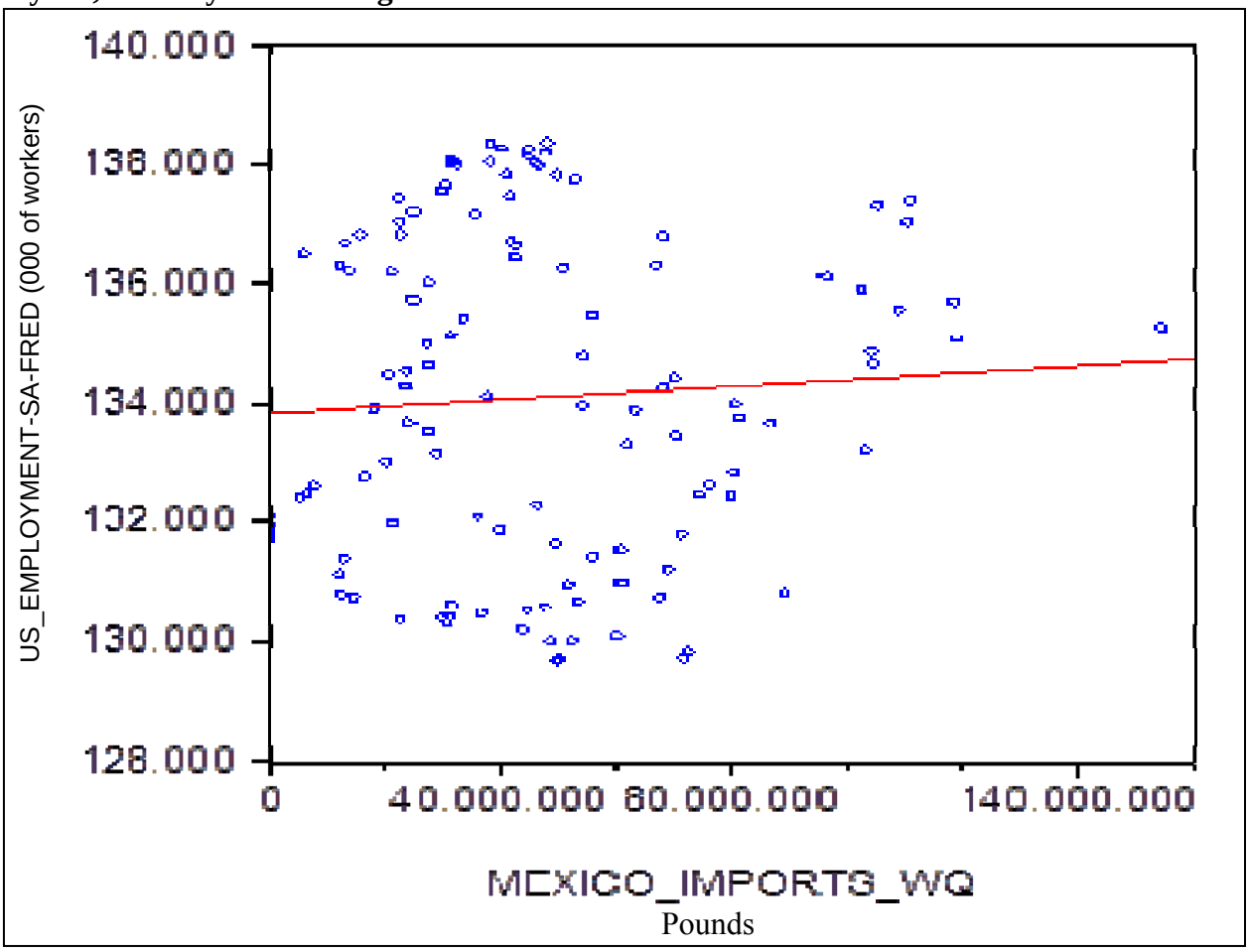
Source: Calculations by authors.

Figure 10: Monthly U.S. Total Non-Farm Employment, 2004 to 2013



Source: Department of Labor, Bureau of Labor Statistics

Figure 11. Scatter Diagram of Monthly Mexican Imports of Avocados and Total Non-Farm Payroll, January 2004 through December 2103



Source: Calculations by authors.

To analyze the impact of Mexican shipments of avocados to the U.S. market on the number of workers in the U.S. economy, we estimate the model generically represented in equation (1). The empirical analysis is summarized in Table 5.

In this econometric specification, we allow for a nonlinear as well as a dynamic relationship between U.S. employment and Mexican imports of avocados. The nonlinearity of the functional representation is accomplished with the use of the logarithm of the dependent variable (number of U.S. workers in thousands) and the square root of the explanatory variable (Mexican imports of Hass avocados in pounds). The dynamics of this relationship is represented through the use of a second-degree polynomial distributed lag with two lags and the use of endpoint restrictions. This optimal lag length and 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).

Table 5: 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: Least Squares
Included observations: 115 after adjustments; Convergence achieved after 7 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	11.80624	0.008249	1431.252	0.0000
US_RECESSIONS(-10)	-0.001612	0.000544	-2.961980	0.0037
PDL01	1.15E-07	6.87E-08	1.677120	0.0964
AR(1)	1.445334	0.023182	62.34748	0.0000
AR(3)	-0.456013	0.023195	-19.65977	0.0000

R-squared	0.998056	Mean dependent var	11.80713
Adjusted R-squared	0.997985	S.D. dependent var	0.020225
S.E. of regression	0.000908	Akaike info criterion	-11.12832
Sum squared resid	9.07E-05	Schwarz criterion	-11.00897
Log likelihood	644.8783	Hannan-Quinn criter.	-11.07988
F-statistic	14115.57	Durbin-Watson stat	1.818093
Prob(F-statistic)	0.000000		

Inverted AR Roots	.97-.08i	.97+.08i	-.49

Lag Distribution of SQRT_MEXICO_IMPORTS	i	Coefficient	Std. Error	t-Statistic
. * |	0	8.6E-08	5.2E-08	1.67712
. *|	1	1.2E-07	6.9E-08	1.67712
. * |	2	8.6E-08	5.2E-08	1.67712
	Sum of Lags	2.9E-07	1.7E-07	1.67712

Source: Computations by the authors using EVIEWS 8.0.

During this last ten years, the U.S. economy was in recession from December 2007 to June 2009. To capture the impact of this recessionary period on U.S. employment, we use a zero-one indicator variable, 1 for the time period December 2007 to June 2009 and 0 otherwise. We considered contemporaneous and lags of this indicator variable. Again on the basis of model selection criteria, the optimal lag for this variable associated with the recessionary period was 10 months.

As indicated in Table 5, more than 99% of the variability in total non-farm payroll is accounted for by the ten-month lag of the recessionary period and the two-month polynomial distributed lag of Mexican imports of Hass avocados. 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) term and the AR(3) term. Hence the error term follows an autoregressive process of order 1 and of order 3.

The econometric model results in Table 5 also indicate that the U.S. recession from December 2007 to June 2009 negatively affected the total non-farm payroll. The number of workers in the U.S. economy was lower by 0.16% during this recession relative to the non-recessionary period.

The impact of the recessionary period was not contemporaneous. This impact on total non-farm employment was delayed by 10 months.

Also, the results indicate clearly that a rise (fall) in the volume of Mexican imports of avocados results in a rise (fall) in the level of U.S. employment. 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 two months, Mexican imports of Hass avocados have a contemporaneous or short-run impact on U.S. employment as well as a 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 two months later. The magnitudes of the short-run and the long-run impacts differ by a factor of 3.37.

We consider now marginal effects, that is, changes in the level of the number of workers in the U.S. economy attributable to unit changes in the level of Mexican imports of avocados. These marginal effects depend on three factors: (1) the estimated coefficients (both short-term and long-term) associated with the level of Mexican imports, (2) the number of workers in the U.S. economy, and (3) the level of Mexican imports. Put another way, the marginal effects vary by calendar year due to variations in Mexican imports of avocados and in the number of U.S. workers.

Table 6 provides the short-run and long-run or cumulative average impact of a million pound change in shipments of Mexican avocados on total non-farm payroll (non-farm workers) for calendar years 2004 through 2013. Over the entire period of 2004 through 2013, the incremental impact of a million pound increase in shipments of Mexican avocados on U.S. employment ranged from a high of 1,823 in 2004 to a low of 638 in 2013 in the short run and from a high of 6,148 in 2004 to a low of 2,151 in 2013 over the long run. As can be seen in Table 6, the marginal effects of Mexican avocado shipments on U.S. employment have been on the decline, with some exceptions.

Another way to summarize the impact of changes in Mexican shipments of avocados on total non-farm payroll is through the use of elasticities. Elasticities measure the impact of the change in one variable on another in percentage terms. An elasticity is calculated as the percentage change in a first variable divided by the corresponding percentage change in a second variable. If the percentage change in first variable is greater than the percentage change in the second variable then the calculated elasticity is greater than 1. In that case, the relationship of the first variable relative to the second variable is termed “elastic.” Conversely, if the percentage change in first variable is smaller than the percentage change in the second variable then the calculated elasticity is less than 1. In that case, the relationship of the first variable relative to the second variable is

Table 6: Short-Run and Long-Run Impacts of a Million Pound Increase in Mexican Imports of Avocados on the Number of Workers in the U.S. Economy

Year	Short-Run Impact	Long-Run Impact
2004	1,823	6,148
2005	1,180	3,978
2006	1,399	4,719
2007	946	3,190
2008	918	3,095
2009	784	2,643
2010	836	2,820
2011	780	2,630
2012	666	2,247
2013	638	2,151
Overall from 2004 to 2013	961	3,241

Source: Calculations by authors.

termed "inelastic." Because elasticities are calculated as the ratio of percentage changes, they are not sensitive to units of measurement.

Based on the marginal effects calculated from the results in Table 6, the short-run and long-run elasticities of U.S. non-farm employment relative to Mexican shipments of avocados for each calendar year are provided in Table 7. These elasticities, like the marginal effects, vary by year due to the nonlinear relationship between Mexican imports of avocados and total non-farm payroll. Note that these elasticities are quite small (inelastic) as would be expected. For example, for calendar year 2013, the short-run elasticity of total non-farm payroll attributable to Mexican imports of avocados is 0.00041043 while the long-run or cumulative elasticity is 0.00138402. On average over the full period of 2004 to 2013, a one-percent increment in the volume of Mexican avocados entering the U.S. market leads to a short-run increase of 0.0002884% in total non-farm payroll (the short-run elasticity) and to a cumulative (over two months) impact of 0.00097265% (the long-run elasticity). Hence, over the period, a one-percent change in the volume of Mexican shipments of avocados (equivalent to 472,008 pounds on average) translates into an immediate change (one-month) of roughly 393 workers in the U.S. economy and into a cumulative change of about 1,326 workers in the U.S. economy (over two months).

To compare these results with those from those of the IMPLAN model for the calendar year 2012, we can use the calculated elasticities to calculate the change in U.S. employment in 2013 from the change in Mexican shipments of avocados that year. The volume of Mexican shipments of avocados grew by 17.01% percent on average from 2012 to 2013. The short-run elasticity of Mexican shipments of avocados on total non-farm payroll for calendar year 2012 is 0.00038128

Table 7: Short-Run and Long-Run Elasticities for Total Non-Farm Payroll Due to Unit Percentage Changes in the Level of Mexican Imports of Avocados, 2004 to 2013

Year	Short-Run Elasticities	Long-Run Elasticities
2004	0.00008046	0.00027132
2005	0.00021170	0.00071389
2006	0.00018943	0.00063878
2007	0.00027208	0.00091749
2008	0.00028077	0.00094678
2009	0.00031604	0.00106571
2010	0.00029727	0.00100242
2011	0.00032475	0.00109510
2012	0.00038128	0.00128571
2013	0.00041043	0.00138402
Overall from 2004 to 2013	0.00028844	0.00097265

Source: Calculations by authors.

and the long-run elasticity is 0.00128571. Consequently, the impact of this 17.01% change in Mexican avocado shipments (13,670,075 pounds) entering the U.S. market was a change of 8,697 workers in the U.S. economy in the short-run (on-month on average) and a change of 29,326 workers in the long-run (over two months on average).

Instead of the elasticities, we can use the calculated marginal effects provided in Table 6 to determine the effects of the same change in Mexican shipments of avocados on U.S. employment. In this case, the results are quite similar to those obtained using elasticities. In this case, the increase of Mexican shipments of avocados by 13,670,075 pounds between 2012 and 2013 results in an increase of 9,108 U.S. workers in the short-run and an increase of 30,713 workers in the long-run.

Our estimate of the number of jobs attributable to the Mexican imports of avocados in 2012 from the IMPLAN model was 11,248 which falls easily into the interval of 8,697 to 9,108 additional workers in the short-run to 29,326 to 30,713 additional workers in the U.S. economy in the long-run for calendar year 2012 estimated using the elasticities and marginal effects, respectively, from the econometric model discussed in this section. Thus, our results are robust with respect to the impact of Mexican imports of avocados on employment levels in the U.S. economy. We can, therefore, conclude with a high degree of statistical confidence that the IMPLAN results are accurate in their measurement of the effects of Mexican avocado imports on the U.S. economy.

Conclusions and Implications

The primary conclusion from this study is that imports of avocados from Mexico have a positive and statistically significant effect on the U.S. economy. Specifically, this study finds that Mexican avocados contributed the following to the U.S. economy in 2012:

- $1.7 billion in output or spending;
- $1.2 billion to the U.S. GDP (value-added);
- 11,248 jobs;
- $690 million in labor income; and
- $165 million in taxes;

The study finds that every dollar of avocado imports from Mexico generates $2.27 dollars in output, $1.59 in U.S. GDP, and $0.91 in labor income. Every million dollars of imports generates 14.8 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 2012 added between 9,000 workers and 30,000 workers to the U.S. economy in that year, a result consistent with the 11,248 jobs added found in the IMPLAN analysis.

The implication of this study is straight forward. Imports of Mexican avocados are pro-growth for the U.S. economy. Given the steep predicted growth path of imports of Mexican avocados, their currently positive contribution to the U.S. economy will only intensify over the years. Any trade policy or other actions to reduce the level of avocado imports would have a substantial and growing negative impact on the U.S. economy.

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