Potential Economic Impact of Cold Inspection Facility Upgrade at Mariposa Port of Entry, Nogales, AZ

Dari Duval, Ashley K. Bickel, & George Frisvold
University of Arizona Cooperative Extension
Department of Agricultural & Resource Economics
December 2018

REVISED SEPTEMBER 2019

Prepared for:
Fresh Produce Association of the Americas

THE UNIVERSITY OF ARIZONA
COLLEGE OF AGRICULTURE & LIFE SCIENCES
Cooperative Extension

COLLEGE OF AGRICULTURE & LIFE SCIENCES
Agricultural & Resource Economics

Executive Summary

What is the issue?

The industry cluster specializing in the importation and handling of fresh produce is a key driver of the local economy of Santa Cruz County and to Arizona more broadly. The county's Nogales port of entry is a top port nationally for shipments of fresh fruits and vegetables from Mexico, the United States' top source of imported fresh produce. While historically a leader in handling imports, Nogales' port facilities currently lack a cold inspection facility. This lack of infrastructure is likely a contributing factor to shippers' decisions to transport highly perishable, high value commodities such as berries and avocados through other ports of entry that have cold inspection facilities.

This study estimates the volume and value of fresh produce currently diverted to other ports of entry that could potentially travel through the Mariposa Port of Entry given existing agricultural production in the Mexican states of Sonora, Sinaloa, Nayarit, and Jalisco (supply) and the estimated consumer demand in the U.S. states of Arizona, Utah, Nevada, Idaho, and Montana (demand), informally known as the CANAMEX trade corridor. Potential increases in trade flows for select perishable produce commodities (asparagus, avocados, blackberries, raspberries, and strawberries) through Nogales are then used to estimate the economic impacts to the Arizona economy.

What did the study find?

Increasing the share of imports from Mexico flowing through Nogales for asparagus, avocados, blackberries, raspberries, and strawberries to meet the demand of the share of the U.S. population living in the trade transportation corridor ranging from Arizona north to Canada (Arizona, Utah, Nevada, Idaho, and Montana) would lead to an estimated increase of between 108 million and 121 million pounds of additional produce imported through Nogales, representing between $134 million and $150 million per year in additional imports by value moving through the port (2017 prices). An increase in imports of this magnitude corresponds to additional wholesale margins generated for Santa Cruz County fresh produce companies of between $23 million and $26 million per year. That net new economic activity in the state would lead to the following estimated annual economic impacts to the state economy, including multiplier effects:

- Between $43 million and $48 million in additional output (sales)
- Between $27 million and $30 million increase in gross state product (value added)
- Between 214 and 241 additional jobs
- Between $15 million and $17 million in labor income (wages and business owner income)
- Between $3.7 million and $4.1 million in additional state and local tax revenues

Considering business owner income and profits directly generated by just 25% of the modeled increases in trade flows (held constant over 15 to 20 years), investment in a cold storage inspection facility would have an internal rate of return (IRR) of between 154% and 191%. Furthermore, a benefit-cost analysis of investment in the cold storage facility found that even if only 25% of the modeled trade flows were realized (and held constant over 15 to 20 years), the project would have a benefit-cost ratio ranging from 3.4:1 to 5.1:1 over its functional life. If higher levels of trade flows were realized, the benefit cost ratio could reach as high as 20:1. These metrics of project viability are not inclusive of the aforementioned regional economic impacts, including increases in employment, labor income, and state and local tax revenues that accrue to the state and local economy.

How was the study done?

This study estimates the volume and value of fresh produce currently diverted to other ports of entry that could potentially travel through the CANAMEX trade corridor, from the Mexican states of Sonora, Sinaloa, Nayarit, and Jalisco to the U.S. states of Arizona, Utah, Nevada, Idaho, and Montana. Potential increases in trade flows for select perishable produce commodities (asparagus, avocados, blackberries, raspberries, and strawberries) through Nogales are, in turn, used to estimate the economic impacts to the Arizona economy. In this study, estimates of consumer demand are limited to states within the CANAMEX trade corridor. Current fresh produce shipments through Nogales are destined for markets beyond the transportation corridor examined in this analysis, for example, to California, Oregon, and Washington. Additional demand in the Western U.S. represents additional opportunity for growth, considering that some produce is currently shipped through Nogales for delivery to California, Oregon, and Washington, as well as through trans-shipments to Canada.

This study uses existing value and volume of fresh produce trade flows from Mexico to the U.S. both nationally and by port of entry to estimate potential changes in the shares of perishable fresh produce commodities that might flow through the Nogales port of entry. These shares are based upon estimates of consumer demand within the U.S. portion of the trade corridor and supply produced within the Mexican portion of the trade corridor[1]. Direct sales and employment impacts are estimated using data on wholesale margins and county-level employment and wage data. Economic multiplier effects and tax impacts are calculated using the IMPLAN 3.1 input-output model.

[1] Currently, Michoacán is the only state in which avocado growers are approved to export their product to the U.S. market. There is a possibility that avocado growers in Jalisco will receive approval to export to the U.S. in the near future. Avocado supply estimates used in this analysis are based upon production in Jalisco.

Contents

Figures

Tables

Introduction

Nogales, Arizona's Mariposa Port of Entry is one of the most important ports of entry into the U.S. for shipments of fresh fruits and vegetables from Mexico. In terms of value in 2017, it handled the largest share of vegetables of any port of entry between the U.S. and Mexico and the third largest share of fruits and nuts. Top commodities transported through Nogales include grapes, mangoes, chiles and peppers, cucumbers, and tomatoes. Meanwhile, Nogales lags behind other ports in its handling of shipments of avocados, strawberries, raspberries and blackberries, asparagus, and other, more delicate commodities. A contributor to this discrepancy is the lack of cold inspection facilities for perishable fruit and vegetable commodities.

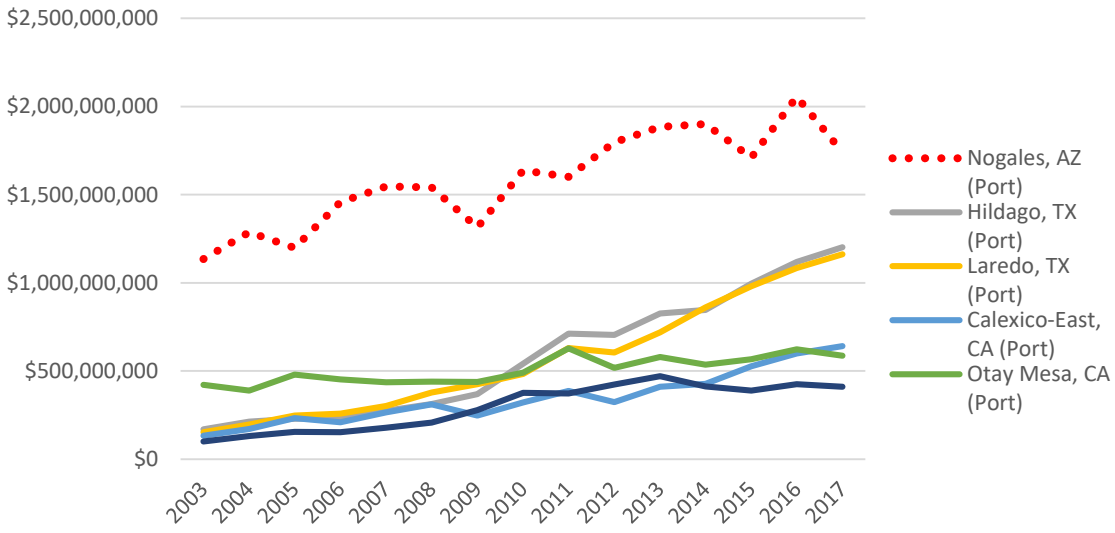
For many fresh produce items, maintaining a continuous cold chain between harvest, packing, storage, transportation, and inspection is essential to reduce spoilage, maximize shelf life, and reduce the likelihood that shipments will be rejected by end-buyers (PMA, 2016; Bachmann & Earles, 2000). This can lead shippers to use other, potentially more circuitous routes through ports where cold inspection facilities are available. Anecdotally, this lack of a cold inspection facility limits the capacity of the Nogales port to handle certain highly perishable produce commodities, particularly during shoulder-season months in the spring and fall when those commodities are in season and high temperatures are common in Southern Arizona. Were a cold inspection facility to exist at Mariposa Port of Entry, fresh fruit and vegetable merchant wholesalers in Santa Cruz County, Arizona may be able to attract a higher volume of shipments during shoulder or off-peak months of the year and expand employment to handle additional volume.

This study estimates the volume and value of fresh produce currently diverted to other ports of entry that could potentially travel through the Mariposa Port of Entry given existing agricultural production in the Mexican states of Sonora, Sinaloa, Nayarit, and Jalisco and the estimated consumer demand in the U.S. states of Arizona, Utah, Nevada, Idaho, and Montana. Using these estimates of increases in trade flows through Nogales, we derive estimates of the effects of those increased sales on the state and local economy. The study estimates the direct impact on jobs and wages in Santa Cruz County as well as the total impact to the state economy including multiplier effects. Furthermore, we present a benefit-cost analysis of the facility over its potential lifecycle, as well as an estimate of the project's internal rate of return.

Background

Nogales, AZ's Mariposa Port of Entry is one of the top ports of entry into the United States for imports of fresh produce from Mexico. Major import commodities shipped through Nogales include tomatoes, cucumbers, bell peppers, grapes, and mangoes. Nogales has long been the top port of entry for fresh vegetables from Mexico in terms of value of imports (Figure 1).

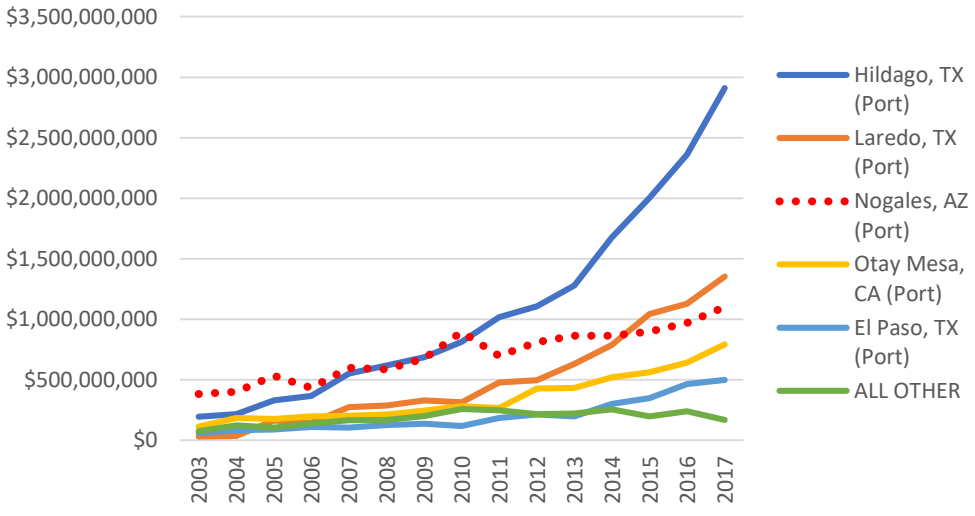
Figure 1. Annual Value of Imports of Vegetables from Mexico by Port of Entry, 2003-2017



Source: U.S. Census Bureau (2018)

The import of fresh fruits and nuts over time reveals a shift in value of imports by port of entry. While historically, Nogales was the top port of entry for fresh fruits up until the mid-2000s, it has since been surpassed by Hidalgo, TX and Laredo, TX in terms of value (Figure 2).

Figure 2. Annual Value of Imports of Fruits and Nuts from Mexico by Port of Entry, 2003-2017



Source: U.S. Census Bureau (2018)

Much of the growth in imports through Hidalgo and Laredo have come from rapid growth in imports of avocados and berries (raspberries and blackberries). These are examples of highly perishable commodities that require an uninterrupted cold chain during shipment.

The fresh produce cold chain is a system that begins with post-harvest cooling of produce and continues uninterrupted through storage, transport, and distribution. One potential interruption to the cold chain can occur at terminals or ports, particularly for imported produce (PMA, 2016). The perishability of certain commodities makes an uninterrupted cold chain of transport critical for minimizing spoilage and deliveries that are rejected by the end purchaser due to quality of the produce.

Nogales, Arizona's port of entry currently lacks a cold inspection facility, thereby making shipments of perishable commodities during hot shoulder and summer months potentially risky for shippers and buyers. Shipments that might naturally travel through Nogales as a least-cost, shortest route are channeled through other ports where cold inspection facilities are available. This represents foregone economic activity in the state.

Commodities

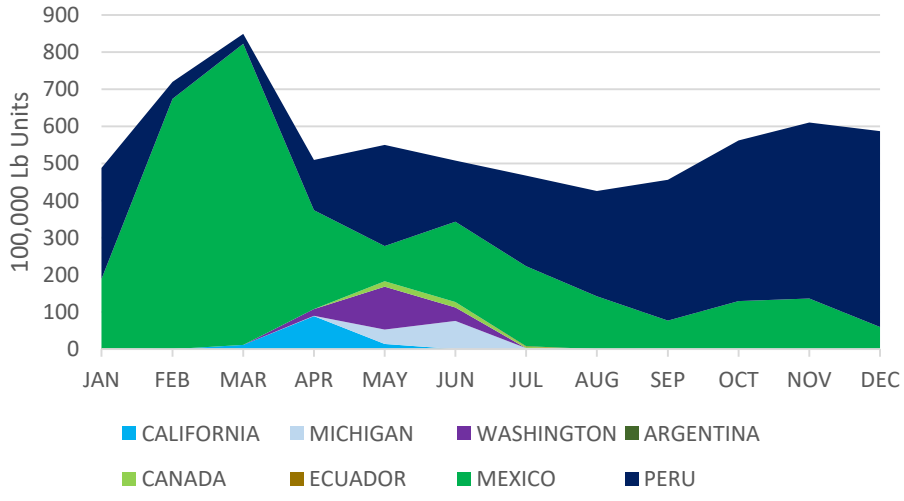
This analysis focuses on highly perishable fruit and vegetable commodities for which Nogales, AZ is not currently a major port of entry. The commodities examined in this analysis and their Harmonized System codes are as follows:

- HS 070920 Asparagus, Fresh or Chilled
- HS 080440 Avocados, Fresh or Dried
- HS 081020 Raspberries / Blackberries / Mulberries / Loganberries Fresh
- HS 081010 Strawberries, Fresh

Asparagus

Asparagus is a heavily imported commodity in the U.S., with 95% of available supply furnished through imports, primarily from Mexico and Peru. U.S. imports by volume from Mexico peak in winter and early spring, meanwhile imports from Peru are at their highest in fall months (Figure 3).

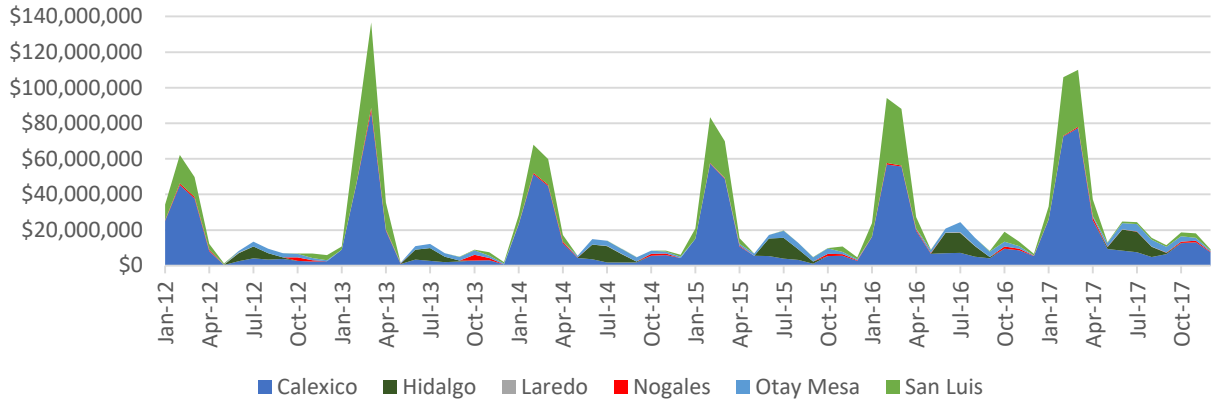
Figure 3. US Movements of Asparagus by Origin, 2017



Source: USDA AMS (2018)

Imports of asparagus from Mexico travel primarily through Calexico, California, and San Luis, Arizona (Figure 4). These ports are nearest to production which is heavily concentrated in the states of Sonora, Baja California, and Baja California Sur, with these states accounting for 85% of Mexico's production in 2017 (SIAP, 2018).

Figure 4. Monthly Value of Asparagus Imports from Mexico by Top Ports of Entry, 2012-2017

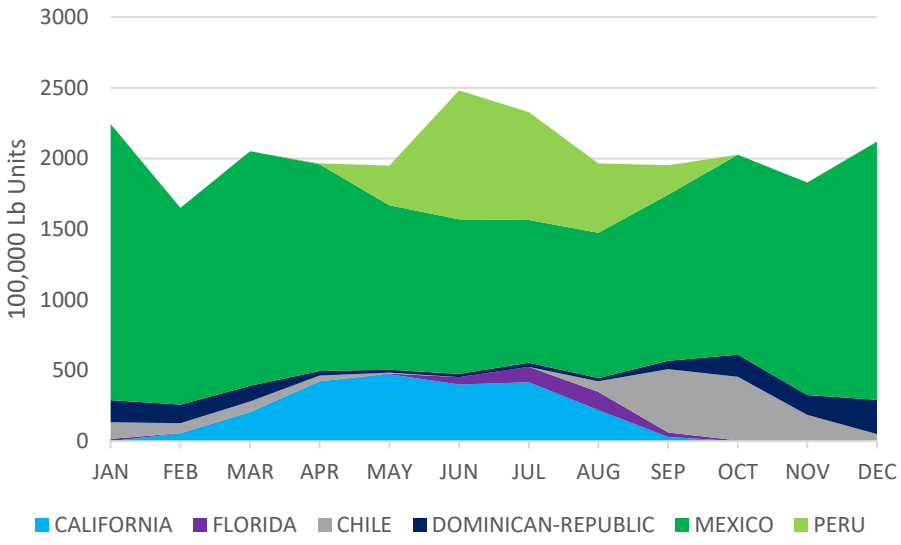


Source: U.S. Census Bureau (2018)

Avocados

The U.S. imported nearly 1.7 billion pounds of avocados from Mexico in 2017. In terms of total available supply, imports represented nearly 86% of U.S. supply as of 2016. Total shipments peak in summer months when both the California, Florida, and Peruvian harvests coincide. Imports from Mexico represent the majority of shipments during other times of the year (Figure 5).

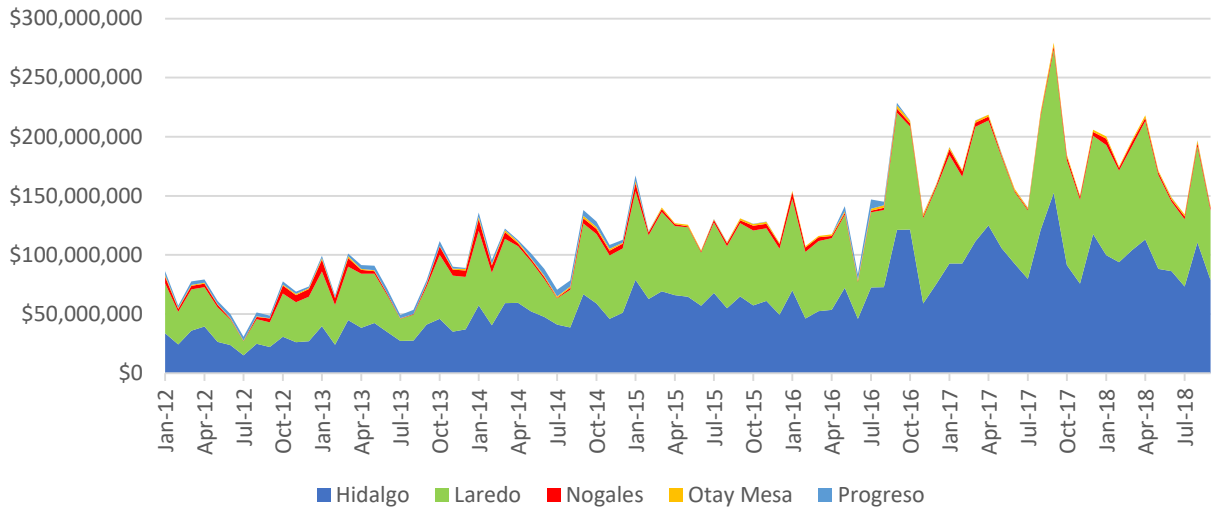
Figure 5. US Movements of Avocados by Origin, 2017, in 100,000 Lb. Units



Source: USDA AMS (2018)

Imports of avocados from Mexico are channeled primarily through two ports: Hidalgo, Texas and Laredo, Texas (Figure 6).

Figure 6. Monthly Value of Avocado Imports from Mexico by Top Ports of Entry, 2012-2017



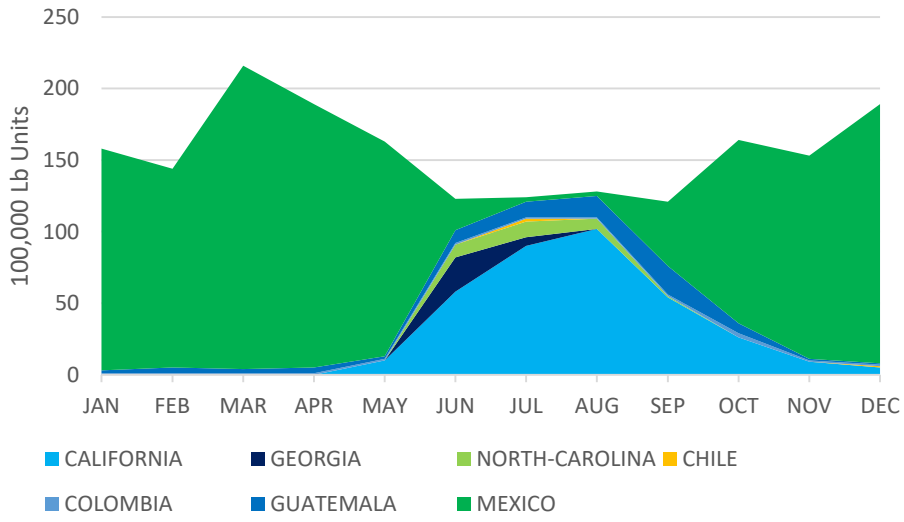
Source: U.S. Census Bureau (2018)

Production of avocados occurs in a number of states in Mexico, however, Michoacán accounts for roughly 83% of national production. Currently Michoacán is the only state in which growers are approved to export their product to the U.S. market. The second largest producer of avocados in Mexico is the state of Jalisco, with 7% of national production. There is a possibility that avocado growers in Jalisco will receive approval to export to the U.S. in the near future. In subsequent sections of this analysis, it is assumed that production from Jalisco would be shipped through the Nogales Port of Entry.

Raspberries & Blackberries

Raspberries and blackberries are high value and highly perishable commodities. Raspberry and blackberry shipments share similar seasonal patterns and are bimodal, shifting between California in summer months and Mexico in fall, winter, and spring months. Figure 7 shows shipments of miscellaneous berries (including blackberries).

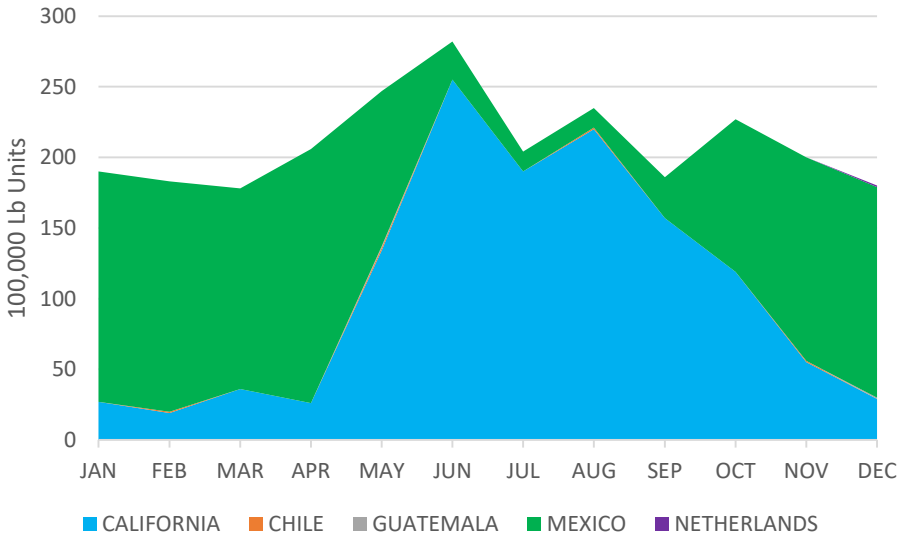
Figure 7. US Movements of Misc. Berries (Blackberries, Etc.) by Origin, 2017, in 100,000 Lb. Units



Source: USDA AMS (2018)

While some production occurs in southern states during early summer months for blackberries and other berries, shipments of raspberries are almost exclusively limited to shipments from California and Mexico (Figure 8).

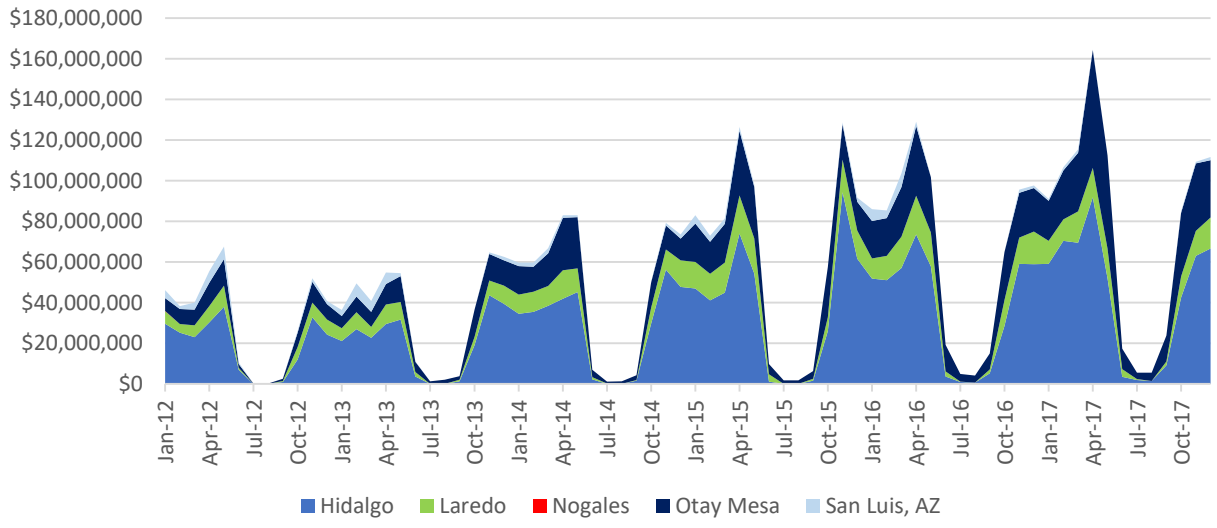
Figure 8. US Movements of Raspberries by Origin, 2017, in 100,000 Lb. Units



Source: USDA AMS (2018)

Imports of blackberries and raspberries from Mexico to the U.S. occur primarily through three ports of entry: Hidalgo, Texas; Laredo, Texas; and Otay Mesa, California (Figure 9).

Figure 9. Monthly Value of Berry (Raspberry, Blackberry, Other) Imports from Mexico by Top Ports of Entry, 2012-2017



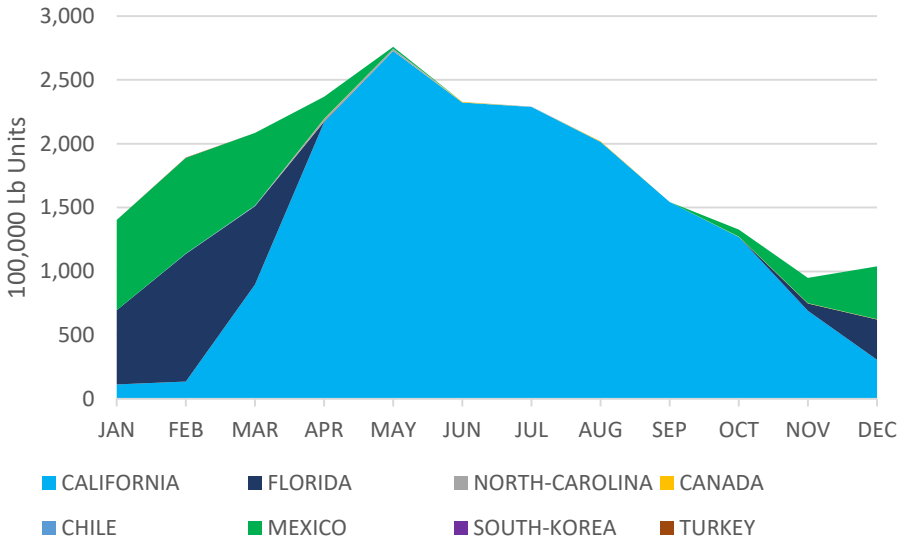
Source: U.S. Census Bureau (2018)

Blackberry production in Mexico occurs almost exclusively in the state of Michoacán, with nearly 98% of production in 2017. Raspberry production is more dispersed, and the top 3 producing states are Jalisco (36.6% of production), Baja California (32.7% of production), and Michoacán (30.4% of production).

Strawberries

U.S. shipments of strawberries are dominated by production from California which peaks in the spring. During winter months, supplies from Florida and Mexico split the market roughly in half in terms of volume (Figure 10).

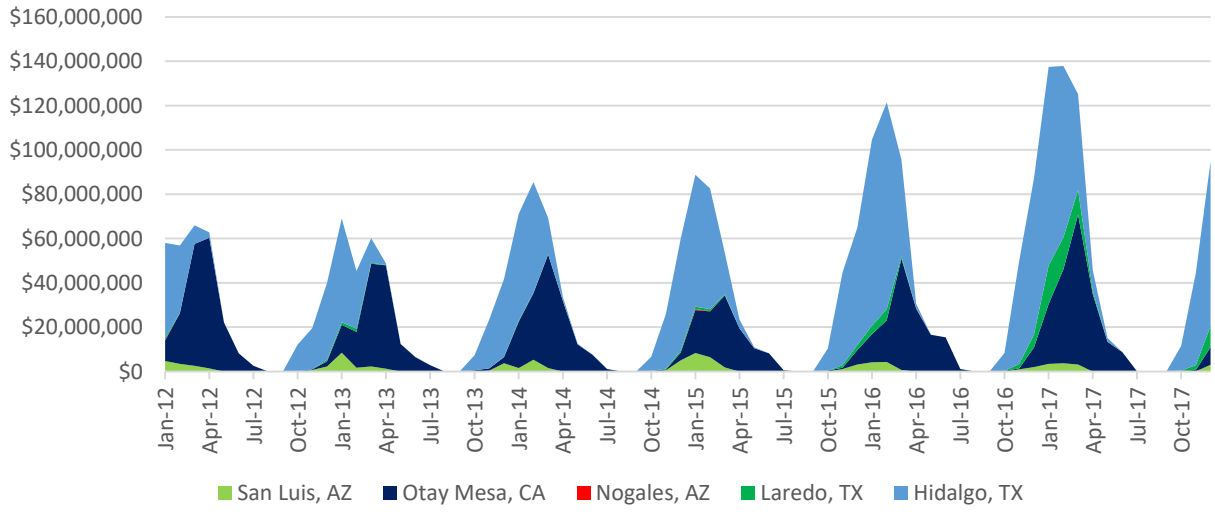
Figure 10. US Movements of Strawberries by Origin, 2017, in 100,000 Lb. Units



Source: USDA AMS (2018)

Strawberry imports from Mexico travel primarily through Hidalgo, Texas and Otay Mesa, California, with an increasing share traveling through Laredo, Texas (Figure 11).

Figure 11. Monthly Value of Strawberry Imports from Mexico by Top Ports of Entry, 2012-2017



Source: U.S. Census Bureau (2018)

Strawberry production in Mexico is heavily concentrated in Michoacán, with 76% of production, followed by Baja California, with 16% of production (SIAP, 2018).

Increased Fresh Produce Trade Volume Scenarios

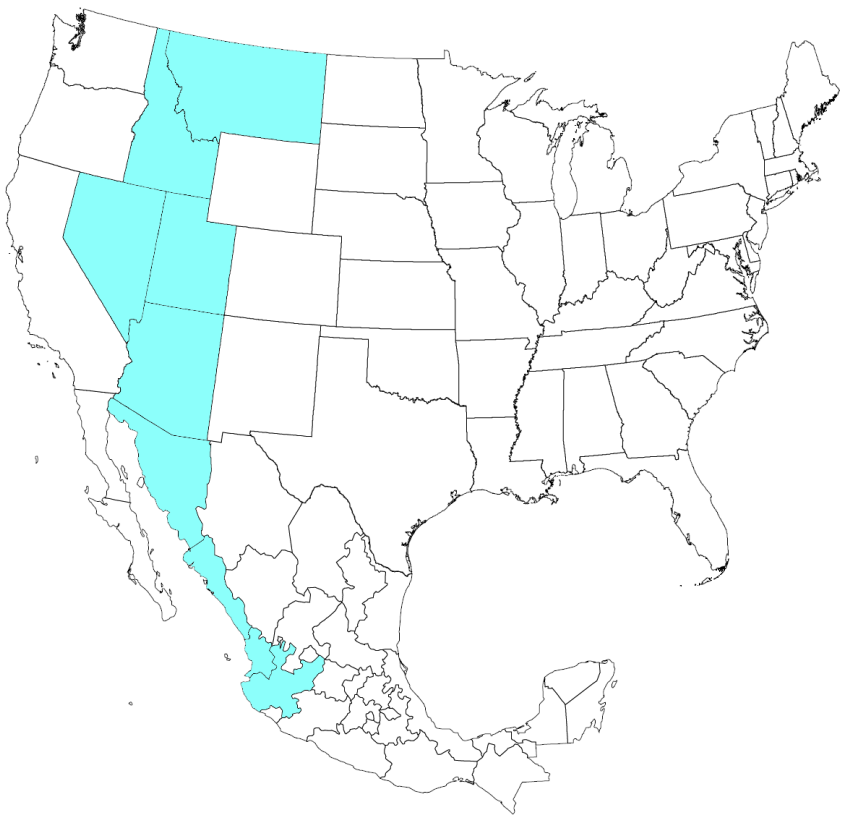
This study estimates the volume and value of fresh produce currently diverted to other ports of entry that could potentially travel through the Mariposa Port of Entry given existing agricultural production in the Mexican states of Sonora, Sinaloa, Nayarit, and Jalisco and the estimated consumer demand in the U.S. states of Arizona, Utah, Nevada, Idaho, and Montana. Potential increases in trade flows for select perishable produce commodities (asparagus, avocados, blackberries, raspberries, and strawberries) through Nogales are, in turn, used to estimate the economic impacts to the Arizona economy.

The study uses two estimates of increases in trade flows. The estimates are developed using constraints, in this case, existing agricultural production within the Mexico portion of the trade corridor (supply) and population within the U.S. portion of the trade corridor (consumer demand). Based upon our assumptions, consumer demand sets the ceiling of trade flows, which in some instances is constrained by the volume of production within the corridor, in which case excess demand is assumed to be fulfilled from supplies traveling from elsewhere. In this study, estimates of consumer demand are limited to states within the trade corridor. Additional demand in the Western U.S. represents additional opportunity for growth, considering that some produce is currently shipped through Nogales for delivery to California, Oregon, and Washington, as well as through trans-shipments to Canada.

Trade Corridor

The trade corridor used for this analysis includes U.S. and Mexican states informally known as the CANAMEX trade corridor, which includes the U.S. states of Arizona, Utah, Nevada, Idaho, and Montana, and the Mexican states of Sonora, Sinaloa, Nayarit, and Jalisco (Figure 12).

Figure 12. U.S. and Mexican States Included in Trade Corridor for Analysis



This analysis estimates potential trade flows using measures of supply and demand in this trade corridor. The analysis measures supply as production occurring within Mexico's portion of the corridor and demand as a share of estimated consumer demand by commodity within the United States portion of the corridor. We assume that trade flows cannot exceed supply produced within the corridor, nor can they exceed demand in the corridor. Two estimates of demand are used. The first estimates total demand in the U.S. portion of the corridor using national average per capita availability statistics from the USDA. Availability refers to the total available supply of individual fresh produce commodities within the United States and is equal to the sum of domestic production and imports, minus any exports. Per capita availability estimates are proxies for per capita consumption. The second estimate of demand in the corridor is based on the corridor's share of the total U.S. population, applied to total imports by value of that commodity from Mexico.

Estimates of Potential Import Volume

This analysis presents two estimates of potential trade volume that could travel through the Mariposa Port of Entry in Nogales. This analysis assumes that trade flows of highly perishable commodities produced within the study corridor will also flow to consumers within the same corridor, demand and supply permitting. By doing this, we are making the simplifying assumption that all produce will take the most direct route to customers.

The first estimate of trade flows uses national average per capita fruit and vegetable availability estimates (proxy for per capita demand) and the share of total U.S. supply by commodity provided through imports from Mexico. Considering the per capita availability (demand) estimates are loss-adjusted and the loss conversion factors are estimated based upon retail, foodservice, and consumer level losses (ERS, 2018), this analysis relies upon farm availability estimates for purposes of estimating import shipment volumes (Table 1). Consumer demand in the trade corridor calculated by Method 1 is provided in Table 2.

Table 1. US Supply of Select Commodities, 2016 (Fruits) and 2017 (Vegetables)

Item	Total U.S. Imports from World (Millions of Pounds)	Total U.S. Commodity Availability (Millions of Pounds)	Per Capita Farm Availability **	Import Share of Total U.S. Availability	Mexico Share of U.S. Imports	Estimated Per Capita Demand for Imports from Mexico (Lbs.)
Asparagus	502	513	1.5	98%	47%	0.7
Avocadoes	1,980	2,306	7.1	86%	76%	4.6
Blackberries*	146	N/A	N/A	N/A	93%	0.4
Raspberries	135	279	0.9	48%	99%	0.4
Strawberries	364	2,598	8	14%	99%	1.1

* Data not available, assumed to be equal to demand for raspberries. Based upon 2017 USDA shipments data for miscellaneous berries, including blackberries, per capita shipments from Mexico equate to just over 0.4 pounds per capita.

** Vegetable (asparagus) availability estimates for 2017 (USDA ERS, 2018) and fruit (avocado, raspberry, and strawberry) availability estimates for 2016 (USDA ERS, 2018)

The second method for estimating demand simply applies the share of U.S. population living in the trade corridor to the total value of imports from Mexico for each commodity, corridor supply permitting. The U.S. portion of the trade corridor includes Arizona, Utah, Nevada, Idaho, and Montana. Combined, those states represent 15.9 million people, or 4.9% of the U.S. population (U.S. Census Bureau, 2017).

A simplifying assumption of this analysis is that all demand can be met through supply within the corridor, up to 100% of production in that corridor. In reality, a share of production within the corridor is

likely destined for Mexico's domestic market. In the case of avocados, production in the corridor represents production in Jalisco. Under current regulation only avocado growers from the state of Michoacán are approved for export to the United States, however, there is a strong prospect that growers in Jalisco will be permitted to export in the future.

Table 2. Estimated Weight of Commodity Demand and Supply in Corridor, Total Imports from Mexico, and Maximum Import Values for Modeling Economic Impacts

	METHOD 1	METHOD 2		
Commodity	***Est. Corridor Import Demand (Lbs.) (Per-Capita Based)***	***Est. Corridor Import Demand (Lbs.) (Population Based)***	***Total Imports from Mexico (Lbs.)***	***Production in Mex. Corridor States (Lbs.)***
Asparagus	*11,635,621	*14,653,774	300,500,000	324,317,239
Avocadoes	*73,794,520	*81,393,058	1,669,100,000	374,097,559
Blackberries	*6,585,341	*6,651,497	136,400,000	16,680,155
Raspberries	*6,585,341	*6,061,445	124,300,000	189,729,597
Strawberries	17,714,708	14,063,722	288,400,000	*3,725,808

* Corridor import volume estimates will be equal to the lesser of either corridor import demand or corridor production (supply). Values marked with an asterisk represent these binding constraints.
Sources: USDA AMS (2018); SIAP (2018)

In order to develop an estimate of the increase in import value moving through Nogales, we compare the shares of the selected commodities with the maximum calculated share based on demand and supply constraints (Table 3).

Table 3. Nogales Share of Imports from Mexico, 2017 and 2016, and Maximum Imports for Economic Impact Modeling

Commodity	Nogales Share 2017	Nogales Share 2016	Method 1 Share	Method 2 Share
070920 Asparagus, Fresh or Chilled	1.23%	1.41%	3.87%	4.88%
080440 Avocados, Fresh or Dried	1.45%	1.71%	4.42%	4.88%
081020 Raspberries / Blackberries / Mulberries / Loganberries Fresh	<0.01%	0.00%	4.80%	4.88%
081010 Strawberries, Fresh	0.01%	0.01%	1.29%	1.29%

Source: U.S. Census Bureau (2018); Calculations by authors

Per Capita Demand-Based Estimate of Potential Import Volume

As detailed, this estimation method uses estimates of per capita demand for imports from Mexico and applies them to the trade corridor population. Maximum share values may be less than 4.9% for a number of reasons. Some shipments from Mexico to the U.S. may represent transshipments to Canada. Additionally, some share of imports may be for industrial uses. In the case of strawberries, the maximum share was constrained by production (supply) in the corridor.

Assuming all imports through Nogales are at the annual average price, based upon value of imports and volume, we derive an estimate of the net increase in sales volume that would be arriving through the port (Table 4).

Table 4. Per Capita Demand-Based Estimates of Increases in Trade Flows Through Nogales (METHOD 1)

Commodity	Nogales Share of Imports from Mexico 2017	Method 1 Share	Difference	Total Value of Imports from Mexico, 2017	Estimated Increase in Sales through Nogales, 2017 USD
070920 Asparagus	1.23%	3.87%	2.64%	$422,357,808	$11,167,507
080440 Avocados	1.45%	4.42%	2.97%	$2,334,650,733	$69,344,174
081020 Raspberries / Blackberries / Etc.	0.01%	4.80%	4.80%	$953,081,070	$45,707,194
081010 Strawberries	0.01%	1.29%	1.28%	$621,070,693	$7,949,016
TOTAL					**$134,167,891**

Sources: U.S. Census Bureau (2018); Calculations by authors

Population Share-Based Estimate of Potential Import Volume

The second estimate applies the share of the U.S. population living within the trade corridor (4.88%) to the total value of imports from Mexico by commodity. While similar in magnitude, this estimate produces a slightly higher value for all commodities, with the exception of strawberries which again are constrained by supply in the corridor (Table 5).

Table 5. Population Share-Based Estimate of Increases in Trade Flows Through Nogales (METHOD 2)

Commodity	Nogales Share of Imports from Mexico 2017	Method 2 Share	Difference	Total Value of Imports from Mexico, 2017	Increase in Sales through Nogales, 2017
070920 Asparagus	1.23%	4.88%	3.648%	$422,357,808	$15,409,572
080440 Avocados	1.45%	4.88%	3.425%	$2,334,650,733	$79,972,617
081020 Raspberries / Blackberries / Etc.	0.01%	4.88%	4.869%	$953,081,070	$46,409,938
081010 Strawberries	0.01%	*1.29%	1.278%	$621,070,693	*$7,937,283
TOTAL					**$149,729,411**

Sources: U.S. Census Bureau (2018); Calculations by authors

Caveats

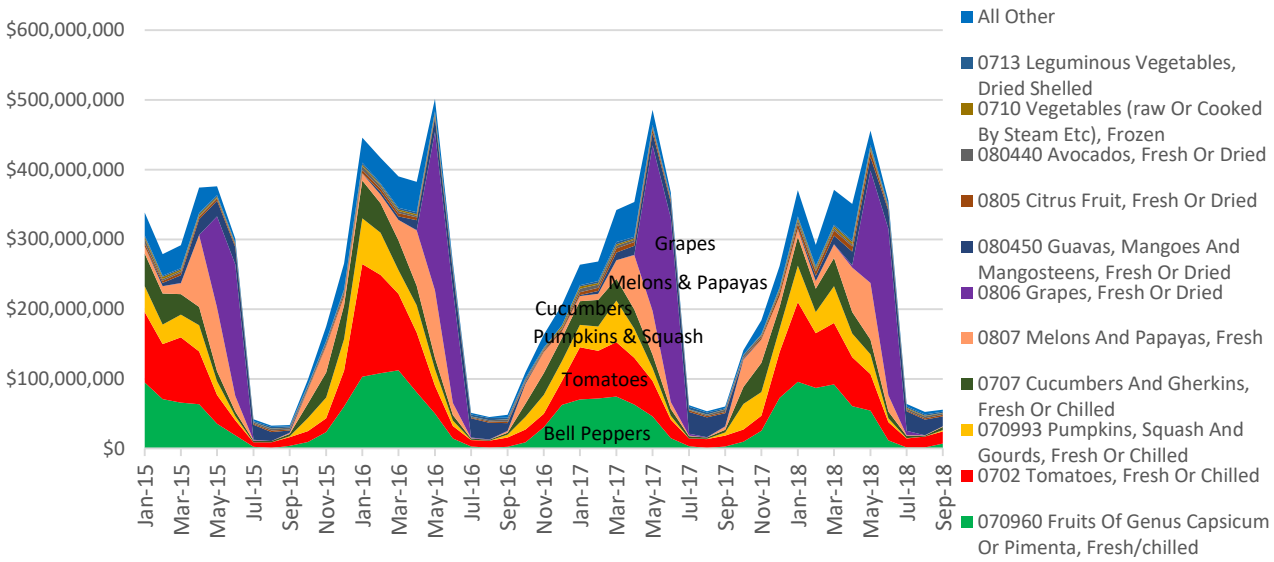
Not all produce travels according to the least-distance route to consumers. Commodity flows are driven by many factors. In some cases, aggregation occurs in different locations across the country, with some distributors specializing in specific commodities. Some of these shipper / distributor linkages are relationship-based, and commodity flows often occur based upon historic patterns versus what might appear as the least-distance route. Some suppliers of fresh produce are multi-national companies with production in multiple countries to supplement their supply during times of the year when U.S. production is low (Johnson, 2016). While on one hand this could mean that distributors might choose to ship produce through other established trade routes based upon their historical behavior, it could also open up potential for more highly concentrated shipments through Nogales for aggregation in Southern Arizona. These outcomes are difficult to predict; therefore, we default to population-driven demand-based estimates for this analysis. An additional supply-side assumption accounts for the strong prospect that growers in Jalisco will be permitted to export to the U.S. Under current regulation only avocado growers from the state of Michoacán are approved for export to the United States.

Finally, the analysis assumes that 100% of additional import activity occurs via transactions with Santa Cruz County-based businesses. In reality, some share of imports may be sold through consignment or sales may be transacted between out-of-state and out-of-country businesses. Nevertheless, most shipments through the Nogales port of entry require services from importers in Santa Cruz County, increasing economic activity in the region.

Fresh Produce Trade Volume Capacity in Nogales

Fresh produce movements through Nogales exhibit a strong seasonal signal, with heavy volumes of imports in winter and spring months and lower volumes in summer months. The heaviest volume of imports occurs during the grape harvest season in Sonora between April and June (Figure 13).

Figure 13. Monthly Value of Imports by Commodity through Nogales Port of Entry, 2015 – Sept 2018

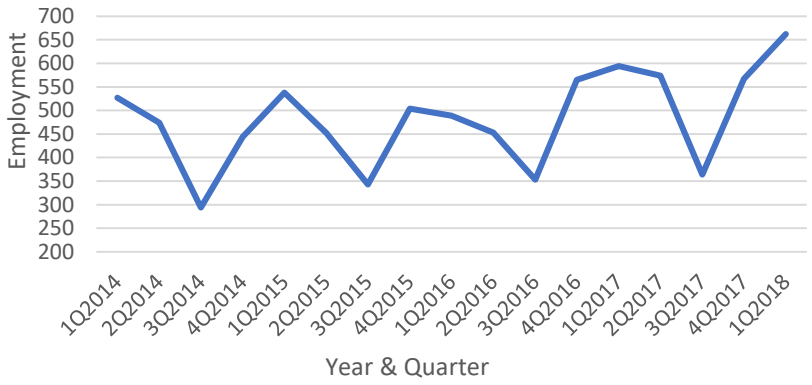


Source: U.S. Census Bureau (2018)

The prospect of additional fresh produce import volume could have implications for the commercial real estate market, driving need for additional warehouse and transport capacity depending on whether that additional import volume coincides with existing seasonal peaks. Figure 15 (in Box 1) illustrates the seasonality of national shipments of the selected perishable commodities (series in dotted lines) plotted against existing import volume for the Port of Nogales. That said, this study does not present an analysis of warehouse and cold storage capacity in the region or assess economic impacts of warehouse construction.

Some volume coincides with the heaviest peak season in Nogales. However, there are shipments of avocados, asparagus, and strawberries during non-peak months for shipments. Volume of miscellaneous berries and raspberries appear to peak closer to peak grape season in Nogales, though there are also movements during non-peak months of December through February. Additional shipments during peak months of April to June could result in the need for additional warehouse capacity. While shipments outside of that window would not require additional warehouse capacity, they could generate additional employment to offset seasonal decreases in employment within the fruit and vegetable merchant wholesale industry, as well as the warehousing and storage industry (Figure 14).

Figure 14. Quarterly Employment in NAICS 493 Warehousing and storage, Santa Cruz County, Arizona



BOX 1. Seasonal Produce Shipments

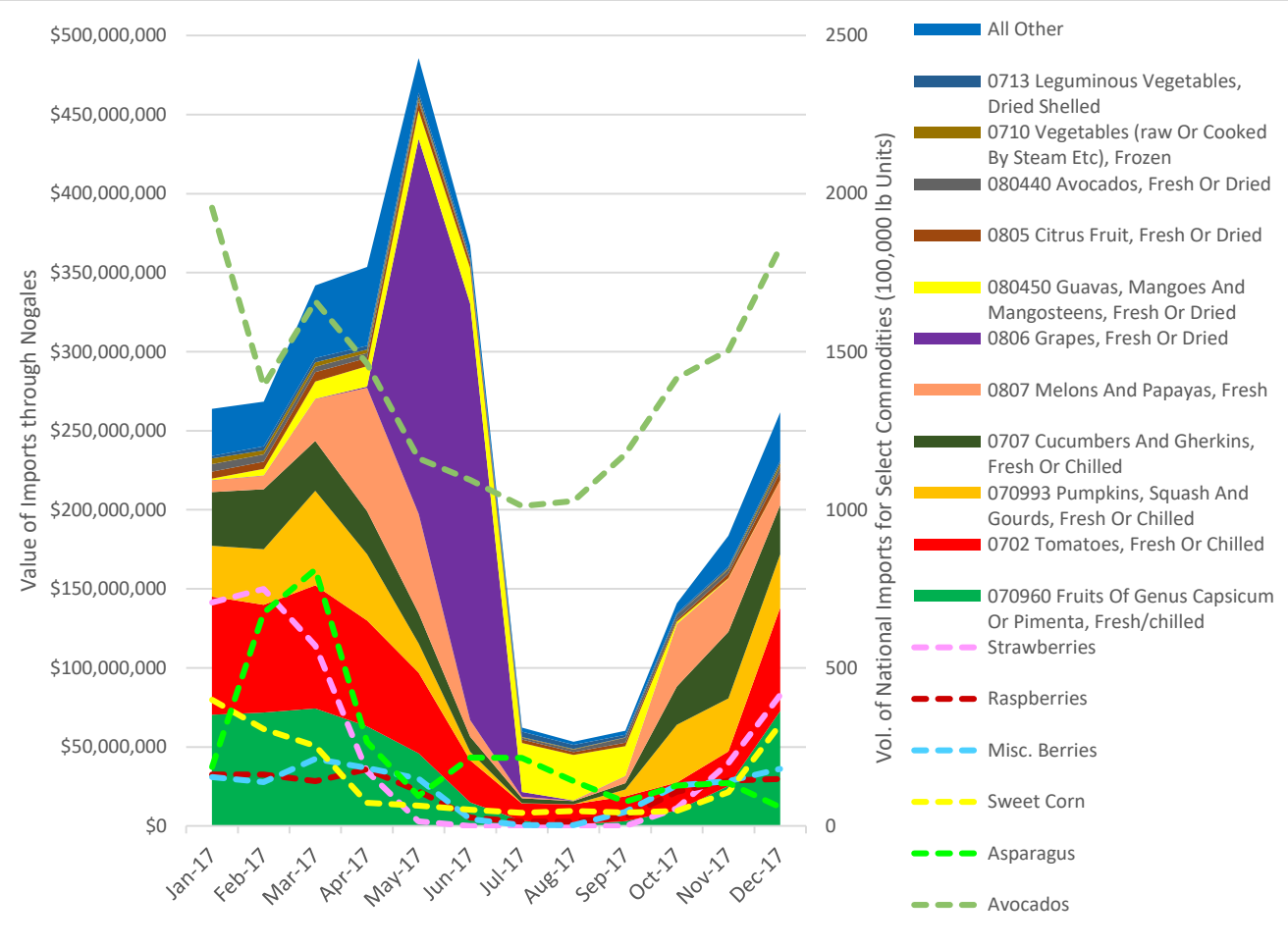
Produce shipments through Nogales exhibit a strong seasonal pattern, with value of imports peaking in the months of April and May with the grape harvest in Sonora, falling to a low in the summer months of July, August, and September. Figure 15 illustrates monthly value of imports by commodity through Nogales over calendar year 2017, pictured in the stacked area portion of the graph.

Superimposed on these seasonal imports through Nogales are national level monthly shipments by weight of the selected highly perishable produce commodities from Mexico to compare their seasonal pattern with current shipments through Nogales. These series are pictured in the dashed lines.

While none of the highly perishable commodities exhibit a counter-seasonal trend compared to current shipments through Nogales, they do exhibit volumes of imports during times of the year that are off-peak for Nogales or that coincide with Nogales' shoulder-seasons. In particular, a significant volume of avocados is shipped during summer months when monthly imports through Nogales are at their lowest levels. This represents an opportunity to employ warehouse capacity and labor force that otherwise might be underutilized during low-volume summer months.

Sweet corn, pictured in the graph, is an example of a highly perishable commodity in which Nogales already represents a strong market share of imports (roughly 68% in 2017). Most shipments occur during winter months, however, and potential exists for growth during summer and shoulder season months.

Figure 15. Monthly Value of Imports Through Nogales by Top Commodities and Monthly Volume of US Imports by Select Commodities, 2017



Sources: U.S. Census Bureau (2018); USDA AMS (2018)

Potential Economic Impacts of Increased Fresh Produce Trade Volume

Using these estimates of increases in trade flows through Nogales, we derive estimates of the effects of those increased sales on the state and local economy. The following sections present our estimate of direct sales impacts, and the components of those sales, the direct impact on jobs and wages, and finally, the total impact to the state economy including multiplier effects.

Direct Sales Impacts

Value of imports does not capture the actual economic activity that would occur in the state economy as a result of this estimated increase in trade volume. The value of imports represents the cost of goods sold for fruit and vegetable merchant wholesalers, and the cost of goods sold in this case represents a leakage from the state economy since the goods are imported. In addition to the costs of goods, wholesalers must cover their costs of doing business, such as operating costs, business owner income, and profits. In order to estimate the increase in revenues (or sales) that would accrue to local businesses in Santa Cruz County, we can apply a national estimate of gross margins as a percent of sales for merchant wholesalers of grocery related products. In 2016, most recent data available, the estimated gross margin for wholesalers of grocery related products was 14.7% (U.S. Census Bureau, 2018b). Similarly, operating expenses as a percent of sales for merchant wholesalers of grocery related products was 11.6% (U.S. Census Bureau, 2018c). Using this information, we can estimate gross revenues, operating costs, and net revenues resulting from increased volume of imports via these wholesalers (Table 6).

Table 6. Estimates of Gross Revenues (Sales), Operating Expenses, and Net Revenues of Fruit & Vegetable Merchant Wholesalers in Santa Cruz County, Arizona Resulting from Estimated Increases in Fruit & Vegetable Imports

Item	METHOD 1	METHOD 2
Cost of Goods Sold (Imports)	$134,167,891	$149,729,411
Operating Expenses (+)	$18,245,575	$20,361,796
Net Revenues (+)	$4,875,973	$5,441,514
Gross Revenues (=)	$157,289,438	$175,532,721

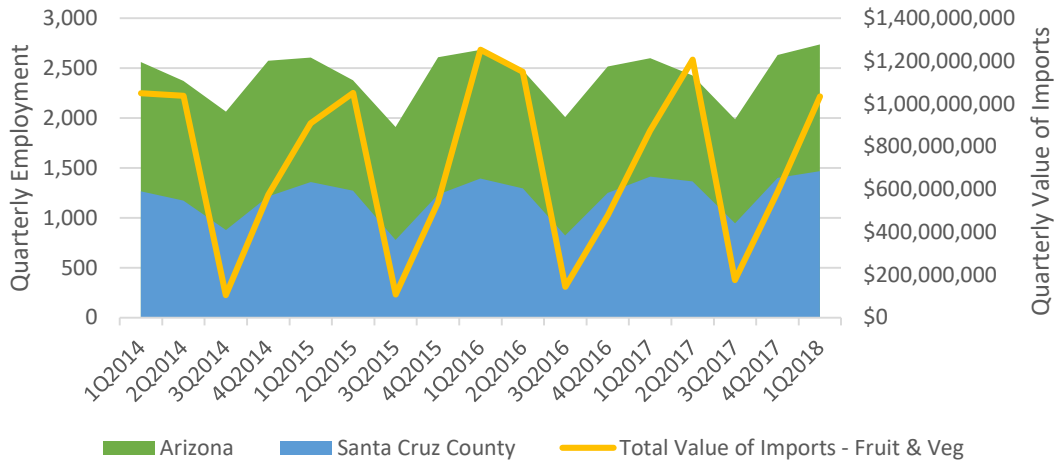
Source: Calculations by authors

This analysis assumes that all modeled increases in imports through Nogales occur through transactions with Santa Cruz County-based businesses, thereby generating wholesale margins for these businesses. Based upon that assumption, an increase in value of imports between $130 million and $150 million would generate direct gross wholesale margins of between $23 million and $26 million for Santa Cruz County businesses.

Direct Jobs Impacts

Similar to revenues, an increase in import activity would require fruit and vegetable wholesalers to hire additional employees to handle the increase in volume of produce. Fruit and vegetable merchant wholesaling employment is highly seasonal in Santa Cruz County, Arizona, and corresponds closely with the value of fresh produce imports arriving through the Nogales Port of Entry (Figure 16).

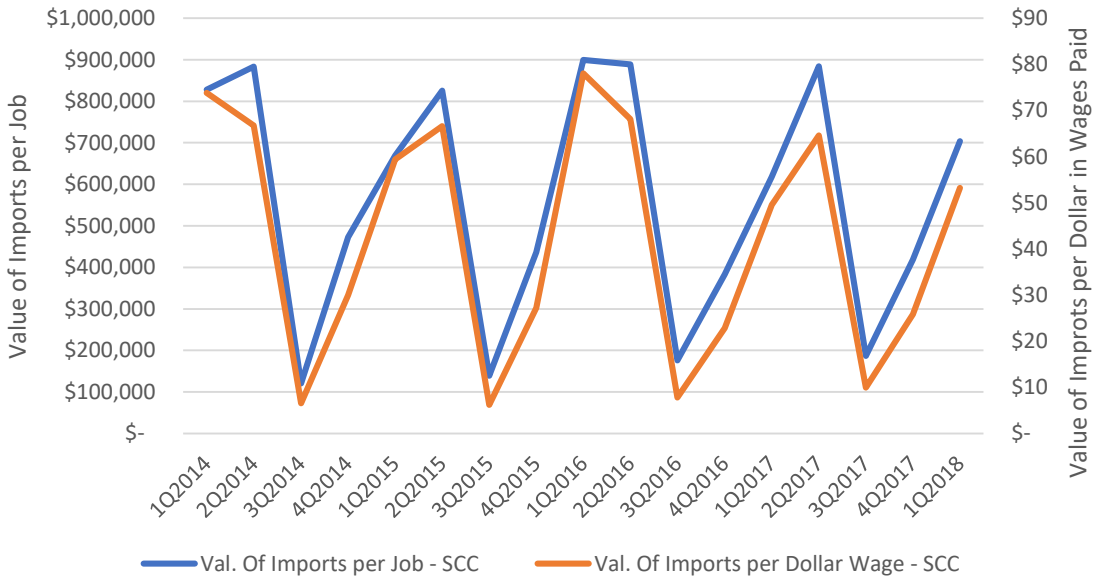
Figure 16. Quarterly Employment, Fruit & Vegetable Merchant Wholesalers (Private), 1Q2014-1Q2018, and Quarterly Value of Fruit & Vegetable Imports through Nogales Port of Entry



* Employment measured by third month in each quarter
Sources: BLS (2018); U.S. Census Bureau (2018)

On a per-job or per-dollar of wage basis, we can visualize the value of imports over the course of the year (Figure 17).

Figure 17. Quarterly Value of Imports per Job and Quarterly Value of Imports per Dollar of Wages Paid, Santa Cruz County, Arizona, 1Q2014-1Q2018



Sources: BLS (2018); U.S. Census Bureau (2018); Calculations by authors

Using these data, we derive quarterly averages, adjusted for inflation, of value of fruit and vegetable imports per fruit and vegetable merchant wholesale job and average quarterly value of imports per dollar in wages paid by fruit and vegetable merchant wholesalers in Santa Cruz County, Arizona (Table 7).

Table 7. Average Quarterly Value of Imports through Nogales Port of Entry per Fruit & Vegetable Merchant Wholesaler Job in Santa Cruz County, 2014-2017, Adjusted to 2017 USD, and Average Quarterly Value of Imports through Port of Nogales per Dollar of Wages Paid by Fruit & Vegetable Merchant Wholesalers in Santa Cruz County, Arizona, Adjusted to 2017 USD

Quarter	Average Quarterly Value of Imports per Job	Average Quarterly Value of Imports per Dollar in Wages Paid
1Q	$ 779,739	$ 67.47
2Q	$ 891,311	$ 68.13
3Q	$ 158,715	$ 7.77
4Q	$ 440,331	$ 27.26

Sources: Calculations by authors based on BLS (2018) and BLS (2018b)

Using these figures, and value of total imports by commodity allocated quarterly according to volume of shipments from Mexico for each commodity, we arrive at estimates of quarterly jobs and wages, according to the two methods, that would be supported in Santa Cruz County through increases in fruit and vegetable imports (Table 8).

Table 8. Estimated Fruit and Vegetable Merchant Wholesaler Jobs Increase in Santa Cruz County

	1Q	2Q	3Q	4Q	Average
METHOD 1	64	34	106	86	72
METHOD 2	71	37	123	94	81

Source: Calculations by authors

Similarly, we estimate the quarterly and annual wages that would be supported in Santa Cruz County by this increased activity in fruit and vegetable shipments (Table 9).

Table 9. Estimated Fruit and Vegetable Merchant Wholesaler Wages Increase in Santa Cruz County

	1Q	2Q	3Q	4Q	Annual
METHOD 1	$736,252	$439,159	$2,170,362	$1,383,231	$4,729,005
METHOD 2	$822,250	$488,536	$2,516,337	$1,519,208	$5,346,331

Source: Calculations by authors

Total Economic Impacts Including Multiplier Effects

These estimated increases in annual sales, employment, and labor income would lead to an additional ripple of economic activity in the state economy, known as multiplier effects. Multiplier effects represent additional rounds of business-to-business and household-to-business transactions in the state economy stimulated when directly affected industries increase their production and require additional inputs to operate. Indirect multiplier effects occur when businesses purchase additional inputs such as boxes, electricity, or lease warehouse space. Induced multiplier effects occur when households employed in fruit and vegetable wholesaling spend their wages in the state economy on household expenses such as rent, mortgage, doctors' visits, and groceries, etc.

Recall from the previous section the estimated increases in gross revenues (sales) that would occur as a result of increases in imports.

Table 10. Estimates of Increase in Gross Revenues of Fruit & Vegetable Merchant Wholesalers in Santa Cruz County

Item	METHOD 1	METHOD 2
Cost of Goods Sold (Imports)	$134,167,891	$149,729,411
Operating Expenses (+)	$18,245,575	$20,361,796
Net Revenues (+)	$4,875,973	$5,441,514
Gross Revenues (=)	$157,289,438	$175,532,721

Source: Calculations by authors

Using the gross wholesale margin (gross revenues less cost of goods sold), we can model the net new wholesale margin created by this increase in economic activity in the regional economy. Part of this margin goes to pay wages and benefits for workers employed in the industry, with wages estimated in Tables 8 and 9. The remainder represents the increase in business-owner income, profits, and taxes as well as operating expenses above the costs of goods sold (Table 11).

Table 11. Estimate of Increase in Wholesale Margin and Jobs from Fruit & Vegetable Merchant Wholesalers in Santa Cruz County

Item	METHOD 1	METHOD 2
Gross Margin	$23,121,547	$25,803,310
Jobs	72	82

Source: Calculations by authors

This net new economic activity in the county can be used with an input-output model to estimate multiplier effects within the state economy. Using the IMPLAN 3.1 input-output model (IMPLAN, 2016), we model gross wholesale margins using IMPLAN's wholesale trade sector to estimate total economic impacts, including multiplier effects (Tables 12 & 13). Assuming trade were sustained at the modeled levels, this economic activity would persist and constitute an ongoing contribution to the local economy.

Table 12. Economic Impact of Increases in Fruit & Vegetable Import Volume through Nogales (METHOD 1)

Impact Type	Employment	Labor Income*	Value Added	Sales
Direct Effect	72	$8,065,154	$15,145,005	$23,121,547
Indirect Effect	62	$3,165,492	$5,138,037	$9,064,536
Induced Effect	80	$3,556,005	$6,371,806	$11,163,490
Total Effect	214	$14,786,651	$26,654,848	$43,349,573

* Labor income includes employee wages, benefits, and proprietor (business owner) income. Value added is the sum of labor income, taxes on production and imports, and profits.

Table 13. Economic Impact of Increases in Fruit & Vegetable Import Volume through Nogales (METHOD 2)

Impact Type	Employment	Labor Income	Value Added	Sales
Direct Effect	82	$9,000,594	$16,901,605	$25,803,309
Indirect Effect	69	$3,532,643	$5,733,974	$10,115,890
Induced Effect	90	$3,968,450	$7,110,843	$12,458,293
Total Effect	241	$16,501,687	$29,746,423	$48,377,492

* Labor income includes employee wages, benefits, and proprietor (business owner) income. Value added is the sum of labor income, taxes on production and imports, and profits.

The annual sales impact to the state economy ranges between $43 million and $48 million. This corresponds to between $27 million and $30 million in in Gross State Product (value added). Between 214 and 241 jobs and $15 million to $17 million in labor income would be supported by the increased

economic activity. The industries most affected by these increases in economic activity would be wholesale trade and real estate.

Tax Impacts

Estimated impacts to state and local tax revenue range between $3.7 million and $4.1 million in additional annual revenue as a result of the modeled increase in economic activity. Again, this analysis assumes that import sales are made through Santa Cruz County-based businesses and therefore sales are taxable in Santa Cruz County and Arizona. Some produce moving through Nogales may have occurred through a transaction between an out-of-state and out-of-country business entity, or through consignment, in which case the transaction would not generate wholesale margin or tax revenues within Arizona. For purposes of this analysis, however, we assume all new shipments require services of businesses based in Santa Cruz County. We have reported tax impacts separately for purposes of information, however, tax impacts are a component of value added and therefore should not be added to previous totals.

Benefit-Cost Analysis

A benefit cost analysis is a common way to examine the financial viability of a project or investment over a stated period of time. We will examine the project benefits and costs over two time periods to account for different potential equipment lifecycles for the cold inspection facility, 15 and 20 years. Benefits are measured as direct impacts to proprietors' income and other property income (such as corporate profits). We model a range of possible trade flow outcomes: 100% of the impacts modeled in previous sections, 75%, 50%, and 25%.

Based upon the two methods of trade flow estimation and the degree to which potential trade flows are realized, the annual increase in business owner income and other property type income ranges between $1.2 million and $5.5 million annually (Table 14).

Table 14. Direct Increase in Business Owner Income & Profits by Trade Flow Model and % of Trade Flows Realized

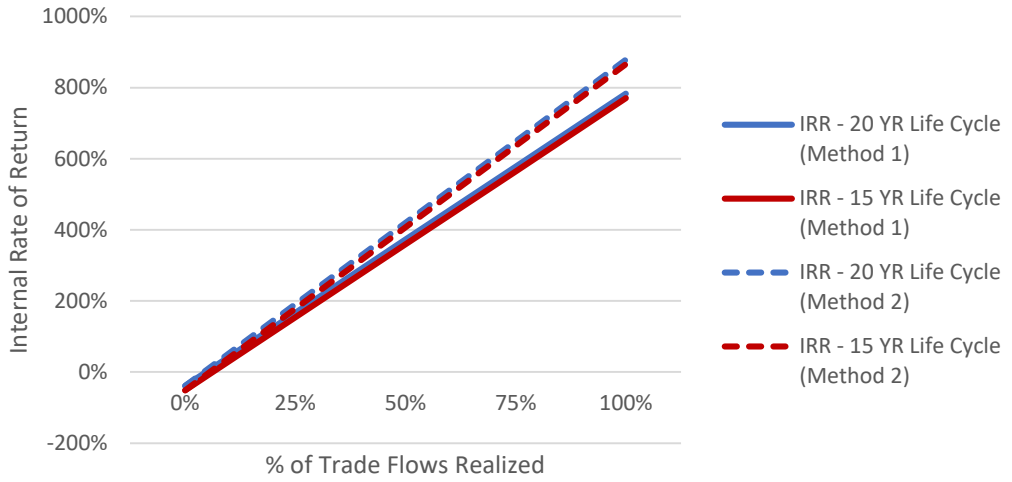
% of Trade Flows Realized	Increase in Business Owner Income & Profits METHOD 1	Increase in Business Owner Income & Profits METHOD 2
100%	$4,928,617	$5,500,265
75%	$3,696,463	$4,125,199
50%	$2,464,309	$2,750,133
25%	$1,232,154	$1,375,066

Assuming this activity remains constant over time, we model the increases as a 15-year and a 20-year stream of income and profits. We also model initial investment costs and ongoing operation and maintenance, including electricity consumption. Initial investment is assumed to be $600,000, and total operation and maintenance costs (O&M) of the cold inspection facility over its life cycle (15 or 20 years) occur at a ratio of 7.77:1 relative to initial investment costs[2] (Wu & Clements-Croome, 2007). This correlates to O&M costs of between $231,000 and $308,000 per year, depending on the life cycle.

[2] This estimate of O&M costs relative to original investment over the lifecycle of the equipment uses a median ratio from Wu & Clements-Croome (2007) based on their analysis of a database of commercial / industrial HVAC system lifecycle costs over 25 years. In this regard, the annual O&M costs modeled in this analysis maybe be conservative (higher) because the costs are broken out over a shorter lifecycle than that used by Wu & Clements-Croome (2007).

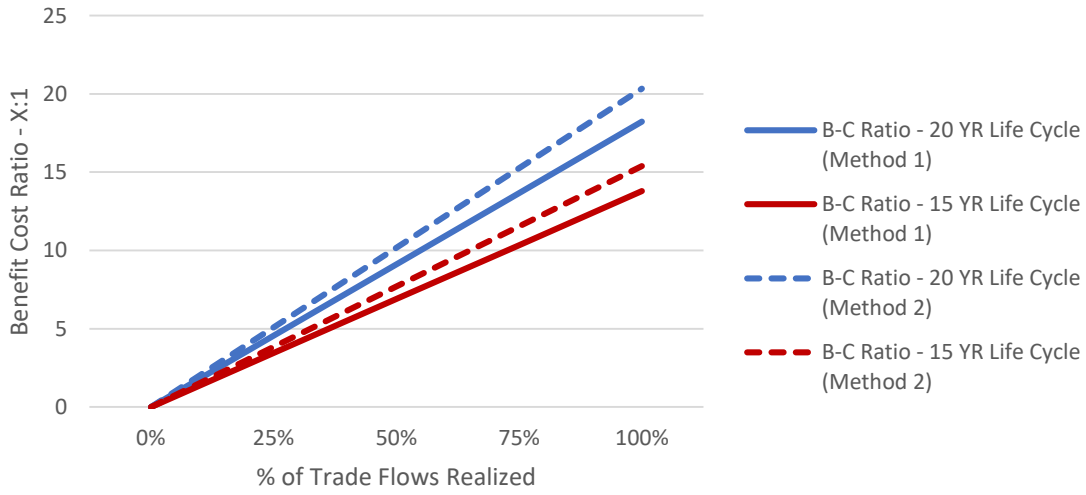
Based upon these assumptions, we see positive internal rates of return[3] (IRR) based on both trade flow modeling methods, from as high as 878% at 100% of maximum modeled trade flows. Positive IRR is maintained down to less than 2% of maximum modeled trade flows, at which the IRR become negative (Figure 18).

Figure 18. Internal Rates of Return on Cold Inspection Facility by Percentage of Maximum Modeled Trade Flows Realized



Similarly, we see benefit cost ratios[4] of investment in the cold inspection facility greater than 1 down to roughly 5% of maximum modeled trade flows realized (Figure 19). Note the difference between the benefit cost ratios using a 15-year life cycle assumption and a 20-year life cycle assumption. In this case, a shorter life cycle is modeled as both fewer years of business owner income and profits, but also higher per-year O&M expenses due to the total being divided out over fewer years, driving the divergence of the two estimates.

Figure 19. Benefit Cost Ratio of Cold Inspection Facility by Percent of Maximum Modeled Trade Flows Realized



[3] Internal rate of return (IRR) is a measure of the profitability of an investment and represents the discount rate that would generate a project net present value of zero.

[4] Net present value calculations used in computing the benefit-cost ratio assume a discount rate of 2.75% per the Federal Reserve Board primary credit interest rate as of December 6, 2018.

Assuming that trade flows proportional to the share of U.S. population and the share of U.S. consumer demand residing in the corridor containing Arizona, Utah, Nevada, Idaho, and Montana are realized, these figures suggest investment in the cold inspection facility would have a strong internal rate of return as measured by increases in business owner income and profits. If trade flows estimated in this study were realized at 100%, the project would have a benefit cost ratio as high as 20 to 1. It's important to note that these benefits would not accrue to a single entity, and the benefit-cost analysis and IRR calculation are only inclusive of direct business owner income and profits. Other positive economic impacts to the regional economy include increases in employment, wages, and tax revenues to state and local governments.

References

Bachmann, J. & R. Earles (2000). Postharvest Handling of Fruits and Vegetables. ATTRA. Retrieved from https://www.pma.com/content/articles/2015/05/cold-chain-defined

BLS (2018). Quarterly Census of Employment and Wages. Retrieved from https://data.bls.gov/cew/apps/data_views/data_views.htm#tab=Tables

BLS (2018b). CPI Inflation Calculator. Retrieved from https://www.bls.gov/data/inflation_calculator.htm

ERS (2018). Loss Adjusted Food Availability Documentation. Retrieved from https://www.ers.usda.gov/data-products/food-availability-per-capita-data-system/loss-adjusted-food-availability-documentation/

IMPLAN (2016). IMPLAN 3.1 Input-Output Model. IMPLAN Group LLC, 16905 Northcross Dr., Suite 120, Huntersville, NC 28078 www.IMPLAN.com

Johnson, R. (2016). The U.S. Trade Situation for Fruit and Vegetable Products. Congressional Research Service Report RL34468. Retrieved from https://fas.org/sgp/crs/misc/RL34468.pdf

PMA (2016). Cold Chain Defined. Produce Marketing Association. September 2016. Retrieved from https://www.pma.com/content/articles/2015/05/cold-chain-defined

SIAP (2018). Atlas Agroalimentario 2012-2018. Primera edición, 2018. Servicio de Información Agroalimentaria y Pesquera, SAGARPA. Retrieved from https://nube.siap.gob.mx/gobmx_publicaciones_siap/pag/2018/Atlas-Agroalimentario-2018

U.S. Census Bureau (2017). Table 1. Annual Estimates of the Resident Population for the United States, Regions, States, and Puerto Rico: April 1, 2010 to July 1, 2017 (NST-EST2017-01). December 2017.

U.S. Census Bureau (2018). U.S. Import and Export Merchandise trade statistics. USA Trade Online. Foreign Trade Division, U.S. Census Bureau. Retrieved from https://usatrade.census.gov/

U.S. Census Bureau (2018b) Table 4. Estimated Annual Purchases, Gross Margins, and Gross Margins as a Percent of Sales for U.S. Merchant Wholesalers, Except Manufacturers' Sales Branches and Offices: 1992 through 2016. Annual Report for Wholesale Trade, 2016. Annual Wholesale Trade Survey. Retrieved from https://www.census.gov/data/tables/2016/econ/awts/annual-reports.html

U.S. Census Bureau (2018c) Table 5. Estimated Annual Operating Expenses as a Percent of Sales for U.S. Merchant Wholesalers: 2002 through 2016. Annual Report for Wholesale Trade, 2016. Annual Wholesale Trade Survey. Retrieved from https://www.census.gov/data/tables/2016/econ/awts/annual-reports.html

USDA AMS (2018). Fresh Fruit and Vegetable Shipments. FVAS-4 Calendar Year 2017. United States Department of Agriculture, Agricultural Marketing Service, Specialty Crops Programs, Market News Division. June 2018.

USDA ERS (2018). Loss-Adjusted Food Availability. Food Availability (Per Capita) Data System. Retrieved from https://www.ers.usda.gov/data-products/food-availability-per-capita-data-system/.

Wu, S. & Clements-Croome, D. (2007). Ratio of operating and maintenance costs to initial costs of building services systems. Cost Engineering. Vol. 49, No 12, pp 30-33.