Produce Sourcing and Transportation Cost Effects on Wholesale Fresh Fruit and Vegetable Prices

Edward Roeger and Ephraim Leibtag
Economic Research Service,
United States Department of Agriculture*

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Background

Increased year-round sourcing of fresh fruit and vegetables has brought many benefits to consumers who now have access to a wider variety of healthier food choices throughout the year, but as items are grown farther away from final consumers, what are the tradeoffs between prices and distance traveled? Within food marketing, fresh produce represents a particularly interesting area of study for these issues because of the generally higher need for refrigerated transport, shorter marketing window for perishable goods, and longer distance from off-season production locations. U.S. consumption of imported fresh fruits and vegetables grew from 21.4 and 3.9 percent, respectively, in 1970-71 to 30.4 and 8.0 percent in 1989-90, and 45.3 and 17.2 percent in 2007-08. Even for domestic produce, growing locations have moved across the country to more productive areas (with California and Florida producing 33.2 and 9.1 percent of the total harvested fruit, nut, and vegetable acreage in U.S as of 2002). Although fuel prices were relatively stable during most of this growth period, recent patterns in world oil markets have shown to be much more volatile and energy prices are generally rising faster now than the 1985-2005 trend.

Purpose

We explore how much fuel prices impact wholesale fresh produce prices (by way of transportation costs) as distance to market varies both within the U.S., and from imports from both neighboring and distant countries.

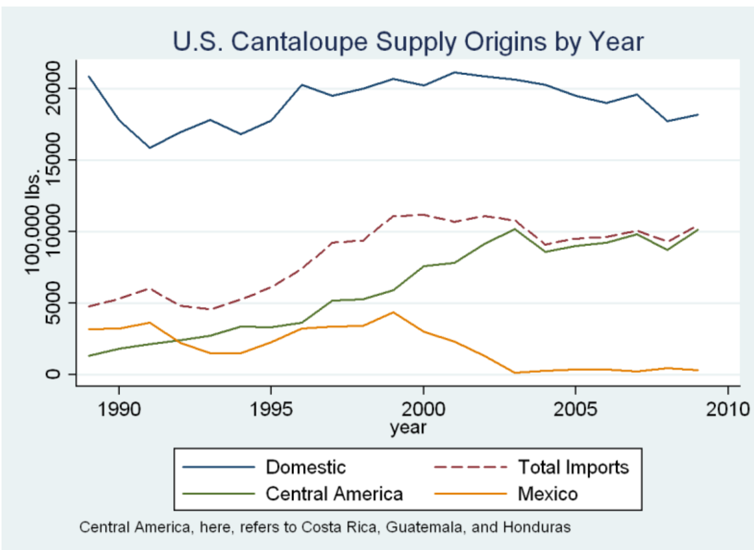
Methodology

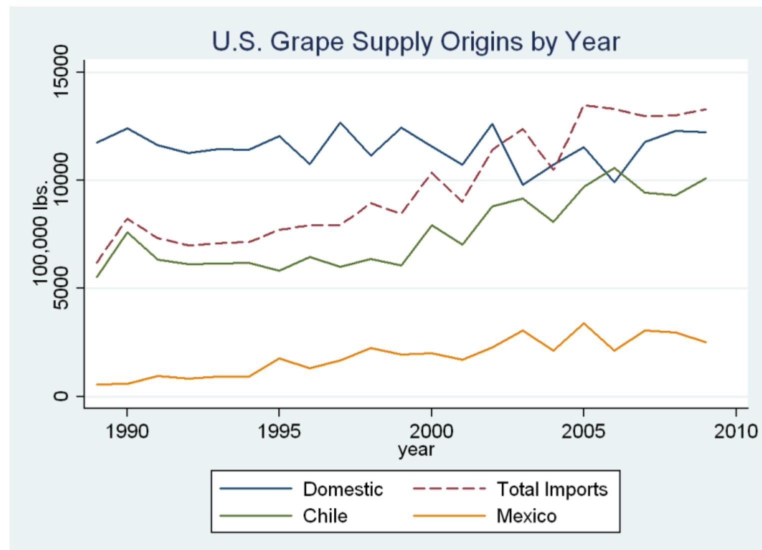
Our analysis is conducted in three parts using wholesale market price data for a selected number of produce items. Our results presented here generally focus on a U.S. regional basis and cover fresh cantaloupes, (table) grapes, oranges, and tomatoes. Each analysis proceeds with basic regression models that explain a dependent variable (with controls for relevant factors including a fuel price in all cases) that is part of the wholesale fresh produce supply chain: domestic truck rates for fresh produce hauling, price margins between farm and wholesale produce, and finally, the wholesale prices themselves.

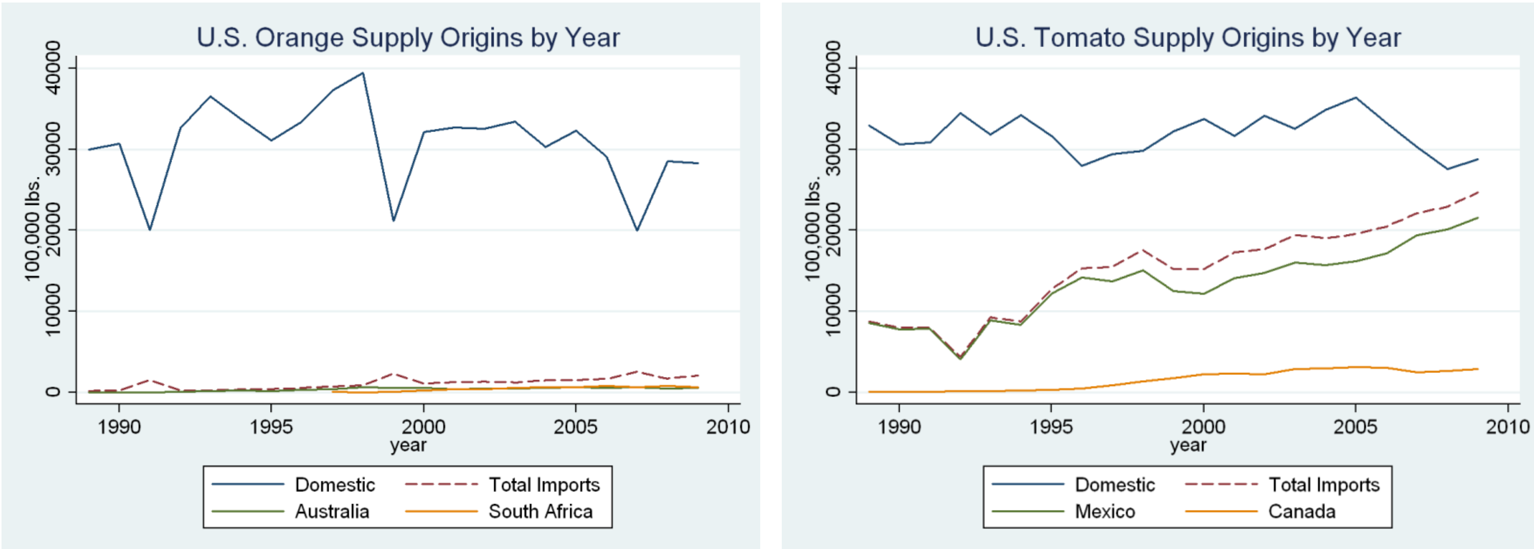
Data

We use wholesale fresh fruit and vegetable prices that were collected by the USDA Agricultural Marketing Service (AMS) for wholesale (terminal) market locations throughout the U.S. covering the period of January 1998 through December 2009 and include weekly aggregated price observations (that are the median of high/low ranges) differentiated by origin and a number of product specification variables. We analyze terminal markets located in: Boston, New York City, Philadelphia, Pittsburgh, Baltimore, Atlanta, Miami, Detroit, Chicago, St. Louis, San Francisco, and Los Angeles. Models are run separately by market, origin, and commodity with prices averaged based on a particular specification variable (e.g. item size or variety).

Annual U.S. Domestic Supply Origins, 1989 to 2009

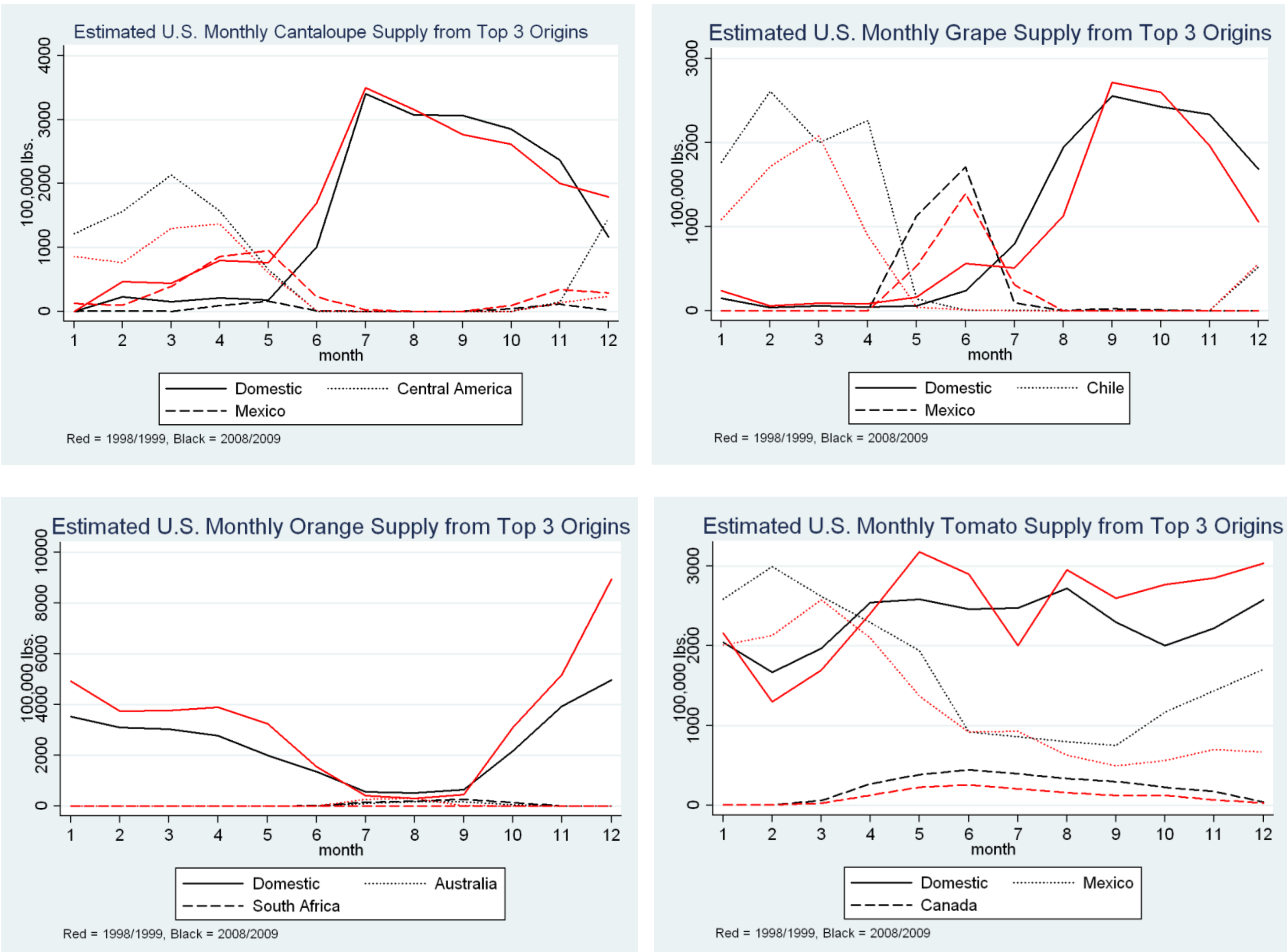






Source: USDA, Foreign Agricultural Service, National Agricultural Statistics Service, and Economic Research Service

Estimated Monthly Seasonal Supply Patterns, Comparison of 1998/1999 and 2008/2009 Averages



Source: USDA, Foreign Agricultural Service, National Agricultural Statistics Service, Agricultural Marketing Service, and Economic Research Service

Terminal Market Price Trends

These wholesale prices typically have strong intra-year cyclical components that follow seasonal supply shifts. For the produce items for which California is a dominant domestic supplier (i.e. cantaloupes, grapes, and oranges) domestic season prices in the sampled cities increase from west to east with distance from the production location in the domestic season. When other supply origins (e.g. Florida in the case of oranges) are also significant co-seasonal producers, this geographic correlation in the market price is not as clear. In the non-domestic season, this trend does not hold and price dispersion is lower across these markets.

Seasonal Marketing Statistics (2008/09 Averages)

		Season-Average Prices[1]		Domestic Season Offerings Shares[3]		
				Domestically Produced		
	City	Domestic	Non Domestic[2]	California	Not California	Import
Grapes						
	Los Angeles	1.06	1.18	95.2%	0.0%	4.8%
	Chicago	1.12	1.17	87.3%	1.1%	11.6%
	New York	1.23	1.28	90.8%	1.2%	8.0%
	Boston	1.37	1.38	87.5%	1.1%	11.4%
Cantaloupes						
	Los Angeles	0.24	0.36	56.5%	36.0%	7.5%
	Chicago	0.35	0.34	71.0%	23.3%	5.6%
	New York	0.38	0.33	64.7%	31.2%	4.0%
	Boston	0.46	0.39	66.8%	31.8%	1.3%
Oranges						
	Los Angeles	0.42	NA	79.7%	11.6%	8.7%
	Chicago	0.52	NA	55.5%	34.2%	10.3%
	New York	0.44	NA	62.7%	35.5%	1.8%
	Boston	0.54	NA	58.3%	32.4%	9.3%

Tomatoes					
Los Angeles	0.80	NA	21.2%	2.8%	76.0%
Chicago	1.04	NA	8.5%	34.1%	57.4%
New York	0.95	NA	7.9%	44.0%	48.1%
Boston	1.00	NA	3.5%	51.1%	45.4%

Notes: 1. Dollars per pound; the domestic season is defined as the weekly range where 80% of domestic offerings occur.
2. For oranges and tomatoes significant domestic production occurs throughout the calendar year, and so for these commodities, numbers are representative of the entire year.
3. Share of sale price observations within the domestic season.

Truck Rate Analysis

We next estimate how rates for produce transport routes of varying distances may be impacted differently by changing fuel prices. The price measure of interest is the cost in dollars per pound that is calculated from the weekly route price for full load produce truck transport between California (the San Joaquin Valley, specifically) and a number of cities across the U.S, covering the time period of roughly 2005-2009. We include a seasonal dummy variable, qualitative supply dummy variables, and the average of the previous five weeks U.S.-on-highway average diesel price (P_{diesel}) as explanatory variables.

We find several basic trends relating the transport cost to the distance traveled. First, in all routes, diesel prices were found to have a statistically significant effect on transport prices (with less than a 1 percent error rate) that increased with the distance that the route covered (from the San Joaquin Valley, California). Also, through comparing the average truck rates and estimated P_{diesel} coefficients, we find that the relative proportion of the overall transportation costs that fuel prices represent is lowest for the Northeastern routes and greatest for Los Angeles.

Regression Coefficients Average Rates for Truck Rate Analysis, By Route						
	Boston	New York	Philadelphia	Atlanta	Chicago	Los Angeles
ln (P_{diesel})	0.0599	0.0573	0.0566	0.0508	0.0430	0.0229
Avg. Rate[1]	0.1536	0.1483	0.1449	0.1184	0.1036	0.0261

Notes: 1. The dependent variable and the average rate are both expressed in dollars per pound.

Price Margin Analysis

To analyze price margin behavior, we use AMS-USDA free-on-board (FOB) shipping point prices in addition to wholesale produce prices so that farm prices (or a proxy for them) are controlled for as well. The use of this farm price proxy allows for greater focus on costs that exist between the two marketing stages but also restricts the available sample as FOB prices are consistently available only for commodities of domestic origin. This analysis, therefore, focuses only on wholesale price margins in which the growing origin is California because of its significant representation in all analyzed commodities. The regression dependent variable is the difference between terminal market and FOB prices (which are lagged one week) and explanatory variables include local and national supply variables, seasonal dummies, item specification dummies, dummies for qualitative demand measures at the shipping level, and the average of the previous five weeks U.S.-on-highway average diesel price.

We find general consistency in fuel price impacts across commodities for a given region, but there are also some differences that are likely due to co-seasonal supply issues (i.e. situations in which the market supply comes from another location as well as California). Comparing the results across regions, the average for all four of these commodities shows that as distance increases, so does the fuel price effect on the margin— California being closest to the original shipping point has the lowest coefficients, markets in the Midwest follow, and margins in the Northeast and Mid-Atlantic appear to be affected the most by fuel price changes. Mid-Atlantic estimates tend to be slightly higher than the Northeast possibly due to the greater distance from the Mid-Atlantic cities and import entry points. Across commodities, cantaloupe and orange margins are most affected by fuel price changes because of their overall lower margins (in dollars/pound).

Price Margin Analysis, Diesel Price Coefficients and Average Margins by Region									
	Grapes		Cantaloupes		Oranges		Tomatoes		Commodity
	Coeff.	Avg.	Coeff.	Avg.	Coeff.	Avg.	Coeff.	Avg.	Avg.
Northeast	0.101	0.272	0.068	0.145	0.072	0.182	0.058	0.230	0.075
Mid-Atlantic	0.121	0.264	0.078	0.159	0.101	0.183	0.076	0.250	0.094
Midwest	0.115	0.284	0.049	0.128	0.039	0.166	0.027	0.193	0.057
California	0.044	0.267	0.004	0.061	0.011	0.075	-0.004	0.126	0.014

Note: 1. The dependent variable and the average margin are both expressed in dollars per pound ($P_{TM} - P_{FOB}$), while the diesel price is in natural log form.

2. The dependent Diesel price coefficients were found to be statistically significant with a p-value less than or equal to 0.1 in 42 out of 44 models presented here.

A Price Analysis Considering Multiple Origins

Our final analysis proceeds in a similar manner to the price margin analysis except that shipping point prices are not included, so that the effects on produce from more origins can be considered. The regression dependent variable is the terminal market (weekly average) price and explanatory variables include local and national supply variables, seasonal dummies, item specification dummies, dummies for qualitative demand measures at the shipping level, and the average of the previous five weeks world crude oil price (this is used instead of the U.S. average diesel price because of the greater variety of produce origins). We run the model separately by terminal market and origin in this analysis.

Here, the ability to control for changing farm prices is traded for the chance to make comparisons among different origins. Thus, although estimates may be indicative of fuel price effects at both the farm level and in post-farm transportation costs, comparisons can now be made across vastly different routes and distances. For the coefficients on the domestically produced commodities, the general pattern appears to be similar to the previous price margin analysis in that the fuel price effect increases with distance (either from Florida or California). Also, interestingly, there are generally similar coefficients among origins within a commodity when multiple origins share a market at the same time (e.g. in the cases of oranges and tomatoes). Between imports and domestic produce items, the imports that are initially transported to the U.S. by ship (cantaloupes and grapes) generally show less fuel price sensitivity in coastal regions for grapes (with the exception of California) and in all regions for cantaloupes.

Price Analysis for Multiple Origins, Oil Price Coefficients by Origin and Region										
	Cantaloupes		Grapes			Oranges		Tomatoes		
	California	Central America[1]	California	Chile	Mexico	California	Florida	California	Florida	Mexico
Northeast	0.056	0.005	0.182	0.145	0.161	0.080	0.070	0.137	0.161	0.099
Miami	0.056	0.014	0.125	0.047	0.039	0.075	0.020	0.088	0.067	0.142
Mid-Atlantic	0.073	0.020	0.215	0.242	0.126	0.106	0.061	0.184	0.156	0.204
Midwest	0.053	0.001	0.187	0.181	0.232	0.054	0.047	0.066	0.148	0.111
California	0.022	0.001	0.131	0.201	0.131	0.039	NA	0.034	0.086	0.108

Notes: 1. Here, Central America includes Costa Rica, Guatemala, and Honduras.
2. Oil price coefficients were statistically significant with a p-value of less than or equal to 0.1 in 106 out of 110 models that these results represent.

Summary

Our analysis highlights some of the ways in which energy costs affect fresh produce prices. In nearly all cases, fuel prices were found to have a significant effect on produce prices, and in the most basic circumstances (for example, a within-season single dominant production location that relies on ground transportation to market) a clear geographic correlation between fuel price effects and distance exists. When market offerings become more diverse, geographic patterns still typically exist but other factors, such as competitive pricing for goods from different origins and transportation method(s) used, play a role as well.

For the commodities sampled, proximity to the major domestic growing regions of California and Florida dampened the effects of increased transport costs, while being situated near ports of entry for imports lowered the impact in certain cases for the Northeast region as well. We find that imports entering the country by ship tend to be less sensitive to fuel price movements than truck transport across the U.S. as long as the shipping origin is close to the U.S. or if the truck transport distance must cover most of the country. Among produce items, results show that cantaloupe prices (during the domestic season), with the lowest per pound price, have the proportionally greatest potential to be affected by increasing fuel costs, and that Chilean grapes have the greatest price sensitivity among the import products and origins that were analyzed.