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Mexicans Are Leaving Farm Work: What Does It Mean for U.S. Agriculture and Immigration Policy?

Diane Charlton and J. Edward Taylor

New econometric evidence shows a declining trend in the farm labor supply from households in rural Mexico, which are the main source of hired labor for U.S. agriculture. At the same time, after a decade of decline, employment on Mexico's fruit, vegetable, and horticultural farms is beginning to rise. This means that U.S. and Mexican farmers are competing for a dwindling supply of farm workers. Changing crop choice, technologies, and management practices, rather than immigration policy, will be the keys to adjusting to a new era of relative farm labor scarcity.

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In the mid-1900s Americans stopped doing hired farm work. We were not alone: In *all* countries, as per-capita incomes rise, people leave the hired farm workforce and the share of the workforce in agriculture plummets. Figure 1 illustrates a sharp decline in the share of the workforce employed in agriculture as per capita incomes rise across countries. Each diamond in the figure represents a country in 2008. The labels for Madagascar, China, Mexico, and the U.S. indicate the relative positions of four countries in different phases of agricultural employment and economic growth.

The United States averted a farm labor crisis by turning to its poor neighbor to the south. Mexico was at an early stage in the transition from farm to non-farm work. Immigration offered a solution to the U.S. farm labor problem.

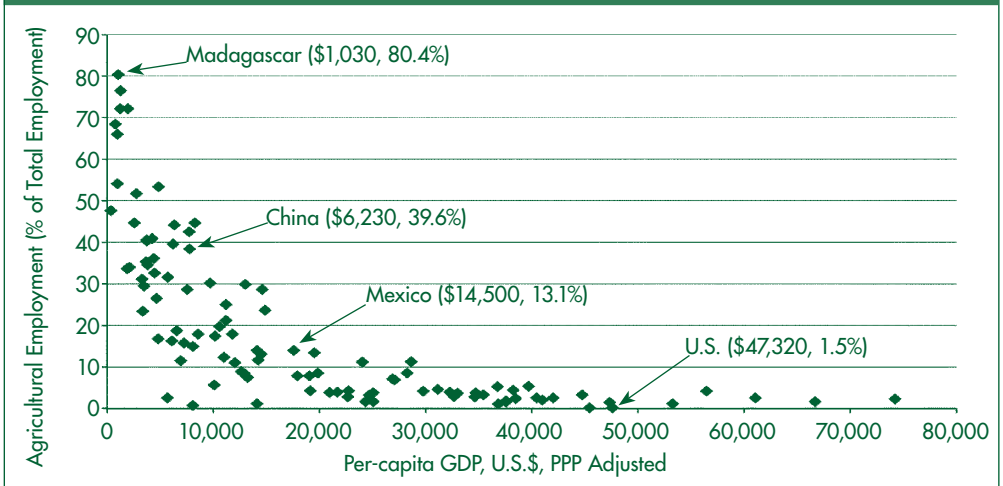
Our research shows that this era of farm labor abundance is coming to an end. There is a declining long-term trend in the farm labor supply from households in rural Mexico. There is also growing competition from Mexico's fruit, vegetable, and horticultural (FVH) farms to employ this dwindling supply of farm labor.

This means that immigration policy will cease to be a solution to the U.S. farm labor problem in the long run and probably sooner. In fact, we already may be witnessing the start of a new era in which farmers will have to adapt to labor scarcity by switching to less labor-intensive crops, technologies, and labor management practices.

The End of Farm Labor Abundance

For more than half a century, FVH farms in the United States had access to an

Figure 1. Farm Workforce Share and Per-capita Incomes, 2008



Source: The World Bank, World Databank, Development Indicators, 2008, http://databank.worldbank.org/data/

Figure 2. The Decline in Mexico's Farm Workforce, 1995–2010

Source: Taylor, Charlton, and Yúnez-Naude (2012)

abundant supply of low-skilled farm labor from Mexico at stable or decreasing real wages. Our analysis of new survey data from rural Mexico reveals that the supply of Mexican labor available to work on U.S. farms is decreasing. Mexico is following the familiar pattern of countries around the world: as its income rises, workers shift out of farm work into other sectors. Mexico's farm workforce fell by nearly two million workers (25%) between 1995 and 2010 (Figure 2). Meanwhile, productivity per farm worker in Mexico tripled.

Mexico's per-capita income, adjusted for the cost of living, now exceeds $15,000 per year. Growth in Mexico's non-agricultural employment began before the recession and persists now. As income and non-farm opportunities increase, the Mexican workforce will continue moving out of agriculture.

In fact, there are simply fewer low-skilled workers in rural Mexico than there used to be, due to a sharp decline in the fertility rate and a significant expansion in rural education. Average schooling is 4.9 years for rural Mexicans fifty or older; for people in their twenties it is 9.7 years. Better educated children eschew farm work in Mexico, just as they do in the United States.

Econometric Evidence of the Declining Farm Labor Supply

The Mexico National Rural Household Survey (Spanish acronym: ENHRUM) gathers panel data on individuals from a nationally representative sample of rural Mexican households. For each year from 1980 to 2010, the ENHRUM provides information on where each individual worked (locally, as a migrant in another part of Mexico, or in the United States), in what sector (farm or non-farm), and in what capacity (as a wage worker or self-employed). These data—a total of 105,389 person-years in all—are uniquely suited to study shifts in the farm labor force over time.

We estimated basic dynamic models of the propensity for rural Mexicans to do farm and non-farm work over the 31-year period covered by the panel. The findings reveal that the probability of engaging in farm work is decreasing significantly over time, while the probability of working in non-farm jobs is increasing.

The good news for farmers is that there is a great deal of *persistence* in farm work: if a rural Mexican does farm work one year, there is more than a 90% likelihood that he or she will do farm work the following year. The bad news is that a transition away from farm work in rural Mexico is underway. The supply of agricultural workers will not disappear immediately, but U.S. agriculture can expect to see a gradual decline in the availability of Mexican farm workers over time.

The recent recession provides additional insight into the declining farm labor supply. Before the recession, many California farmers complained that construction contractors were recruiting immigrant workers away from their farms. The "great recession" of 2008 had a large negative impact on construction and service jobs, but it did not affect agriculture; labor demand in the U.S. farm sector remained steady. We would expect, then, to see an increase in the farm labor supply, as unemployed workers returned to farm work.

Our data show the opposite. Figure 3 illustrates the percentage changes in numbers of rural Mexicans employed in different sectors and countries between the first (2002–2007) and second (2007–2010) two survey rounds. The share of rural Mexicans working in U.S. agriculture decreased more sharply than the share working in non-agricultural jobs. Our data permit us to track individual immigrants before and after the recession. Some people did switch from non-farm to farm jobs during the recession, but more moved off the farm—further evidence of a negative trend in the farm labor supply.

Why the Decrease in Mexican Farm Labor Supply?

The received wisdom in development economics is that the domestic supply of agricultural labor starts out being relatively elastic (i.e., abundant), but the farm labor supply shifts inward and becomes less elastic as countries' per-capita incomes increase and people shift from farm to non-farm jobs. In order to induce domestic workers to supply their labor to farm jobs, agricultural wages must rise apace with nonagricultural wages. This is all the more true if non-farm jobs bring non-pecuniary benefits compared to farm jobs and/or workers who associate farm jobs with drudgery.

An elastic supply of Mexican farm labor transformed the U.S. agricultural labor supply curve by flattening it out once it reached the reservation wage for migrant workers—that is,

the minimum wage required to induce new workers to migrate from rural Mexico to U.S. farm jobs. This reservation wage equals the wage rate in rural Mexico, or the marginal value product of labor, plus the costs—material or otherwise—associated with migrating to work on a U.S. farm.

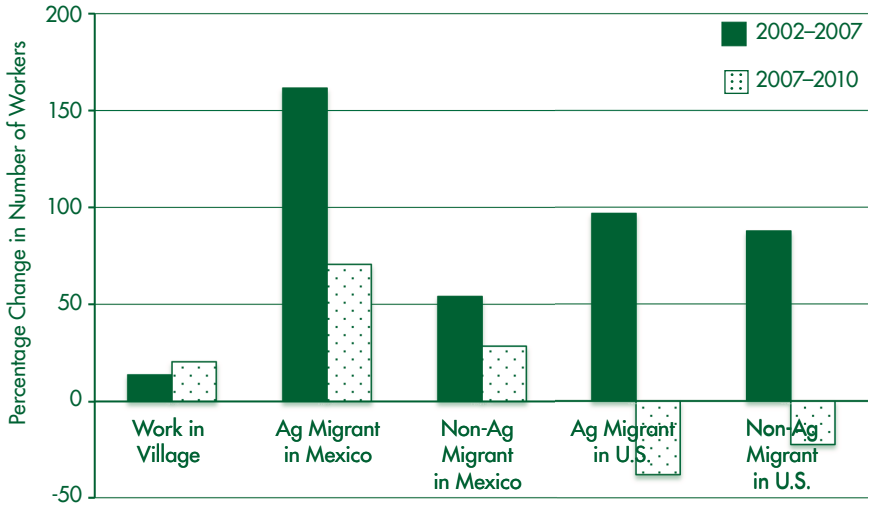
The result was a U.S. farm labor market with a high equilibrium quantity of labor, consisting mostly of Mexican workers, and a low equilibrium wage, equal to the reservation wage required to induce Mexican farm workers to migrate northward. In the United States, the share of domestic workers in the hired farm work force fell to the point where, by 2006, only 23% of workers (2% in California) were U.S.-born. The rest were immigrants. As Martin notes, "the farm workers of tomorrow are growing up outside the United States."

An elastic farm labor supply in Mexico, then, has been the key to U.S. farmers' access to an abundant supply of farm labor at a low wage. As the rural Mexican labor supply pivots inward, reorienting itself towards non-farm jobs, the reservation wage increases. Unless U.S. farm wages adjust, there will be an excess demand for Mexican farm workers, or as farmers commonly call it, a "farm labor shortage."

Competition from Mexican Farms

Recent developments in Mexican agriculture exacerbate the U.S. farm labor problem. Labor productivity in Mexican agriculture is rising. In the ten years following NAFTA, Mexico's agricultural production increased while its farm employment fell. Since 2007, however, Mexico's farm labor demand has increased slightly, fueled by an expansion of FVH production for exports and to feed Mexico's growing food demands. Clearly, in the face of an overall decline in the farm workforce, this cannot continue indefinitely without exerting upward pressure on U.S. as well as Mexican farm wages.

Figure 3. Percentage Change in Number of Workers Who Migrate to Each Sector by Survey Round



Source: Taylor, Charlton, and Yúnez-Naude (2012)

U.S. farmers thus face multiple sources of competition for rural Mexican labor: Mexican farms, the non-farm sector in Mexico, and labor-intensive industries and services (e.g., construction) in the United States, which is certain to rebound as the U.S. economy recovers from recession.

Is Legalization the Solution?

There are many reasons why legalization is a good idea, but ensuring an abundant farm labor supply is not one of them. Legalization increases workers' economic options in the United States, and this makes farm workers more mobile. Farm work traditionally has been a first stop for new immigrants, who move on to non-farm jobs when they are able. Legalization under the Special Agricultural Worker (SAW) program in the 1987 Immigration Reform and Control Act (IRCA) stimulated the movement of immigrant workers out of farm work.

Legalization conditional upon doing several years of additional farm work might contribute slightly towards stabilizing the farm workforce in the short run. However, with a backdrop of diminishing farm labor, research findings suggest it may do the opposite in the long run.

A New Farm Labor Dynamic

In the past, when legalized SAWs left agriculture, they left behind a vacuum that was quickly filled by newcomers. That is why the current share of illegal immigrants in the U.S. farm workforce is higher than it was before the 1986 legalization program.

This constant replenishing of the farm workforce with new immigrants is changing. The U.S. Department of Labor's National Agricultural Worker Survey (NAWS) found that foreign-born newcomers (first-time arrivals who had been in the United States for less than a year at the time of interview) comprised nearly a quarter (23%) of all crop workers in 1998–2000, but fell to just 9% in 2007–2009.

Border Enforcement and Violence

Tighter border enforcement and drug-related violence along the border may deter migration, but our analysis suggests that their effect on the farm labor supply is largely secondary, reinforcing a negative trend in rural Mexicans' willingness to do farm work.

If the decrease in immigration in recent years were the result of increases in border patrol or drug-related violence, the decrease in farm labor supply would be similar to the decrease in

non-farm labor supply. Our data show the opposite.

Implications for U.S. Immigration Policies

A declining farm labor supply in rural Mexico means that U.S. and Mexican farmers must compete for a gradually dwindling pool of farm workers. The combination of decreasing labor supply and growing demand for farm workers in Mexico raises the reservation wage of migrating to the United States—that is, the wage U.S. farmers have to offer to induce farm workers to migrate northward.

Our econometric analysis finds that increases in U.S. border enforcement do discourage international migration by farm and non-farm workers. This suggests that U.S. immigration policies could reduce farm labor pressures in the short run by opening the border for farm workers. Guest worker programs could enable U.S. farms to compete for labor more effectively with Mexican farmers.

Attempts to accommodate farm interests in immigration reforms, however, are a stopgap measure at best. U.S. immigration policies cannot change the reality that Mexico's workforce is moving out of agriculture. Immigration is a solution to the U.S. farm labor problem only if there is an ample supply of workers on the other side of the border willing to do farm work.

Limits to the Recruitment Solution

One solution in an age of growing farm labor scarcity is to seek migrant workers from other countries with lower reservation wages. However, the U.S.-Mexico situation is unique. Historically, two countries at vastly different levels of income shared a common border; today, the income gap between the United States and Mexico is shrinking.

Farther to the south, Central American countries have lower per-capita incomes than Mexico. In fact, Mexico now imports farm workers from Guatemala; it is in a transition phase of being both an exporter and importer of farm labor. However, Central America's populations are small compared with Mexico's, and they, too, are becoming less agricultural. Agriculture's share of the labor force is falling more rapidly in Guatemala, Honduras, and El Salvador than in Mexico.

The cost of importing low-skilled labor increases progressively as one looks farther afield, say, to Asia. Consequently, importing agricultural labor into the United States from more distant countries does not appear to be the solution to the farm labor problem.

The Labor Conservation Solution

Both U.S. and Mexican growers will have to seek labor substitutes as the supply of agricultural workers diminishes. Farmers will have to invest in labor-saving agricultural technologies, transition away from labor-intensive crops, and adopt labor management practices that make more efficient use of a smaller farm workforce. Capital improvements in farm production, like shake-and-catch harvesting, will increase the marginal product of farm labor, and U.S. farms will hire fewer workers at higher wages. This means wrenching changes for farms that cannot easily adjust their cropping patterns and technologies but new incentives to develop and adopt labor-saving methods.

What It All Means for Farm Workers and Rural Communities

The end of farm labor abundance could be good news for farm workers and rural communities. In 2007–2009, 23% of U.S. farm worker families had incomes below the poverty line. Studies show that between 1980 and 2000, growth in non-farm jobs reduced poverty, but growth in farm jobs did the opposite.

In the past, increased demand for farm labor induced new immigration from Mexico, while increases in the supply of farm labor through immigration stimulated growth in the agricultural sector, thereby increasing the demand for farm labor. The key to this circular relationship between farm labor demand and immigration was that the supply of immigrant farm labor was elastic; that is, immigration was responsive to changes in U.S. farm wages.

Our findings suggest that Mexico's farm labor supply is not as elastic as it once was. Raising worker productivity is a prerequisite for increasing farm wages and enabling farm worker families to rise above the poverty line. Rising farm wages, in turn, create an incentive for farmers to make investments that will make farm workers more productive.

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For additional information, the authors recommend:

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Taylor, J.E. 2010. "Agricultural Labor and Migration Policy." *Annual Review of Resource Economics* 2:369–93 www.annualreviews.org/doi/pdf/10.1146/annurev-resource-040709-135048.

The Elasticity of Demand for California Winegrapes

Kate B. Fuller and Julian M. Alston

The demand for California winegrapes is quite elastic–i.e., responsive to prices. This demand elasticity reflects substitution between wine from California and other sources and between quality categories. We estimate elasticities of demand for winegrapes from three regions of California that range from –2.6 to –9.5.

Winegrapes contributed roughly $2.1 billion, or 5.9%, to the total value of California farm production in 2010.

In California, grapes rank as the highest-valued agricultural crop and the second-highest valued agricultural product after milk and cream. Winegrapes alone contributed roughly $2.1 billion, or 5.9%, to the total value of California farm production in 2010, with a further $0.9 billion contributed by table grapes, raisin grapes, and grapes crushed for other uses. California produced 86% of both the volume and value of U.S. winegrapes in 2010.

Measures of demand response to economic factors, including price and income, are often used in economic analysis of markets and policies. The elasticity of demand for winegrapes is useful for estimating the price, quantity, and economic welfare effects of anything that causes a change in the production or consumption of winegrapes—new policy, disease, or pests, for example. Despite the economic importance of this industry, and the usefulness of elasticities, estimates of demand response for California winegrapes are scarce.

In our recent article in the *Journal of Wine Economics* we report estimates of demand response for California winegrapes. We also discuss the pitfalls and challenges of the estimation of demand response for commodities that are highly differentiated, with huge variation in price by agronomic variety, geographic location of production, and other characteristics that affect "quality" and end-use of winegrapes. Here, we summarize the main findings of that work, leaving aside the technical details, which can be found in the longer article in the *Journal of Wine Economics*. We focus on *price elasticities of demand* for winegrapes, which measure the percentage change in quantity demanded in response to a one-percent increase in price.

Conceptual Issues and Practical Considerations

Several aspects of the demand for California winegrapes are pertinent when estimating elasticities (measures of price and income responsiveness) that will be useful for policy and market analysis, and in interpreting the results from estimation. First, it is appropriate to estimate an "inverse" demand model, in which the market price varies in response to variations in market quantity, rather than vice versa. Winegrapes are a perennial crop, for which current production is determined to a great extent by decisions made years, or even decades, earlier. Thus, variations in the current market price have comparatively little influence over the quantity supplied in the current season. Consequently, we can treat year-to-year quantity variation as determined by factors other than the current price, including past vineyard investment decisions, as well as current pest and disease incidence and weather, and treat the market-clearing price as responding to these quantity variations.

Second, as for most farm commodities, the demand for California winegrapes does not reflect final consumer demand, but rather demand from processors who use grapes to produce a consumer product. This is important for how we approach the estimation problem and how we interpret the resulting estimates.

Third, California wine is sold in the rest of the United States and exported, and competes in these markets—even in California—with wine produced in other states and other countries. Thus, global supply and demand conditions influence the demand for California wine and hence the demand for California winegrapes from which California wine is derived. With close substitutes in the market (in the form of wine produced elsewhere), we expect the quantity of California winegrapes demanded to be more sensitive to price than it would be otherwise.

Fourth, wine is highly differentiated, made from highly differentiated winegrapes of many varieties produced across a diverse range of agroecologies. Reflecting this differentiation and diversity, the California Department of Food and Agriculture (CDFA) collects

Table 1. Regional Statistics for California Winegrapes, 2010 Values

California Winegrape Region	Value of Production	Average Price	Total Crush	Bearing Area	Average Yield
	Millions of 2010 $	2010 $/ton	Thousands of Tons	Thousands of Acres	Tons/ Acre
High-Price (H)	835.0	2,526	331	100.4	3.30
Medium-Price (M)	1,051.6	737	1,427	224.3	6.36
Low-Price (L)	529.8	289	1,831	132.2	13.85
State Aggregate	2,416.4	673	3,589	456.9	7.85

detailed data for each of the 17 geographically based California "crush districts." Broadly speaking, Napa and Sonoma vineyards produce comparatively few tons per acre at comparatively high cost per ton. In the Central Valley, especially in the southern San Joaquin Valley, yields are up to 10 times higher and grape prices per ton are in the range of one tenth of prices in the Napa and Sonoma crush districts. The rest of the state has a range of yields, costs and prices that fall between these extremes.

For the purposes of our demand analysis, we aggregated the 17 crush districts into three regions that we defined as "High," "Medium," and "Low" based on their average winegrape prices, while noting that every region produces a range of winegrape varieties and characteristics. The regions are depicted in Figure 1. Table 1 presents regional statistics on value of production, average price per ton, total crush, and average vineyard yield in 2010.

Derived Elasticities of Demand

As noted, in this work we focus on price elasticities of demand for winegrapes, which measure the percentage change in quantity demanded in response to a one-percent increase in price. James Fogarty (2010) reviewed the worldwide literature on demand for alcohol. He reported estimates of the own-price elasticities of demand for beer, wine, and spirits from 141 studies. He reported 177 estimates of the elasticity of demand for wine with respect to its own price (31 of which refer to the United States) ranging from –1.86 to –0.18.

These are measures of price responsiveness of demand for *wine,* a finished product, which is different from the demand for *winegrapes*, an input. In what follows we use an average value of –0.80 for the elasticity of demand for wine together with other information to derive estimates of elasticities or price responsiveness of the demand for California winegrapes.

The demand for California winegrapes as an aggregate category is derived from the demand for California wine in conjunction with technology of winemaking and the supply of winemaking inputs. Hence, the elasticity of demand for California winegrapes can be represented as a specific mathematical function of several factors including:

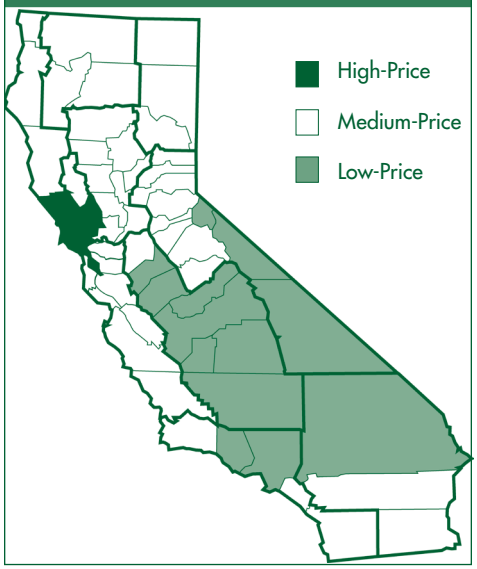
- the overall elasticity of demand for wine from all sources
- the elasticity of supply of winegrapes in the rest of world (ROW—representing all regions other than California)
- the elasticity of price transmission between countries or regions, and
- the elasticity of supply of winemaking inputs other than grapes.

We evaluated this equation using a range of values for the parameters related to ROW winegrape supply response, supply response of winemaking inputs, and international price transmission, combined with a value of –0.80 for the elasticity of demand for all wine. The resulting estimates of the own-price elasticity of demand for California winegrapes range from –0.4 to –4.5. The range reflects alternative assumptions about the elasticity of supply of winegrapes from the rest of the world, price transmission, and the elasticity of supply of other winemaking inputs. Using intermediate values for these key parameters and available data, we estimated the overall elasticity of demand for California winegrapes as –2.2.

The demand for California winegrapes can be further decomposed into interdependent demands for winegrapes by quality category. The corresponding elasticities of demand for winegrapes from different quality regions can be measured as a function of the overall elasticity of demand for California winegrapes, market shares, and the extent to which the different quality categories can substitute for one another in winemaking.

We derived the equations for these disaggregated elasticities and evaluated them using data on market shares, the intermediate value for the overall elasticity of demand for California winegrapes (–2.2), and a range of substitutability (low, moderate, and high) between the different qualities of winegrapes. Allowing for quality differentiation

Figure 1. California Winegrapes Regions



and imperfect substitution among winegrapes from the three different regions—as defined Figure 1—gives a full set of own- and cross-price elasticities as shown in Table 2. (The own-price elasticities reported here are the percentage change in quantity demanded of a particular quality category of winegrapes in response to a one percent increase in its own price. The cross-price elasticities are the percentage change in quantity demanded of a particular quality category of winegrapes in response to a one percent increase in price of a different quality category). The own-price elasticities are in boldface.

Table 2. Elasticities of Demand for California Winegrapes

Quantity Region	Price Region	Alternative Sets of Derived Estimates s = 3	s = 5	s = 10	Econometric Estimates
		(1)	(2)	(3)	(4)
L	L	**–2.9**	**–4.5**	**–8.7**	**–2.6**
	M	0.4	1.2	3.4	–0.6
	H	0.3	1.1	3.0	3.1
M	L	0.1	0.5	1.3	–0.5
	M	**–2.6**	**–3.8**	**–6.6**	**–5.2**
	H	0.3	1.1	3.0	5.0
H	L	0.1	0.5	1.3	1.9
	M	0.4	1.2	3.4	5.6
	H	**–2.7**	**–3.9**	**–7.0**	**–9.5**

Notes: Entries denote the percentage change in quantity of winegrapes from each respective "Quantity Region" with respect to a one percent increase in price of winegrapes from each respective "Price Region." "L" denotes the low-priced region, "M" denotes the medium-priced region, and "H" denotes the high-priced region. Derived estimates in columns (1), (2) and (3) are based on low (s=3), medium (s=5), or high (s=10) substitutability between winegrapes from different regions.

Econometric Estimates

In addition to the "derived" estimates just discussed, we estimated elasticities using an econometric model of demand. We estimated inverse demand system models for the three quality-cum-regional categories of winegrapes defined in Figure 1 and with differences in average prices and yields as illustrated by the summary statistics in Table 3. The models were estimated using annual data on prices and quantities of California winegrapes taken from the annual NASS/CDFA Crush Reports for the years 1985–2010.

Table 2 shows the elasticities estimated using this method in Column (4). The own-price elasticity of demand for high-priced winegrapes is fairly large in magnitude (–9.5), suggesting that a one percent increase in price for winegrapes from Napa and Sonoma counties, holding all other prices constant, would induce a 9.5% decrease in quantity demanded. The other own-price elasticities are substantially smaller in absolute value (–5.2 and –2.6); a one percent increase in price for medium- or low-priced winegrapes, holding all other prices constant, would result in roughly a 5.2% or 2.6% decrease in quantity demanded, respectively.

Thus, demands for all three categories are fairly elastic. The econometric estimates indicate that demand for high-priced winegrapes is the most elastic and the demand for low-priced winegrapes, mostly from areas in the southern San Joaquin Valley, is the least elastic. We might have anticipated the converse, given the very strong international competition in the bulk wine market, and we have some reservations about putting too much credence in any particular disaggregated elasticities for particular quality categories estimated in this fashion.

Several points are clear from the comparison of the econometric estimates in Column (4) and the derived estimates in Columns (1), (2), and (3)—the latter computed using a range of assumptions about substitutability among different qualities of winegrapes (low, moderate, or high) and an elasticity of aggregate demand for California winegrapes of –2.2.

First, reflecting our assumptions, the derived estimates of cross-price elasticities are all positive numbers whereas some of the econometric estimates are negative numbers, indicating complementary relationships—though small values relative to the negative own-price and positive cross-price effects. While cross-price elasticities are of some interest, analysts are typically more concerned with own-price

Table 3. Data Sample Statistics by Region of California, 1985–2010

	California Winegrapes, Annual Quantity Crushed by Region				California Winegrapes, Annual Average Price by Region			
	High Price (H)	Medium Price (M)	Low Price (L)	State Total	High Price (H)	Medium Price (M)	Low Price (L)	State Avg.
	(thousand tons per year)				(2010 $/ton)			
Average of Annual Values	262.3	787.1	1,415.5	2,465	2,118	866	290	674
Standard Deviation	63.0	383.1	147.1	541.1	621	180	58	141

elasticities, and for this comparison we would place greater weight on own-price elasticities while giving some weight to cross-price elasticities.

Second, while the econometric estimates are broadly comparable to the derived estimates they are not completely consistent with any particular assumption about the degree of substitutability, denoted s, among winegrape qualities. The econometric estimates for the "Low"-price region are closest to the derived estimates assuming low substitutability (s=3); those for the "Medium"-price region are closest to the derived estimates assuming moderate or high substitutability (s=5 or 10); and those for the "High"-price region are closest to the derived estimates assuming high substitutability (s=10).

Conclusion

This article presents estimates of price responsiveness (or elasticities) of demand for winegrapes from different regions in California, differentiated on the basis of average prices as an indicator of quality. It adds to the wine economics literature by estimating measures of demand responsiveness for the most important input in winemaking—winegrapes—comparing derived and econometric estimates. The two approaches have different strengths and weaknesses and in this sense they are complementary.

Our derived estimates of elasticities of demand for wine and winegrapes were calculated using readily available information along with careful guesswork and sensitivity analyses where data were not available. These calculations show that basic estimates of demand elasticities can be made without econometric estimation, but that the results can be sensitive to assumptions and thus are conditional and uncertain.

Previous studies have estimated elasticities of demand for wine by final consumers. These studies suggest that the overall demand for wine in total is probably inelastic—that an increase in price results in a less-than proportional decrease in quantity demanded. We use a value of –0.8 as our best estimate of this elasticity. Using this estimate and other information, we derive estimates of the elasticity of the demand for California winegrapes as an aggregate input to wine production ranging from –0.4 (in the very short run) to –4.5 (in the very long run).

The longer-run elasticities represent the consequences of substitution between wine from California and other places and between winegrapes and other winemaking inputs when the price of California winegrapes changes. In the very short run, the demand for aggregated California winegrapes is inelastic. This means that, holding other factors constant, weather damage causing yield losses in the current season will result in a more-than proportionate increase in price and thus an increase in the total value of the crop. In the long run, however, demand is elastic. Hence, holding other factors constant, increases in production resulting from investment in capacity will result in much less-than proportional decreases in price, and an increase in the total value of the crop.

We use an intermediate value of –2.2, for the elasticity of demand for California winegrapes in aggregate, to derive elasticities of demand for the three quality categories of California winegrapes as would apply if we allow some time (say, several years) for response in production of winegrapes and winemaking to changes in winegrape prices. The resulting own-price elasticities range from moderately elastic (around –3) to highly elastic (around –7), depending on the assumed degree of substitutability among different qualities of winegrapes.

Our econometric estimates, based on 25 years of data, also suggest that the demand for every category of California winegrapes is quite elastic, consistent with the derived elasticities, albeit with some differences in detail. The two approaches yield estimates that are of comparable magnitudes, at least for the majority of combinations of parameter values used for the derivations. The two approaches are complementary, each providing reinforcement to the other and strengthening our confidence in the general results, which indicate that the demands for individual categories of winegrapes are elastic and that winegrapes from different regions are substitutable for one another to some extent.

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For additional information, the authors recommend:

Fogarty, J. 2010. The Demand for Beer, Wine, and Spirirts: A Survey of the Literature. *Journal of Economic Surveys*, 24, 428–478.

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New Demand for an Old Food: The U.S. Market for Olive Oil

Bo Xiong, William Matthews, and Daniel Sumner

Olive oil consumption and imports have grown rapidly in the United States, tripling over two decades. Virgin oil accounts for much of the growth that is driven by higher incomes and changes in information about the role of olive oil in a healthy diet. Quantities consumed of particular types and import sources of olive oil are sensitive to relative prices.

Olive oil is hot. From the *New York Times* to the *New England Journal of Medicine* to the U.S. International Trade Commission (USITC), olive oil is making news and raising important economic and policy issues.

The California olive oil industry is also hot. Planting, production, and the reputation for quality are all increasing. Leaders in the California industry have plans to improve its competitive position in the market and become a major crop in the state. To act on their plans, however, they need more information and analysis.

To understand how the market for olive oil in the United States is evolving and the importance of economic trends and policy initiatives, we must examine the market in some detail, including how factors such as prices, income, and new information affect quantities of olive oil demanded. This article begins this detailed examination.

Global production of olive oil increased from less than 1.5 million tons in 1990 to over 3 million tons in 2012. (All "tons" in this article refer to "metric tons.") Major producing regions, which surround the Mediterranean Sea, produce about 95% and consume about two-thirds of the world's olive oil (Table 1). About 300,000 tons of olive oil were sold in the United States in 2012, tripling the quantity sold in 1990. Thus, U.S. consumption now accounts for about 10% of world production.

Spain is the world's largest olive oil producer, with Italy a distant second. Spain exports more than half of its production—most to destinations within the EU. Italy is a major exporter to destinations outside of the EU and some of what is exported from Italy is oil produced elsewhere. North Africa is a major producer and an even more important exporter of olive oil. The U.S. industry produces only 4,000 tons of olive oil annually, or only about 1.3% of U.S. consumption.

Figure 1 shows clearly that imports account for almost all the growing consumption of olive oil in the United States. Figure 1 also shows that virgin olive oils account for most of the growth of U.S. imports. The U.S. imported 200,000 tons of virgin olive oil in 2012—two-thirds of total imports. While the EU (led by Italy, Spain, and Greece) remains the dominant supplier of olive oil to the United States, shares from non-EU countries (especially Tunisia and Morocco) have grown.

Policy Interventions, Quality Controls, and International Trade

As part of an ongoing study requested by Congress, the United States International Trade Commission held a public hearing in December 2012 to assess the U.S. competitiveness in olive oil in the context of market trends and policies, especially in Europe. At the USITC hearing U.S. olive oil industry representatives expressed concerns about European olive oil policies as well as global quality standards and compliance.

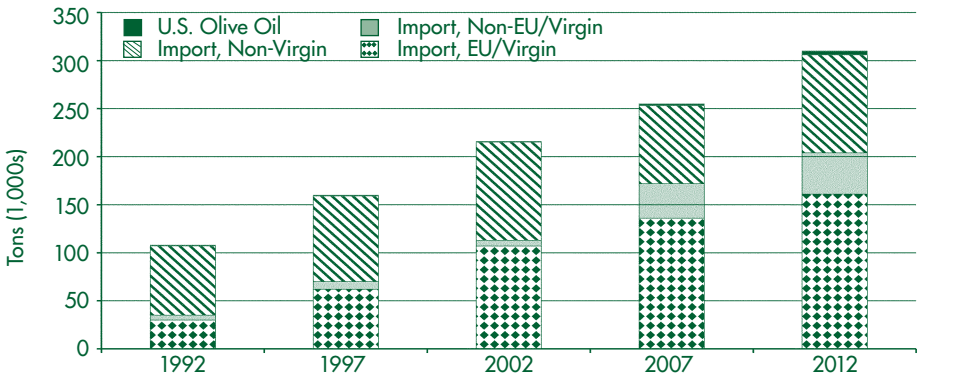
The European Commission has provided substantial support for its olive industry for decades. Until the mid 2000's, the European Union tied financial support directly to production of olive oil. Support to the industry continues, but is less direct; now, the EU ties payments to recent capacity to produce an aggregate of commodities and as an incentive to meet environmental standards. For olive oil specifically, the EU also offers

Table 1. World Production and Exports of Olive Oil (1,000 tons), Market Year 2010/11

	Production(%)	Export (%)	
		Extra-EU	Intra-EU[a]
Spain	1392 (45%)	196 (28%)	650 (67%)
Italy[b]	440 (14%)	224 (32%)	151 (16%)
Greece	301 (10%)	13 (2%)	100 (10%)
All EU-27	2209 (72%)	481 (69%)	967 (100%)
North Africa[c]	336 (11%)	139 (20%)	
Other Med Countries[d]	412 (13%)	39 (6%)	
United States	4 (0%)	-275	
Rest of World	114 (4%)	37 (5%)	
World Production/Export	3075 (100%)	696 (100%)	

Sources: International Olive Council and for EU trade information UN-Comtrade.
Notes: a. Intra-EU export is the average export of 2010 and 2011. b. Italy is a net importer when both extra-EU and intra-EU trade are considered. c. North Africa includes Tunisia, Morocco, Algeria, Egypt, and Libya. d. Other Mediterranean counties include Turkey, Syria, Israel, Jordan, and Lebanon.

Figure 1. U.S. Consumption of Olive Oils, 1000 Tons



Source: International Trade Commission and USDA-Foreign Market Service PSD online.

"Private Storage Aid" that pays whenever market prices of olive oil are lower than government-set minimums. Such aid was provided in 2011 and 2012.

Subsidies for olive oil vary by country within the EU and aggregate figures are difficult to assemble. In a 2012 statement, the Spanish Minister for Agriculture, Food and Environmental Affairs said that subsidies were equal to about 40% of the value of Spanish olive oil, with aid of about $1.3 billion. (Quoted in *Olive Oil Times*, April 2, 2012.)

Lack of quality control and standards also raises concerns among U.S. industry representatives. The retail grades and quality standards developed by the International Olive Council are not binding in the United States, and the U.S. Department of Agriculture quality monitoring program that was launched in late 2010 is only voluntary.

Olive oil producers in Europe and U.S. importers of olive oil from Europe have expressed concerns about the U.S. government investigations. European producers asked the European Commission to be ready to act on the potential threats of U.S. trade barriers.

Summary of Data and Methods for Statistical Analysis of Demand

Data on olive oil imports into the United States are available by point of entry, country of export, container size (bulk or packaged), and "quality"—as indicated by the "virgin" designation. No publicly available data provide information on country of production of the oil (for example, if it is shipped between countries before export to the United States) and import data do not record "extra virgin" or other more-specific quality characteristics.

Olive oil is sold into three broad channels in the United States: (a) retail packages of olive oil sold to consumers, (b) olive oil sold to food service establishments for cooking and table use, and (c) olive oil used in food processing and sold as an ingredient in other foods such as sauces.

Olive oil imported in bulk containers (typically bladders holding thousands of liters) may be delivered to food processing firms, but most bulk oil is packaged in the United States for food service or retail sales. Bulk shipments have been increasing because of improved technology and the cost savings inherent in not shipping fragile and heavy retail containers. Because the consumers and market channels are mostly the same for bulk and bottled imports, we aggregate oil imported in different containers.

We estimated demand equations for three categories of olive oil at the wholesale/import stage of the market. We use the quantity of per capita imports each month to measure quantity demanded. For the relevant prices, we use average unit values computed as the ratios of import values to quantities. We treat the United States as a price-taker in the world market for olive oil because the United States accounts for less than 10% of the world consumption, so we would not expect changes in import prices to be caused by changes in U.S. demand. In fact, import prices have fluctuated widely—driven by exporting country production and demand (Figure 2).

One concern is that given how we measure price simply as the import value divided by the import quantity, errors in the measurement of quantities would exaggerate the measured price responses in the estimation by creating an additional negative correlation between measured quantity and measured price. However, after reviewing the variations in import series by port of entry and using standard statistical tests for potential bias caused by measurement error in import prices, we conclude that any remaining bias is small in magnitude.

To complete the demand model, we use per capita U.S. personal income, the number of articles published in U.S. newspapers and magazines that report either the health benefits or the Mediterranean diet attributes associated with olive oil to account for consumer awareness, imports of Italian-style cheese and the price of canola oil—a potential substitute. Finally, we include monthly indicators to reflect seasonality and deflate all prices and income by the CPI.

For most of the discussion here, we group olive oil into three categories: virgin oils imported from the EU, virgin oils imported from elsewhere, and non-virgin oils. The classification accounts for the quality difference in olive oils and is supported by the price relations in Figure 2. We estimate separate price and income effects and substitution relationships across olive oils.

Key Findings About Olive Oil Demand in the United States

Our set of estimated demand equations includes the impacts by type of olive oil. We also use our estimates by type of oil to calculate effects for all olive oil considered as an aggregate.

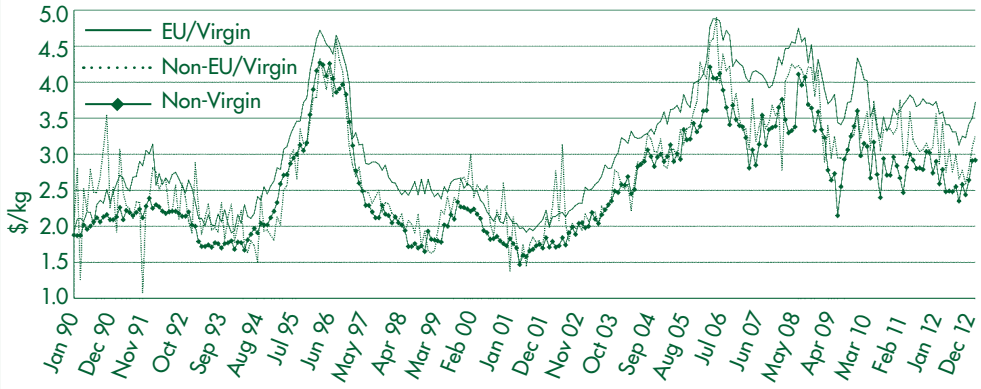
We evaluate the estimated elasticities of demand (the percentage change in the consumption quantity in response to a 1% increase in each demand determinant) at recent average prices and quantities (the three-year period January 2010 to December 2012).

The U.S. quantity demanded for all olive oil falls when the average price of olive oil increases, but the percentage effect is small. A 10% increase in the price of all olive oil would reduce U.S. total consumption of olive oil by about 2%. Because of substitution among olive oils, the price elasticity of demand for each individual olive oil type is larger.

We find that the quantity demanded of EU virgin oil would increase significantly with a 10% increase in the price of virgin oil imported from non-EU countries, but U.S. consumption of both types of virgin oils is insensitive to changes in the price of non-virgin oils. That is, virgin oils imported from EU and non-EU countries tend to substitute for each other, but non-virgin oils do not seem to compete significantly with virgin oils. We find that canola oil is a slight substitute for olive oil as a group, but the substitution effect applies mostly to non-EU virgin oil.

We also find that U.S. consumption of olive oil would grow by about 10% if U.S. personal income grows by 10%. Most of the income effect applies to EU virgin olive oil, which would rise by more than 20% with an increase in income of 10%. In contrast, the consumption of non-virgin oil has no statistically significant response to an increase in personal income. Finally, we find that accumulated information about the healthiness and trendiness of olive oil (measured by the number of articles published in the popular press) and the ongoing globalization of the American diet (measured by the quantity of imports of Italian-style cheese) both stimulate more olive oil consumption in the United States.

Figure 2. Unit Values of Olive Oil Imports, $/kg, January 1990–December 2012



Source: International Trade Commission

Alternative aggregations, specifications, and methods used to check robustness of our estimated impacts, yield results that are consistent with those reported here.

Final Remarks

Olive oil consumption has been growing rapidly in the United States, but U.S. production remains a tiny part of the total supply in the U.S. market. Virgin oil imports have been gaining, as have imports of olive oil directly from North Africa—both at the expense of non-virgin oil from the EU. These trends have generated controversy as the U.S. industry seeks to evaluate how EU policies and lack of consistent mandatory quality standards affect demand and market shares for olive oil. We find that attention to the health benefits of olive oil and its place in a flavorful and healthful Mediterranean diet has contributed to growth in consumption. Olive oil consumption also responds to income growth and to relative price changes.

The currently available data have not allowed us to estimate impacts of prices, income, or market trends on the consumption of olive oil produced in the United States. Nonetheless, the growing market provides opportunities and U.S. industry can gain insights from analysis of market relationships and estimates of effects of prices and other factors on olive oil imports.

Much more work is needed to understand olive oil demand more fully and to place the demand analysis reported here in a context that allows one to evaluate impacts of policy. We are engaged in such a project and expect to report results later this year.

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