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Olive Oil: A "Rediscovered" California Crop

by

Olga Senise Barrio and Hoy Carman

Increasing demand for olive oil has encouraged many small California olive producers to concentrate on oil production for a high-quality, premium-price niche market. This market will remain small due to economic relationships. Ê

Growing U.S. demand for olive oil related to publicity concerning its health benefits, has led to increased imports and renewed interest in oil production by California olive producers. Many have entered value-added production of olive oil targeted to a premium-quality niche market, and marketing of boutique olive oil appears to have taken on some of the characteristics of boutique wines. Growing interest in olive oil production raises questions about its economic potential. This article examines some of the history and economics of olive and olive oil production in California with comparisons to Spain, the world's largest olive producer.

Industry Background

Early California olive production was for oil but the emphasis changed to production of table olives in the early 1900s with the advent of canning technology and higher returns for canned olives. Recently, 90 percent of California olive production has been canned, with ten percent crushed for oil. The roles are reversed in Spain and other Mediterranean countries, with about 90 percent of the crop crushed for oil and only about ten percent used for cured olive products.

Olives are an important California crop but the California olive industry is dwarfed by Spain's olive acreage and production. In 2002, the Census of Agriculture found that California had 39,591 acres of olives grown on 1,549 farms, while Spain had 5,662,139 acres of olives grown by 571,150 producers. Thus, the acreage devoted to olive production in Spain is over 140 times larger than in California.

Olive acreage per farm is relatively small in both California and Spain, with an average size of 25.55 and 9.91 acres, respectively. Spanish statistics classify 5,274,710 acres (93 percent) as designated for oil production and the remaining 387,691 acres (seven percent) for table olives. A recent California survey conducted by Vossen and Devarenne found 6,168 acres of olives for oil production (approximately 15.6 percent), which would leave about 33,423 acres (84.4 percent) for production of table olives (assuming that total acreage was constant between the 2002 Census and the Vossen and Devarenne survey). There are 528 California olive producers with an average of 14 acres of olives grown for oil.

The Spanish industry is oriented to dryland production (only about 13 percent of olive acreage is irrigated), with many groves planted on rolling hills with rocky soils that will produce few other crops. In contrast, California olive production is concentrated on level and productive irrigated land in the Central Valley. However, even the small percentage of irrigated olive acreage in Spain is over 736,000 acres.

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Average annual yields vary significantly between Spain and California as a result of differences in soil quality, irrigation, management practices and varieties, as well as the alternate bearing tendencies of olive trees. California olive production averaged 108,000 tons annually from 1999 through 2002, while Spanish production averaged 5,024,995 tons for the same period. Overall, average per acre Spanish yields are less than one-half of California's but, with its huge acreage, Spain's annual total olive production is more than 50 times larger than California's.

Production of Olive Oil in California

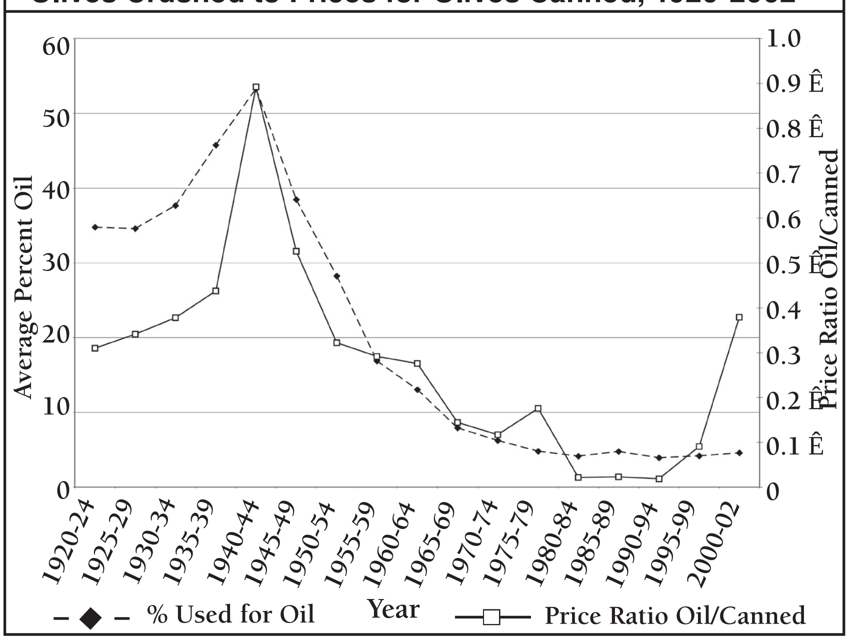
The annual utilization of the California olive crop is driven by economics, as shown by the close relationship between the proportion of the crop used for oil and relative returns from oil. Five-year averages of the proportion of California's annual olive crop crushed for oil and the ratio of prices of olives crushed to prices of olives canned are plotted in Figure 1 for 1920-2002. Note that the proportion of California's olive crop crushed for oil increased after 1920, peaking at an average of 53.3 percent during the World War II years of 1940-44. The prices that producers received for olives used for oil also increased relative to prices of olives canned during the same period, peaking at an average of 89 percent.

Average annual prices of olives used for oil dropped to $12 per ton in 1980 and remained in a range of $8 to $17 per ton through 1998. Note that prices reported were for cull table fruit through 1998. The higher returns available for olives used for small-scale production of premium olive oil began to affect industry statistics in 1999, when average prices of olives used for oil increased to $200 per ton. Average prices of olives used for oil increased further to $300 per ton in 2000 and 2001, before decreasing to $240 per ton in 2002. Average returns for olives used for oil continue to be significantly below those canned and the proportion of the crop used for oil has remained under six percent since 1985. Crop utilization for oil and the ratio of prices of olives used for oil to prices of olives canned can be expected to increase, however, as the premium-quality, premium-price olive oil market niche grows.

Economic Feasibility of Oil Production

U.S. consumption of all salad and cooking oils increased steadily from 15.4 pounds per capita in 1970 to 33.7 pounds per capita in 2000. Imports of olive oil, which account for over 99 percent of U.S. consumption, increased from 97 million pounds in 1985 to 449 million pounds in 2000. The increase was from 0.41 pounds per capita in 1985 to 1.59 pounds per capita in 2000. Despite the very large increase in consumption, olive oil still accounts for less than five percent of total U.S. salad and cooking oils consumption. While there is room for additional growth for olive oil, it faces competition from lower priced vegetable oils, including canola, corn and safflower. California olive oil will become slightly more competitive if the European Union reduces subsidies for olive oil production, which have recently been equivalent to about $0.70 per liter.

Figure 1. Average Proportion of California Olive Crop Utilized for Oil with Ratio of Prices for Olives Crushed to Prices for Olives Canned, 1920-2002



Input–output relationships for olive oil provide a measure of net prices required to provide returns equivalent to those available for canning olives. Important variables considered include oil content, processing costs, price for canning olives and average per acre yields. The oil content of olives varies by variety. Currently, the five most important California varieties, listed in descending order of crop size, are Manzanillo, Sevillano, Mission, Ascolano and Barouni. The Mission variety is best for oil extraction with oil content in the range of 20 to 24 percent. The

Manzanillo variety, with oil content in the 18 to 20 percent range, is best suited for canning but is also used for oil. The other major varieties are not well suited for oil production.

Approximately 4,000 acres of new olives have been planted specifically for oil production during the last six years. This includes 1,886 acres of the Spanish varieties, Arbequina and Arbosana, and 110 acres of the Greek variety, Koroneiki, that are suitable for super-high-density planting (650 to 900 trees per acre) and that can accommodate over-the-row mechanical harvesters. There are another 810 acres of high-density plantings (250 to 300 trees per acre) of Italian oil varieties (Frantoio, Leccino, Pendolino, Taggiasca and Coratina). The total acreage of olives grown for oil in 2004 was reported to be 6,168 acres with 66 percent classified as organically grown. These specialized plantings will increase the supply of olive oil and improve the economics of oil production as they reach bearing age and mature.

The method and scale of oil extraction is also an important cost consideration. Production stages include cleaning the olives, grinding into paste, mixing and heating the paste, separating the oil and water from the paste, and storage and bottling the olive oil. Technologies for grinding include stone olive mills, metal toothed grinders or hammer mills. The technologies available for separating the oil and water from the paste include lever or screw olive presses (the oldest technology), hydraulic olive press, centrifugal decanter, triple-phase centrifuge and the advanced dual-phase centrifuge (the most recent technology). A few of California's small-scale olive oil producers use stone mills and old-style presses and there are also producers that use hammer mills and dual-phase centrifuges. Note that the modern technology is more environmentally friendly with reduced water disposal.

Olive Oil Production Costs

Budget data, charges for custom operations and input/output relationships can be used to illustrate the impact of various cost components on total costs of olive oil production. Important variables include opportunity costs based on prices paid for olives used for canning, recovery and oil extraction rates, custom rates for processing, packaging costs and marketing costs.

Cost of Raw Olives: The net cost per liter of olive oil attributed to raw olives will vary with the price per ton for olives, the oil content of the olives and the proportion of oil recovered. Table 1 includes the effects of three alternative prices per ton for olives and three net extraction rates for oil. University of California budgets have used a recovery rate of 90 percent. This means that the oil content of olives before processing would be 16.67, 19.44 and 22.22 percent to yield net extraction rates of 15, 17.5 and 20 percent. Three levels of returns for canning olives, $500, $600 and $700 per ton, will be used to show the contribution of raw product to the cost of producing a liter of oil. The derivation of the figures in Table 1 can be illustrated for a cost of olives of $500 per ton and a 15 percent extraction rate. A ton of olives will yield 300 pounds of oil at a 15 percent extraction rate, which converts to 151.5 liters of oil at 1.98 pounds per liter. If olives cost $500 per ton, the raw product value of the oil will be $3.30 per liter.

Table 1. Cost of Olive Oil for Alternative Values of Olives and Net Oil Extraction Rates

Opportunity Cost of Olives, $ per Ton	Net Extraction and Recovery Rate		
	15%	17.5%	20%
	Raw Product Cost, $/Liter of Oil		
$500	$3.30	$2.83	$2.48
$600	$3.96	$3.39	$2.97
$700	$4.62	$3.96	$3.47

Custom Processing Charges: Firms offering public milling services charge from $275 to $400 per ton, with the charge varying by firm and the total amount of olives milled. Thus, the cost of processing on a per liter or per case of oil basis will also depend on the oil content of the olives and the extraction rate.

Budgeted Costs: The University of California budgeted costs for olive oil production include a charge of $29.07 per gallon ($7.68 per liter) to press, process, bottle, label and cork olive oil, and a marketing charge of $13.87 per gallon ($3.66 per liter), for a total cost of processing and marketing of $42.94 per gallon, or $11.34 per liter. Costs for the olives to produce the oil will be in addition to the processing and marketing charges. At $500 per ton (including harvesting costs), the cost of the olives will add another $2.83 per liter, for total costs of $14.17 per liter. With costs at this level, it is clear that a premium price is required for profitability. A number of factors could work to reduce the high costs of processing and marketing, including economies associated with increased processing volumes and improved plant utilization, economies associated with larger volume purchases of inputs, increased mechanization with larger scale operations and economies of scale in marketing operations.

Spanish Cost Structure

Spain, with a well-established and large-scale olive oil processing sector, enjoys a cost structure that is much lower than outlined for California. The Spanish processing sector already has high input volumes, high plant utilization and is mechanized. The majority of Spanish olive oil is processed by grower cooperatives. In 2001, Spanish growers' prices for olive oil ranged from $2,990.88 to $3,234.51 per ton of oil, depending on quality. With 1,010.10 liters of olive oil per ton, this converts to $2.96 to $3.20 per liter of oil. Subsidies from the European Union of approximately $0.70 per liter increased grower returns to a range of $3.66 to $3.90 per liter of olive oil. We can work back to obtain a price per ton for olives used for oil. Using an oil yield of 20 percent, a ton of oil would require five tons of olives. Thus, the price per ton for the olives would range from $598.18 to $646.90. If the oil yield was 15 percent, more olives would be required and the price per ton would be in the range of $448.63 to 485.18.

Costs of production for Spanish-grown olives vary significantly depending on the number of trees planted per hectare, yields per hectare and production system. Sample costs of production for Andalucia illustrate the range of total costs per hectare and per kilogram of olive oil. The traditional production system with low average yields has the lowest total costs per hectare (685.15 euros per hectare), but with low average yields, it also has the highest average costs at 2.85 euros per kilogram of oil production. The modern intensive production system, which includes more trees per hectare and irrigation, has the highest estimated total costs but with the highest average yields, the average costs of olive oil are reduced to 1.14 euros per kilogram of oil produced. Therefore, given recent exchange rates ($1.30 per euro), Andalucia's average costs of production range from $1.33 to $3.33 per liter of oil.

Detailed data for costs of processing, packaging and distribution of Spanish olive oil are not readily available. Given the scale of the Spanish industry, however, average costs are certain to be substantially less than costs of custom processing in California. Retail price data for extra virgin olive oil in the U.S., as reported by IRI, provide an indication of the cost advantage. The 2004 Chairman's Report for the North American Olive Oil Association shows average supermarket retail prices of $7.98 per liter (in 1 liter containers) and $5.16 per liter (in 3 liter containers) for the 52 weeks ending May 30, 2004. Most of the olive oil sold at retail in the U.S. is imported from Italy and Spain, so these prices are essentially for imported oil. The lack of grade standards for olive oil in the U.S. lead California producers to charge that much of the imported oil labeled as extra virgin is actually lower in quality than that sold as extra virgin olive oil in Europe. The California Olive Oil Council has petitioned the USDA to enforce International Olive Oil Council standards in the U.S. They believe that this will result in a much lower proportion of imported olive oil labeled as extra virgin and that a larger price premium for the higher quality product will make California extra virgin olive oil more competitive with imports.

Concluding Comments

U.S. per capita consumption and imports of olive oil have more than doubled over the last decade, with a portion of the increase attributed to consumers' diet and health concerns. A niche market has developed for California produced, handcrafted, boutique olive oil, but the volumes sold continue to be small, and imported olive oil continues to account for over 99 percent of U.S. consumption. Even with the overall growth in demand for olive oil and California's small market share, the high costs of small-scale processing and marketing will limit the amount of olive oil that can be profitably processed in California. If California's entire olive crop were crushed for oil, it would be able to substitute for less than 10 percent of recent imports. As in the past, increased demand for olive oil will be largely satisfied by imports from Italy and Spain, the largest traditional suppliers for the U.S. market.

For additional information,
the authors suggest the following sources:

http://naooa.mytradeassociation.org/bm~doc/chairmans-report-for-2004.ppt.

The Olive Oil Source, http://www.oliveoilsource.com.

Vossen, P., K.Klonsky and R. DeMoura. *Sample Costs to Establish An Olive Orchard and Produce Olive Oil 2001,* University of California Cooperative Extension, Ê http://coststudies.ucdavis.edu. Ê

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Forming Coalitions for Cleaner Air?

by

Maximilian Auffhammer, Antonio Bento and Scott Lowe

During the 1990s, most California cities have experienced a sharp decrease in particulate-matter air pollution. The magnitude of the improvement in this amenity differs across cities. In ongoing work, Ê *we show empirical evidence that more ethnically homogeneous cities have experienced larger drops in ambient* Ê *concentrations. We argue that this is consistent with a model of coalition formation.* Ê

An extensive literature in sociology and political science addresses a concept known as environmental justice. The hypothesized phenomenon at the center of this debate is the argument that low-income households and minorities are exposed to larger levels of pollution relative to better off or majority households. Two arguments have been brought forth to explain the empirical finding of this effect. The first relates to a sorting effect, whereby poorer households and minorities sort into communities with lower levels of amenities to take advantage of lower-cost housing. The second, which is more contested, argues that polluting facilities intentionally locate in cities which are inhabited by poorer households and minorities.

While this argument may hold with respect to location of facilities within cities, there are a few concerns that have been raised in relation to studies looking at variation in pollution exposure across cities. First, there is no obvious economic motivation for why firms should locate in cities with larger minority populations, while controlling for other characteristics of the resident population such as experience, education and age. Further, it is not quite clear in the urban context, what constitutes a minority population. In the literature, minorities are often defined as the share of "non-white" population. Looking across California cities, this measure does not capture the correct definition of a "voting minority" for 21 percent of the 1,023 cities we consider, which make up 89 percent of California's total population.

In this ongoing work, we are rephrasing the question asked and argue that the ability by populations to form coalitions to successfully lobby authorities, or to elect representatives to decision-making administrative bodies, may provide a better explanation for observed trends in air pollution exposure.

The Clean Air Act Amendments (CAAAs) of 1990 required the Environmental Protection Agency (EPA) to set National Ambient Air Quality Standards (NAAQs) for pollutants considered harmful to public health and the environment, including particles of 10mm in diameter or less (PM_{10}). Specifically, the CAAAs clarify how areas are designated as being "in attainment." The CAAAs also allow the EPA to define the boundaries of "nonattainment" areas: geographical areas whose air quality does not meet the NAAQs which are designed to protect public health.

The California Air Resources Board (CARB) has divided the state of California into 15 air basins, which were then subdivided into various Air Quality Management Districts (AQMDs) or Air Pollution Control Districts (Figure 1). These management districts were chosen based on their meteorological and geographic conditions, in addition to the local political boundaries. The inclusion of political boundaries into the regional management of the AQMDs, and the appointment of elected officials onto the AQMDs' governing boards is the driving force behind this research: if the elected officials are representing the preferences of their constituents, then it is likely that political variables will enter the decisions that the AQMDs make. In this case, it is possible that one could predict the degree of non- or overcompliance with the NAAQs based on the preferences of the constituents.

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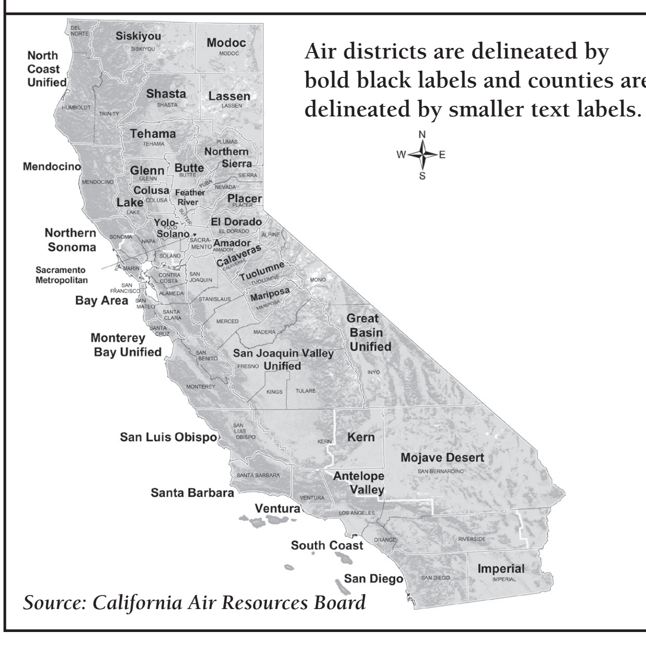
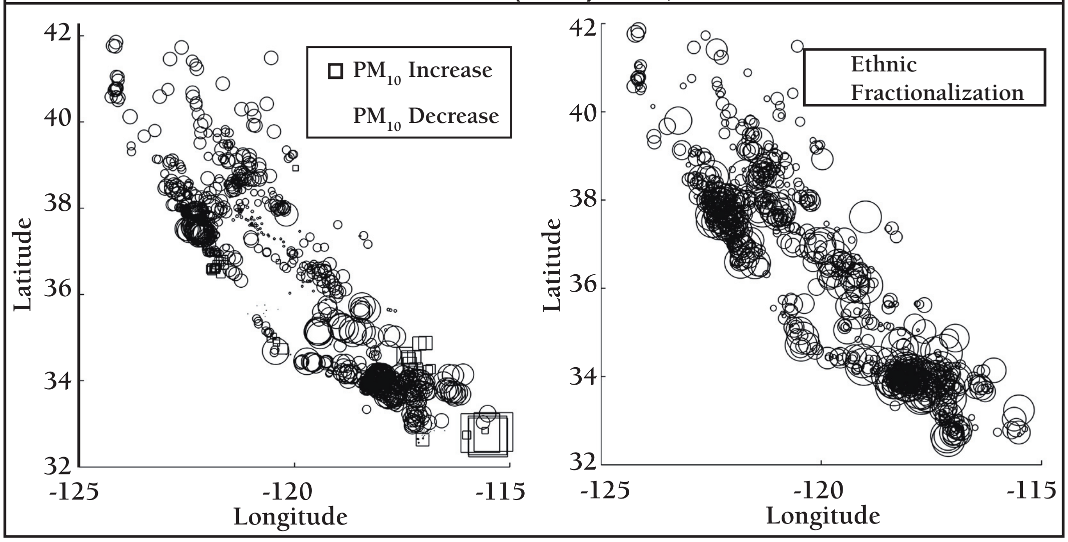


Source: California Air Resources Board

Figure 2: Change in PM_{10} Concentration (1990 to 2000) and Ethnic Fractionalization (1990) for 1,023 California Cities



Description of the Model and Data

As a basis for our empirical model, we propose a theoretical framework which shows how members of a community with preferences for a variety of public goods vote for a candidate to represent them on a body deciding on the allocation of the public good in question (in our case lack of air pollution). They chose the candidate who most closely matches their preferences. An election process evolves under which officials are lobbied by industry, while at the same time having to garner enough support from individuals with preferences for clean air. A lack of coalition formation or uniformity of the electorate results in the elected official's stronger preference for concerns raised by industry. Previous analyses of government expenditures in racially fragmented communities have shown that spending on public goods such as parks and trash pickup in U.S. cities is inversely related to the cities' ethnic fragmentation, even after controlling for socioeconomic and demographic variables. We argue that more ethnically fragmented cities have higher transaction costs of coalition formation and therefore experience "worse" outcomes.

We extend this literature by considering how changes in particulate-matter pollution from 1990 to 2000 vary across California cities and what factors drive these observed differences. The variable we are attempting to explain is the observed change in particles of 10mm in diameter or less (PM_{10}) relative to the national standard of 50 µg/m3, which is the annual average concentration. These ambient concentrations have been monitored through an extensive network operated by California state agencies since the mid 1980s. Consistent with our model and the literature, we use a set of variables characterizing preferences of voters to explain variation in the observed concentration changes. We control for the share of seniors, children below the age of nine, mean household in-come, income distribution and education. These variables are thought to reflect constituents' preferences for local public goods and therefore govern voting behavior. To construct our measure of fragmentization, we use data on the share of the five ethnic groups collected by the U.S. Census. This is different from considering the share of the non-white population, since a mostly Hispanic city (e.g., East Los Angeles) will show up as a homogeneous town the same way a mostly white city (e.g., Newport Beach) will. The focus therefore shifts from a minority story to a coalition story. Figure 2 above demonstrates the heterogeneity of the change in PM_{10} concentrations and the difference in ethnic fractionalization across California cities.

In the left panel, circles indicate decreases in PM_{10} concentrations for a given California city, while squares indicate an increase in concentration. The larger the circle/square, the larger the experienced de/increase. It is noteworthy that most of the cities which experienced increased PM_{10} concentrations are located in Southern California. Ethnic fractionalization is measured using an index, which ranges from 0 to 0.8, with 0.8 indicating the largest degree of fractionalization and 0 indicating a homogeneous city. The right panel shows the large variation in ethnic heterogeneity across California's cities. Orange County, for example, is fairly homogeneous while Riverside is very heterogeneous.

Results and Discussion

We considered a large variety of specifications and found a robust negative relationship between the degree of fractionalization and the experienced drop in emissions for California's cities—in other words, cities with more ethnic fragmentation experienced less improvement in emissions. This finding is robust if we consider all cities, cities above 5,000 inhabitants, or cities with populations larger than 25,000. Our estimates indicate that cities with a larger share of seniors and small children, wealthier households and a more equal income distribution experienced a larger decrease in emissions, holding all else constant. We also show evidence that larger cities and cities with a larger share of college graduates experienced smaller decreases in emissions. These findings are robust whether we include the few cities which actually experienced increased emissions.

Table 1 shows the list of the five most and least fragmented cities along the ethnic dimension in California. To get a feeling for the impact of ethnic fractionalization, we have calculated a few counterfactual experiments for the most and least fragmented cities with populations of more than 50,000. The counterfactual for the least fragmented cities is to assume that they started in 1990 with the degree of fractionalization of Carson, CA, a city with a highly fragmented population. The counterfactual column indicates the hypothesized level of year 2000 PM_{10} concentrations using the fragmented (Carson) electorate. The counterfactual shows much higher particulate concentrates than what occurred in reality for the least fragmented cities. We perform the same experiment for the most fragmented cities by showing the predicted year 2000 PM_{10} concentrates, for the counterfactual scenario of an almost perfectly homogeneous society, using the East Los Angeles value of 0.11. Here, we see the scope of environmental improvement that might have been obtained through the coalitional capabilities of a homogeneous population.

Using econometric techniques designed for model selection, we split the sample into cities which, by the NAAQs definition, were in compliance and cities which were not in compliance. We further controlled for the potential existence of unobservable characteristics of AQMDs, which may taint our results. Using this approach, an interesting pattern emerges. The coalition formation effect is significantly larger for cities which were not in compliance with the 1990 amendments. Further, we show that the effect is stronger for smaller cities, which is consistent with the argument that coalitions form more easily in smaller communities. The results are robust to controlling for unobservable effects across AQMDs, which indicates that city-specific characteristics of the population and ethnic makeup have a significant impact on observed improvements in air quality.

Table 1. California's Most and Least Fragmented Cities, 1990

Least Fragmented	Ethnic Index	PM 1990	PM 2000	Counter-factual
East Los Angeles	0.11	52.94	39.98	52.34
Newport Beach	0.14	41.22	27.78	39.49
Redding	0.19	29.70	18.86	29.57
Walnut Creek	0.22	26.36	18.09	28.25
Most Fragmented				
Stockton	0.69	51.36	33.67	22.45
Oakland	0.69	33.62	24.63	13.37
Union City	0.71	32.12	21.72	10.12
Carson	0.75	41.22	39.98	27.62

From a policy perspective, this is encouraging. The California Health and Safety Code specifies that the governing boards of the AQMD consist of city mayors and county officials and further that "the governing board shall reflect […] the variation of population between the cities in the district." The observed reductions in ambient concentrations are consistent with predictions from our model, which is based on this structure.

Conclusions

Understanding what drives the spatial heterogeneity in the level of amenities across California's cities is of great importance for the design of efficient policies. In the case of particulate air pollution, we show that the ability of communities to form coalitions has a statistically significant and reasonably small-sized impact on the experienced drops in ambient concentrations. This is encouraging from a community perspective since, in the case of particulates, working together is likely to result in a better outcome for the community.

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George Judge Turns 80

The following is a tribute to UC Berkeley Professor Emeritus George Judge written by his colleague, Maximilian Auffhammer, in honor of Professor Judge on his 80th birthday. Ê

For those of us who have the privilege of interacting with George Judge, Professor in the Graduate School at UC Berkeley, it is hard to believe that he turned 80 on May 2, 2005.

George was born on a Carlisle, Kentucky farm in 1925. After serving in the Air Force during the last two years of WWII on Siapan Island, which involved thirty B-29 missions over Japan between November 1944 and May 1945, he received his bachelor's degree in agricultural economics from the University of Kentucky in 1948. Four years later, he earned his Ph.D. in economics and statistics from Iowa State University. As is typical for George, he wasted no time and accepted an appointment as assistant professor at the University of Connecticut in 1951. He moved on to a position as full professor at Oklahoma State University in 1955. After a visit to Yale University, he moved to the University of Illinois, where he stayed until 1986. George visited the UC Berkeley economics department in 1970. He must have liked the golf courses, since he was appointed a full professor of agricultural and resource economics in 1986 and has been an active member of the faculty ever since.

George has published more than 150 research papers in the leading research journals. His research program has changed the way we use information in situations which involve making decisions in the face of uncertainty. Specifically, George has generated a basis for squeezing information out of samples of data so farmers, firms, individuals and policymakers can make optimal use out of the available data. Early on in his career, he helped establish a framework for determining the optimal number of birds per square foot of coop space. His very first paper helped farmers determine the optimal size of broilers considering inputs and the price of the birds. His work in spatial economics provided a method which was used to determine the optimal routing of box cars, airport location and the location of slaughter and distribution plants. His work on Markov processes helped explain the size distribution as well as scale economies of firms, and informed us about the equilibrium distribution of firms.

George Judge has truly changed the way we think about estimation and inference to this day. He has literally and figuratively written the book on econometrics. His undergraduate and graduate textbooks to this day serve as the main instructional and reference works for most graduate programs. His clear treatment, which is always accompanied by enlightening practical applications, has reserved these books a permanent spot in any applied economist's library.

Although his research contributions are extensive and impressive, George's greatest contribution to the discipline of economics is his ability to inspire young researchers at various stages of their career. As part of his birthday celebration, Assistant Professor Sofia Villas-Boas sent out an old set of "economists baseball cards" issued in the 1980s to the depicted economists and had them autographed and returned. The numerous letters accompanying the cards are witness to the tremendous respect and friendship George has garnered during his ongoing career. We are extremely lucky to have George as a colleague. He is a source of advice, inspiration and, most importantly, a positive outlook. Happy Birthday, George!

For those of you who wonder what George did on the day of his 80th birthday—he came to the office and read a 70-page paper on divergence estimators.

What Would Happen if Federal Farm Subsidies Were Eliminated? Evidence for Colusa and Tulare Counties

by

Sandra Gonzalez, Rachael E. Goodhue, Peter Berck and Richard E. Howitt

The abolition of federal farm program payments would significantly affect regions in California that primarily produce federal program crops, have limited opportunities to produce substitutes and are highly dependent economically on agriculture.

Due largely to its agricultural diversity, California has historically drawn a very small share of traditional federal commodity subsidies, relative to its status as the nation's largest agricultural state. In 2000, California received three percent of federal conservation, disaster and commodity payments but accounted for 12.8 percent of the total value of U.S. agricultural production. Only nine percent of California's more than 74,000 farms received federal commodity subsidies, conservation payments or disaster payments between 1995 and 2002. Many observers believe that a reduction in commodity payments, or even the complete abolition of federal commodity subsidies, will have a negligible effect on California. However, federal subsidies are very important for certain California commodities, such as rice, cotton and dairy. Because of the geographic concentration of production, subsidies may have an important effect on regional economies within California.

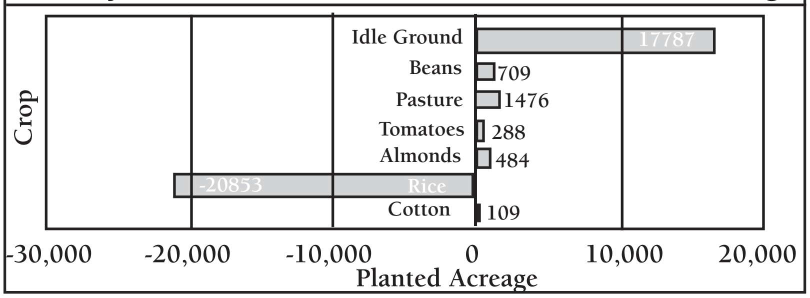
We examine the effects of federal farm program spending on two county economies: Colusa County and Tulare County. We estimate how growers' crop production decisions could change in response to the elimination of farm subsidies, by integrating two types of economic models. The first was a calibrated production function model using the positive mathematical programming values to measure the different costs between regional crops. This model was used to predict the shifts in acreage for major crops when federal farm aid was eliminated. The second model was a social accounting matrix, which calculated the effect of one additional dollar in crop production on county economic output and employment. The results from the two models were combined in order to estimate the effect of the changes in acreage predicted by the non-linear optimization model on county output and employment.

The non-linear approach allowed us to model how growers will change their use of land, fertilizer and other inputs, rather than limiting their response to a change in acreage. This flexibility is important because changes in input use and yields, not only changes in crop acreage, will affect growers' contribution to the local economy. In order to assess how these changes will affect employment and total economic activity, we used employment and economic activity multipliers, specific to each county, that are adjusted to reflect the use of inputs for the production of selected crops. Economic multipliers measure the effect of an additional dollar received by agricultural producers, who spend most of this additional dollar for agricultural inputs and personal consumption. Employment multipliers measure the number of additional workers needed in other sectors to meet the needs of an additional worker employed in agriculture.

Colusa County's economy is heavily dependent upon the agricultural sector, with agriculture accounting for 34 percent of total employment in 2000. In turn, the agricultural sector is heavily dependent upon federal farm programs. In 2000, federal payments equaled 22 percent of the county's total value of agricultural production. The Colusa County crops selected for this study were cotton, rice, almonds, tomatoes, pasture and beans. Rice received the majority of federal farm program payments, and accounted for 46 percent of the county's total agricultural value. Cotton is the only other analyzed crop that received federal funding, however it accounted for only three percent of the county's agricultural value and 3.7 percent of federal farm program payments. The other products selected for this study contribute significantly to the county's agricultural value although they are not recipients of any pre-determined federal farm aid.

Tulare County ranked as the second largest producer of agricultural products in 2000, among all counties nationally, with gross agricultural receipts in excess of $3.068 billion. In spite of its large value of production, agriculture accounted for only 26 percent of total county employment. We analyze six crops: cotton, oranges, raisins, alfalfa, almonds and milk. Milk, oranges, grapes and cattle were the top four commodities in terms of the value of production in 2000. Cotton is the largest commodity crop that receives federal funding. Tulare

Figure 1. Net Change in Planted Acreage in Colusa County in Absence of Federal Farm Subsidies Funding



County is one of the largest California dairy counties, and its number of dairy farms has increased substantially over the last ten years.

Results

In Colusa County, baseline federal farm program payments were estimated to be over $58 million in 2000. (This estimate differs slightly from actual program payments, due to modeling assumptions.) In the absence of these payments, the county economy would decrease by $73.5 million. Nearly one of every three agricultural jobs within Colusa County is sustained by federal farm program payments. County agricultural employment would decrease by 30 percent to 4,241 persons, according to the model.

Rice responds the most dramatically to the elimination of payments. The model estimates that the value of rice production declines by nearly 54 percent from base case revenues. The majority of this change is due to the loss of payments, since planted rice acreage declines by only 14 percent and yields per acre increase. Due to limited crop alternatives for land used for rice production, and the significant investment in equipment required for rice production that has limited or no alternative uses, the model predicts that producers will chose to reduce planted acreage and farm the remaining acreage more intensively rather than switching from rice to other crops (Figure 1). Rice yields would increase from 4.27 to 4.79 tons per acre as a result of increases in the use of non-land inputs (Figure 2). The production function model predicted that expenditures per acre on other inputs increase as the acres of rice farmed are reduced. Chemical expenditures increase by 48 percent, labor expenditures by 31 percent and machine expenditures increase by 61 percent.

Cotton is also predicted to sustain a significant loss in output value. However, the effects are not as large, due to cotton acreage of only 10,820 in the base year. The model predicts that production decisions do not respond significantly to the elimination of federal farm program payments: Neither planted acreage nor yields were predicted to change significantly.

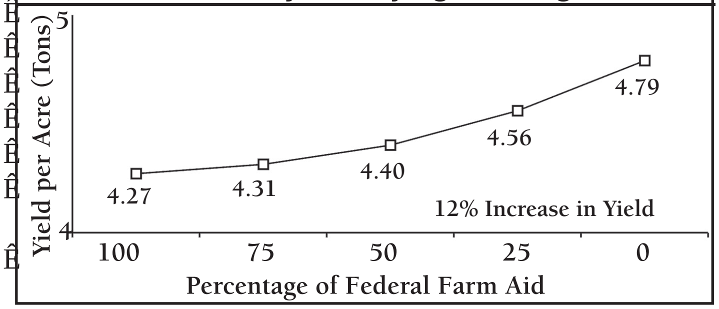
Crops which do not directly receive federal farm program payments are not directly affected by their abolition but may be affected indirectly due to reallocation of acreage. Although predicted pasture output would increase by 80 percent, total acreage is small–less than 2,500 acres. Predicted crop values, acreage planted and crop yields would not change significantly for almonds, tomatoes or beans (Figure 1).

One reason that other crops are not predicted to be affected by the abolition of federal farm program payments is that since rice requires clay soils that are not suitable for other crops, growers have limited opportunities to substitute away from rice production. Most of the farmland that is predicted to be taken out of rice production would remain out of agricultural production completely. Indeed, if federal farm program payments were cut to 50 percent of the 2000 base year value, our analysis predicts that producers would begin to fallow agricultural land. In turn, this behavior implies that marginal rice land has no value in production in the absence of farm program payments, given our assumptions and baseline values.

In Tulare County, baseline federal farm program payments were projected to be $23 million. In the absence of payments, total economic activity in this county is actually predicted to increase by nearly $2 million. Consistent with the increase in economic activity, estimated agricultural and total employment would increase slightly, by less than 1,000 people, which is less than a one percent change in employment. These changes are driven by growers' reallocation of acreage from cotton to alfalfa. Alfalfa has the highest employment multiplier effect of all the crops in the planting mix in Tulare County. When compared to cotton, alfalfa production generates almost seven times the agricultural jobs and over three times the total jobs that cotton generates for every million dollars of output.

As the crop with the largest acreage eligible for payments, the model predicted that cotton would be affected the most by the elimination of federal farm program payments. Total output value and planted acreage levels were estimated to decrease by 68 percent and 44 percent, respectively. Predicted yields were largely unchanged, showing that 24 percent of the reduction in value of cotton is due to the loss of payments. Production budgets collected for all major crops in Tulare County indicated that alfalfa was the most Ê profitable crop in the Tulare County crop mix. Alfalfa Ê generated a profit level that was nearly $200 per acre Ê greater than cotton, even though it does not receive Ê federal farm program funding. Given the complete Ê elimination of federal farm Êprogram payments, Ê alfalfa realizes a 20 percent increase in planted acreage, while yields remain constant. This prediction is Ê sensible given that a producer can generate a higher profit level by planting alfalfa where cotton was once planted.

Figure 2. Projected Rice Yields in Colusa County at Varying Funding Levels



Federal farm program payments to the Tulare dairy sector were calculated to be roughly $10.2 million, which represents less than three percent of the total farmgate value of milk production in 2000. Effects on the industry were correspondingly negligible. However, this analysis did not incorporate commodity purchases of milk products by the USDA, so it may understate the effects of all federal agricultural support programs on the dairy industry. The orange, almond and milk industries all exhibited less than a five percent estimated increase in total output values. The output value of raisins was predicted to increase by six percent in the absence of federal farm program payments to cotton and milk.

Unlike Colusa County, where the model predicts that growers began to fallow land when federal farm program payments were 50 percent less than the baseline value, the model predicted that all of the available farmland in Tulare County was planted even in the absence of federal farm program payments. Because the model predicted that all farmland was planted, we were able to use the results of the non-linear optimization model to calculate the effect of federal farm program payments on land values. At the 100 percent federal farm program funding level, this calculation indicates that $43.10 of federal farm program benefits were capitalized into every acre of farmland in Tulare County. This figure represents a wealth transfer of $23 million from American taxpayers to Tulare County farmland owners.

Conclusion

Our analysis illustrates the influence of federal farm program payments on the use of resources within regional agricultural systems. The importance of the elimination of federal farm program payments on regional economies depends on the importance of agriculture to these economies. Because agriculture accounts for a larger share of employment and economic activity in Colusa County than it does in Tulare County, changes in subsidy payments have a larger economic effect in Colusa.

In Tulare County, according to our analysis resources reallocated from cotton production in the absence of farm program payments would increase employment, because they would be reallocated to the production of more labor-intensive crops. However, these effects are relatively small, accounting for less than a one percent change in total employment. In Colusa County, more resources per acre are expended on rice production than would be the case in the absence of subsidies. Subsides induce producers to plant rice on land that would not be cropped in the absence of these payments. Growers would use more non-land inputs and achieve higher yields. Agricultural employment in Colusa was predicted to decline by 30 percent. Overall, our analysis suggests that the elimination of federal farm payments would significantly affect regions in California that primarily produce federal program crops, have limited opportunities to produce substitute crops and depend on agriculture as a primary source of economic activity.

For additional information, Ê
the authors suggest the following source: Ê

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