Agricultural and Resource Economics
UPDATE
GIANNINI FOUNDATION OF AGRICULTURAL ECONOMICS • UNIVERSITY OF CALIFORNIA
V. 11 no. 5 • May/June 2008

What is the Price of Oil?

Joeri de Wit and Aaron Smith

A quoted price for a commodity such as oil is specific to a particular location at a particular time. This article describes how the crude oil prices reported in the media relate to world oil prices and local gasoline prices.

Also in this issue

In the next issue

Oil prices first hit $100 per barrel on January 2, 2008. On that day, a single trader looking for notoriety bid $100 to buy the minimum 1,000 barrels before unloading the position immediately for a small loss. This trader did not physically take possession of any oil and, being a floor trader on the New York Mercantile Exchange (NYMEX), did not have the capacity to take possession of 1,000 barrels of oil. How do NYMEX futures prices relate to prices of physical barrels of oil in world markets, and how do they relate to the price of gasoline at California pumps?

NYMEX operates a futures market in crude oil, among other commodities. Contracts in this market constitute the promise to buy or sell crude oil in the city of Cushing, Oklahoma at a fixed price in a particular month in the future. The media usually quotes the nearby price, i.e., the price for delivery next month. Thus, the buyer of $100 oil on January 2 specifically entered a contract to buy 1,000 barrels of oil in Cushing for $100 per barrel in February. Instead of following through on this commitment, the trader canceled it by entering an offsetting contract to sell exactly the same quantity of oil in February.

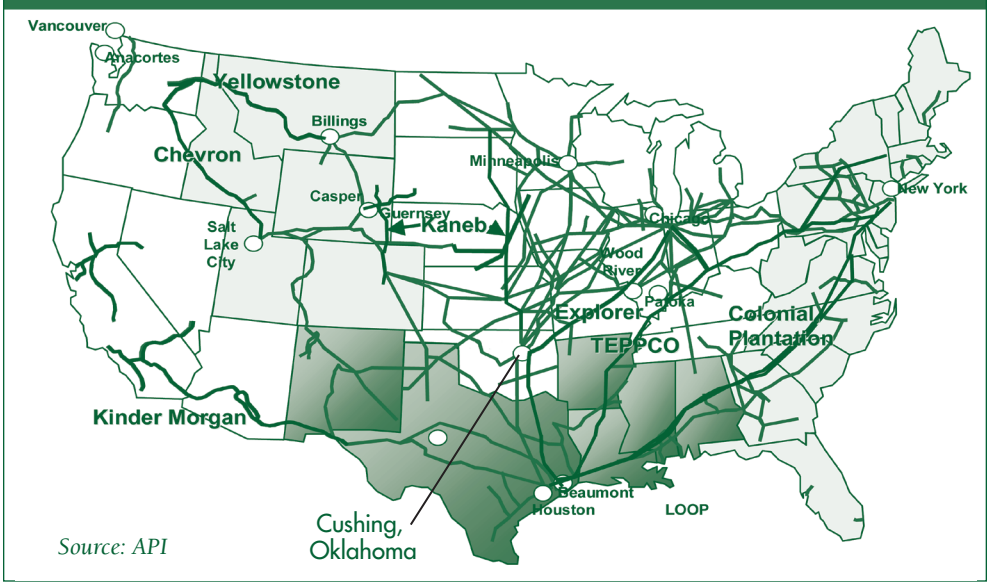
Although most futures contracts do not end in delivery, the nearby NYMEX futures price is almost identical to the spot price for immediate delivery at Cushing. This spot price carries the label West Texas Intermediate (WTI), which describes the grade of oil deliverable on this market. In the remainder of this article, we describe how the WTI spot price relates to world crude oil prices and California gasoline prices.

Cushing, Oklahoma: An Oil Pipeline Hub

Oklahoma is a natural choice for deliveries on futures and spot crude oil contracts because of its close historical ties with the oil industry and proximity to Texas and the Gulf Coast. Cushing is a hub at which WTI and other domestic crude oils come together with supplies imported through the Gulf Coast and are re-distributed mostly northward to Chicago-area refineries. The Gulf Coast is not only the largest producer of crude oil but also the largest importer, currently importing 50 percent of all foreign crudes. This oil needs to be directed northward and is divided equally between deliveries to the East Coast and to the Midwest. Cushing, lying en route right above the two largest producing states, is well-situated for delivery across the United States.

Two-thirds of all domestic shipments of petroleum (crude oil and refined products) are transported by a 1,000-mile network of underground pipelines (see Figure 1). Pipelines usually provide the cheapest mode for transporting petroleum products over land. To speed up delivery, most trunk lines tend to operate in "fungible" mode, in which the shipper receives the same

Figure 1. Select Delivery Lines



Source: API

quality of product that it tendered for transport, but not the same molecules. The alternative is batch mode, in which the shipper receives the exact molecules that it tendered for transport.

Flexibility in oil supply through the pipeline system is essential for suppliers to be able to respond to price signals. Storage tanks at logistics hubs enhance the flexibility of supply by reducing the average distance and therefore time until oil can be supplied to consumers. Their central role is to enable markets to clear because their storage and supply options allow market participants to respond to price signals by adjusting their demand and supply to restore balance.

Limits to Arbitrage

The flexibility of petroleum supply is limited by pipeline and storage tank capacity and by the time it takes to move oil from one place to another. As a consequence, local supply gluts and shortages affect local prices. For example, increases in stock of crude oil in Cushing put downward pressure on the WTI spot price. To bring out this relationship, Figure 2 plots the stock of crude oil in Cushing (excluding the Strategic Petroleum Reserve) against the difference between WTI and Brent crude oil prices.

Brent crude is produced in Northern Europe and is used as a pricing benchmark for 60 percent of crude streams around the world. It can be thought of as a measure of world crude prices. By taking the difference between the WTI and Brent spot prices, we filter out movements in the WTI spot price that result from changes in world crude prices, thereby illuminating the relationship between Cushing stocks and the WTI spot price. Figure 2 shows evidence of an inverse relationship between the WTI–Brent price spread and stocks at Cushing. In other words, high levels of stocks at Cushing tend to depress the WTI spot price relative to the Brent spot price.

In the time frame of Figure 2, stockpiles at Cushing reached their highest level in April–May 2007 due to a combination of three factors: the shutdown of Valero Energy Corporation's McKee refinery in Texas on April 13, high volumes of Canadian imports, and low refinery throughput in general. These factors caused a slump in the spot price of WTI which traded at $8.34 per barrel less than Brent on May 24, 2007, a record price difference. This difference is especially notable because WTI trades at an average premium of about $2 per barrel over Brent. WTI is lighter (lower wax content) and sweeter (less sulfur) than Brent crude, properties that make WTI more desirable for the production of refined products. Therefore, this episode reveals the significant limitations of short-term price arbitrage in the current oil distribution network.

There is anecdotal evidence that WTI has become more sensitive to local market conditions in recent years, to the extent that some market analysts view WTI as no longer an appropriate benchmark for pricing international crude streams. One reason for this increased sensitivity may be reduced flexibility in pipeline transport arising from increasingly heterogeneous fuel formulations. State and local government regulations specify different formulations in many parts of the country. These formulations need to be transported over pipelines in batch mode, effectively reducing the capacity of the refinery and distribution system in a number of ways: batching produces more downgraded product and costly transmix as fuels of increased heterogeneity come into contact with each other; tanks must be completely emptied before being filled with products that meet more stringent requirements; batch schedules for trunklines need to be established months in advance so that more formulations make planning ahead more complex. This last point is illustrated by the fact that the Colonial Pipeline, a major trunk line from Texas to New York, currently transports over 100 distinct grades of gasoline.

California Gasoline Prices and WTI

Although WTI may be losing its status as an international benchmark, it remains the predominant benchmark in the United States. Figure 3 plots the WTI spot price, the spot price of regular conventional gasoline in LA, and the average retail price of reformulated gasoline in California. The LA spot gasoline price represents a wholesale price for gasoline in California. Figure 3 shows that wholesale

gasoline prices have increased at the same rate as WTI crude oil.

California retail gasoline prices have increased at a slower rate than the other two prices. In the last five years, both the WTI price and the LA spot gasoline price have tripled, whereas retail gasoline prices only doubled from about $1.70 to about $3.40 per gallon. Put another way, the retail margin has remained about $0.80 per gallon over the last five years, which means that it has declined from about 50 percent of the retail gasoline price to about 30 percent. This result suggests that retail margins are determined mostly by factors unrelated to oil prices.

Figure 3 also shows that California gasoline prices exhibit higher volatility than crude oil prices. Moreover, California has more volatile gasoline prices than the rest of the country because the state's unique product-quality requirements reduce supply flexibility. Essentially all of California's refined product demand is met by output from the state's refineries. Although there is one pipeline carrying refined petroleum products from the Gulf Coast to California, its supply capacity is not sufficient to enable arbitrage of price differentials between the West Coast and the rest of the country. Other modes of transportation also do not offer short-run supply flexibility. For example, it takes 14 days to travel from the Gulf Coast to the West Coast by barge.

Figure 2. Prices and Supply at the Cushing, Oklahoma WTI Spot Market

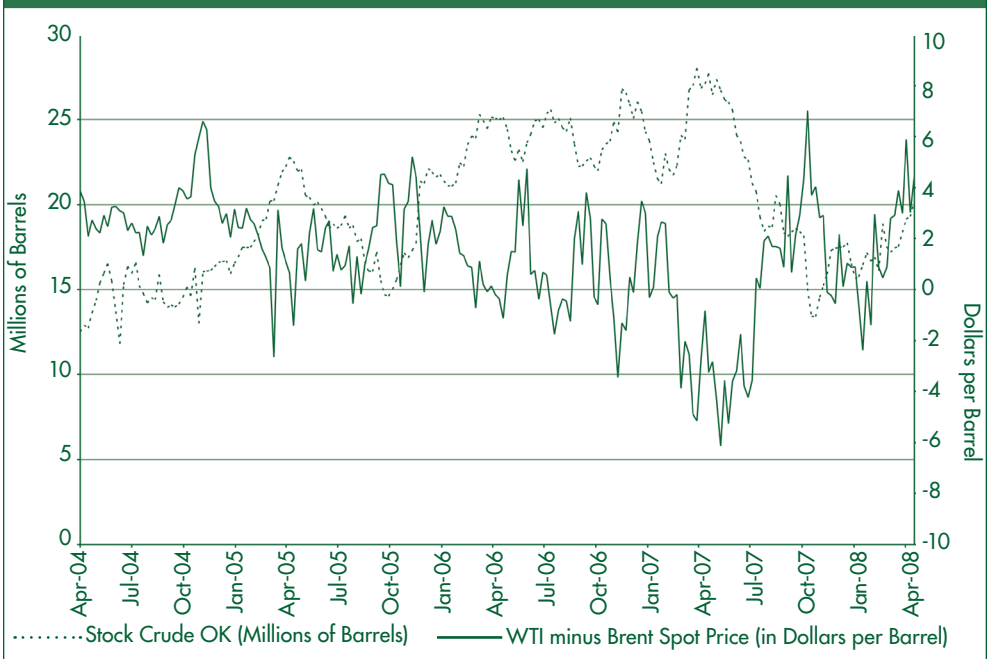
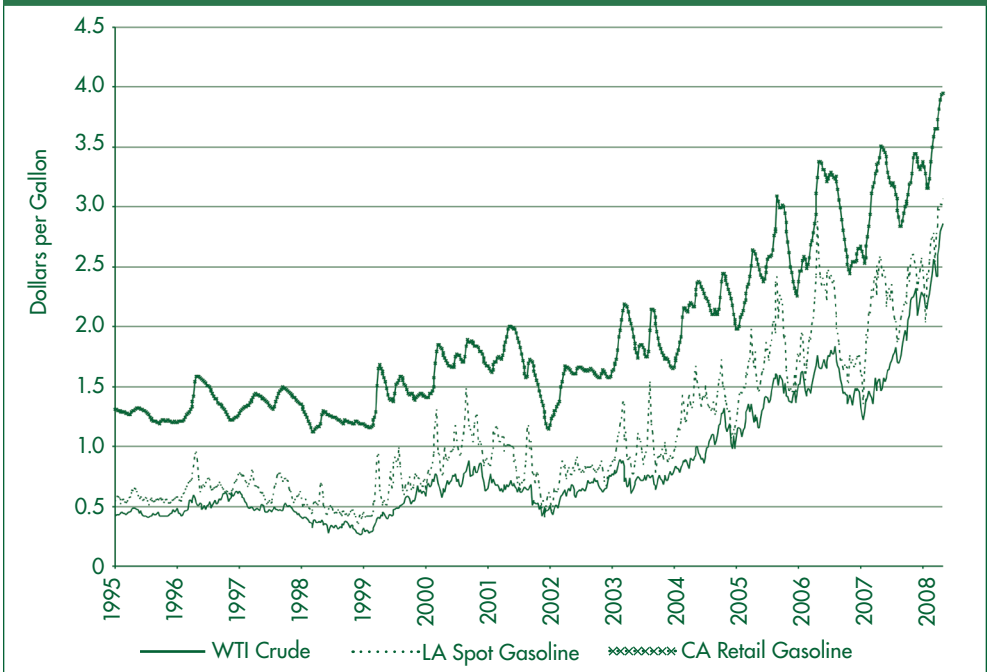


Figure 3. WTI as a Benchmark for Refined Products



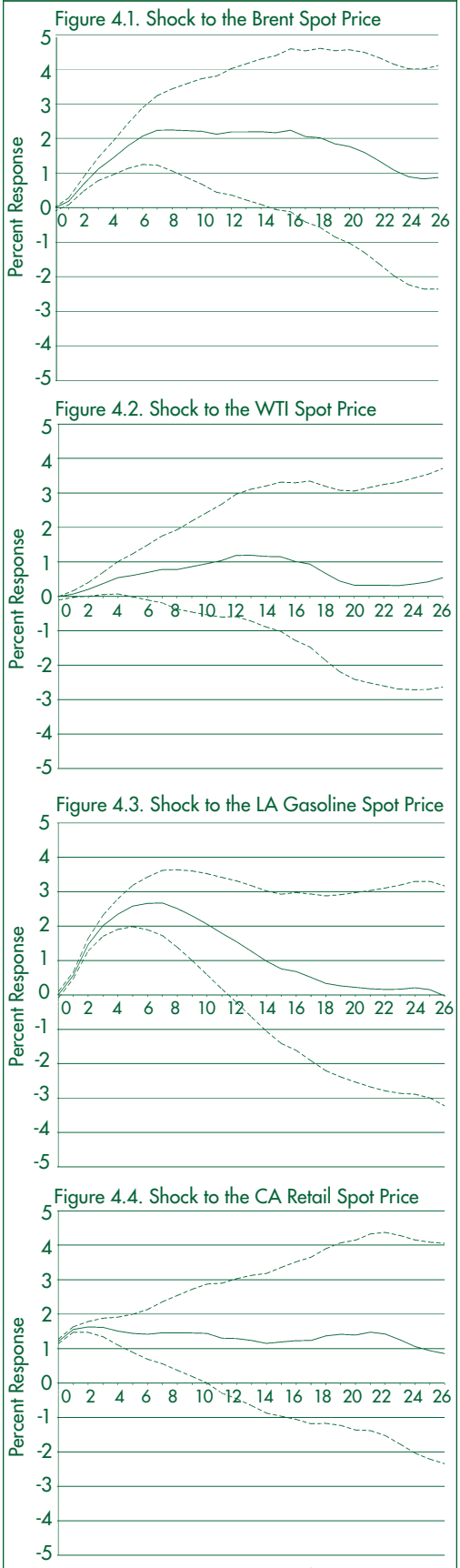
Data source: www.eia.doe.gov/oil_gas/petroleum/info_glance/petroleum.html

Price Dynamics

Figure 3 reveals the long-run relationship between California gasoline markets and the WTI crude oil price. How do average retail gasoline prices in CA respond to week-to-week fluctuations in crude oil and wholesale gasoline markets? We answer this question by plotting impulse response functions in Figures 4.1-4.4. These plots illustrate the predicted dynamic response of CA retail gasoline prices to unanticipated shocks in four prices: the Brent spot price, the WTI spot price, the LA spot gasoline price, and the CA retail gasoline price itself.

We define each shock conditional on those before it in the production process. For example, a shock to the LA spot price of gasoline represents an unanticipated change in the wholesale price of gasoline after observing the Brent spot price and the WTI spot price, but not the CA average retail price of gasoline. Thus, we interpret shocks to the LA gasoline spot price as representing shocks to the refining margin. Each shock represents a one-time, one-standard deviation unanticipated price increase. We use weekly data, with the spot prices recorded every Friday and the retail price measured from an EIA survey on the following Monday morning. We plot the responses over a period of 26 weeks, all series are in

Figure 4. Predicted Responses of CA Retail Gasoline Prices to Upstream Price Shocks



The dashed lines represent 95% confidence intervals for the impulse response estimates. Based on weekly data spanning 1995-2007. Data Source: http://tonto.eia.doe.gov/pet/pet_pri_top.asp

natural logs, and our sample runs from January 1, 1995 to January 7, 2008.

A one-standard deviation shock to the Brent spot price is equivalent to a five percent hike of this price in one week and represents a shock to world crude oil prices. After a five percent shock, the Brent spot price tends to pull back somewhat and settle about three percent above its initial level. In response, Figure 4.1 shows that CA retail gasoline prices increase gradually over a seven-week period, eventually increasing by about two percent. This predicted two percent response to a three percent long-run increase in oil prices is consistent with the declining percentage retail margin revealed in Figure 3. The predicted response curve also suggests that gasoline prices may start to decline at around the 20-week mark, but the large confidence interval around this prediction means that it is statistically insignificant.

Figure 4.2 shows that California gasoline prices hardly react to WTI price shocks. Because we define a WTI price shock conditional on a fixed Brent price, this shock represents an unanticipated change in the WTI price without a change in world prices. Such shocks have little effect on California gasoline prices for two reasons. First, they are short-lived, disappearing within a few weeks as WTI and Brent prices come back together. Second, almost all of the West Coast crude oil supply comes from the Alaskan North Slope oil fields or from California.

California retail prices also do not respond immediately to shocks to the LA spot price. As shown in Figure 4.3, it takes about six weeks for these shocks to fully affect retail prices. The initial one-standard deviation shock is about 6.6 percent, and it disappears after about 12 weeks. The retail price reaction peaks at about 2.5 percent before fading to zero after about 20 weeks. Figure 4.4 shows that shocks to retail prices that are uncorrelated with upstream prices are small (about one percent), but they tend to persist. This persistence reflects the declining percentage retail margin over time. Specifically, when the percentage retail margin decreases, it tends to stay at that lower level rather than reverting back to its previous level.

Conclusion

When the media report the latest crude oil price, they refer to a futures price that closely matches the spot price in the town of Cushing, Oklahoma. Much of the short-term variation in this price reflects local crude oil supply conditions near Cushing. Such variation has little or no effect on California retail gasoline prices. Nonetheless, California gasoline prices exhibit much greater volatility than crude oil prices. This volatility reflects supply inflexibility caused by California's unique gasoline formulation regulations. It illustrates the inefficiencies generated by the current system, which allows states and counties to set their own fuel standards.

Long-run changes in crude oil prices affect California retail gasoline prices gradually over a couple of months. After this adjustment period, the final percentage change in California gasoline prices is less than the corresponding oil price change because retail margins do not increase with oil prices. Overall, month-to-month variation in crude oil prices provides a much better signal of future California gasoline prices than day-to-day or week-to-week price movements.

Joeri de Wit is a Ph.D. student in the Department of Agricultural and Resource Economics at UC Davis. He can be reached by e-mail at jfdewit@primal.ucdavis.edu. Aaron Smith is an associate professor in the ARE department at UC Davis. He can be reached at asmith@primal.ucdavis.edu.

Farmland Conversion in California: Evidence from the Williamson Act Program

Kent Kovacs

The recent boom in the housing market created significant pressure for farmland conversion throughout California. The highest expected net loss of farmland from the Williamson Act program, California's premier agricultural land protection program, was in 2007. In spite of the widespread pressure, conversion in most regions of California is consistent with historic levels of conversion from the last housing boom. The exception is the San Joaquin Valley, where unprecedented farmland conversion is likely in the next decade.

California land is in high demand, not only for agriculture, but for non-agricultural land use that creates pressure for farmland conversion. This demand for non-agricultural land use comes largely from urban influence driven by anticipated population growth of California. The Public Policy Institute of California (PPIC) estimates that by 2020, California's population will grow from 37 million to reach between 42 million to 48 million people. This growth relies on new commercial, industrial, and residential real estate which all occupy land.

The housing market is cyclical and until recently, California's market was booming. The PPIC estimates that, between 2000 and 2005, the median sale price for single-family homes rose by 117 percent, and building permits issued for single-family homes rose by 42 percent. A key finding of this article is that the boom in the housing market resulted in farmland loss throughout California, but most significantly in the San Joaquin Valley. This rapid low-density development has significant implications, not only for farmland loss, but for traffic congestion, air quality, and the cost of public services.

Tracking the loss of farmland in California is possible through an examination of the cumulative non-renewals in the Williamson Act program. The California Land Conservation Act, better known as the Williamson Act, is the state's premier agricultural land protection program since its enactment in 1965. Private landowners voluntarily restrict their land to agricultural and compatible open space uses under minimum 10-year rolling term contracts with local governments. In return, restricted parcels are assessed for property tax purposes at a rate consistent with their actual use rather than potential market value. Cumulative non-renewal acreage refers to the total amount of acreage undergoing the nine-year phase out of contract status at any one time. Non-renewals indicate the anticipation of converting farmland to other uses.

Since 2003 each year had an expected net loss of farmland in the Williamson Act program, as shown in Figure 1. The figure shows *expected* net loss because cumulative non-renewals indicate how much acreage is planning to leave the program. (Ideally, new enrollment would show acreage planning to join the program, rather than just enrollment for that year, but such data are not available.) Large enrollment in Merced County in 2001 and 2002 kept new enrollment above cumulative non-renewals in those years. However, after 2002, the new enrollment fell and the cumulative non-renewals rose rapidly. The greatest expected net loss of acreage to the program was in 2007. A decomposition of the cumulative non-renewals into non-renewal initiations (acreage initiating phase out of the program) and expirations (acreage leaving the program) shown in Figure 2 allows for a closer examination of the rapid rise of

Figure 1. Statewide Enrollment and Non Renewal

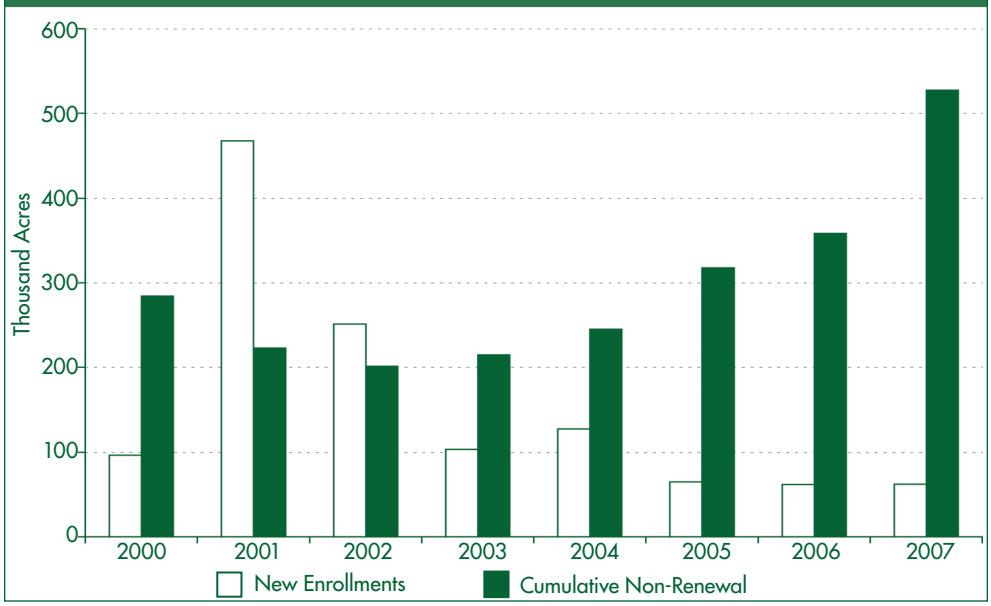


Figure 2. Statewide Non Renewal and Expirations

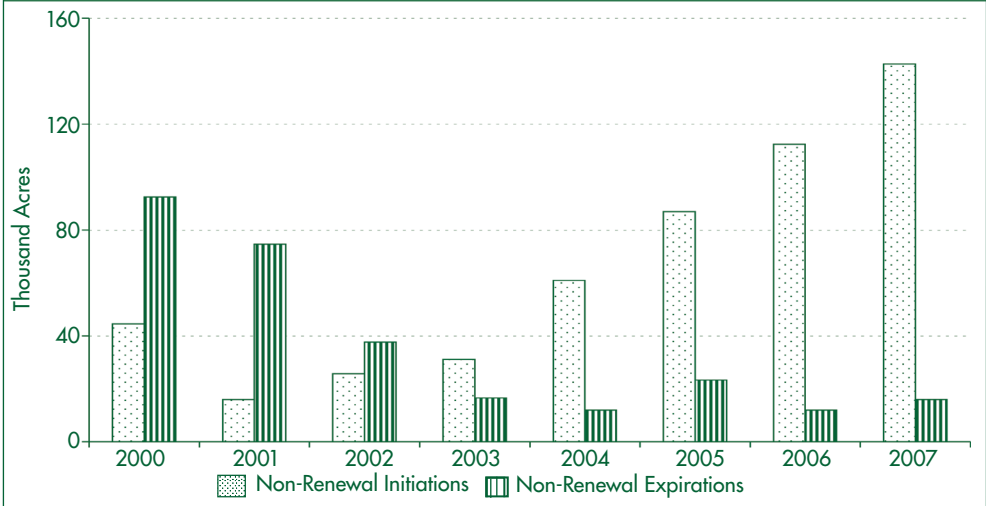


Figure 3. Williamson Act Regions

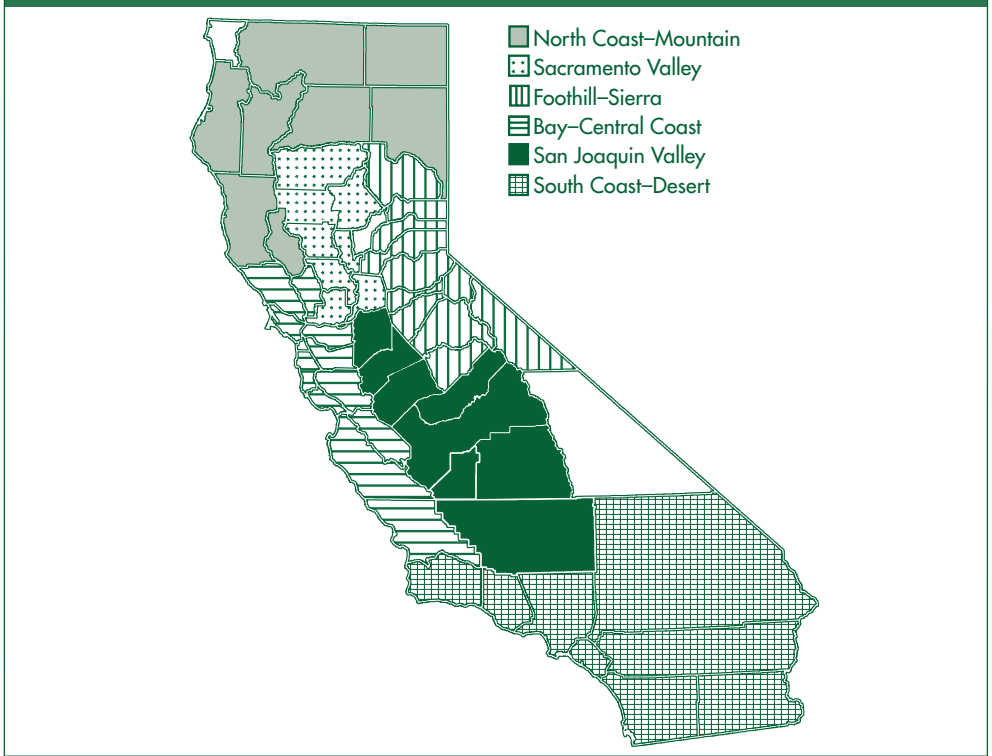
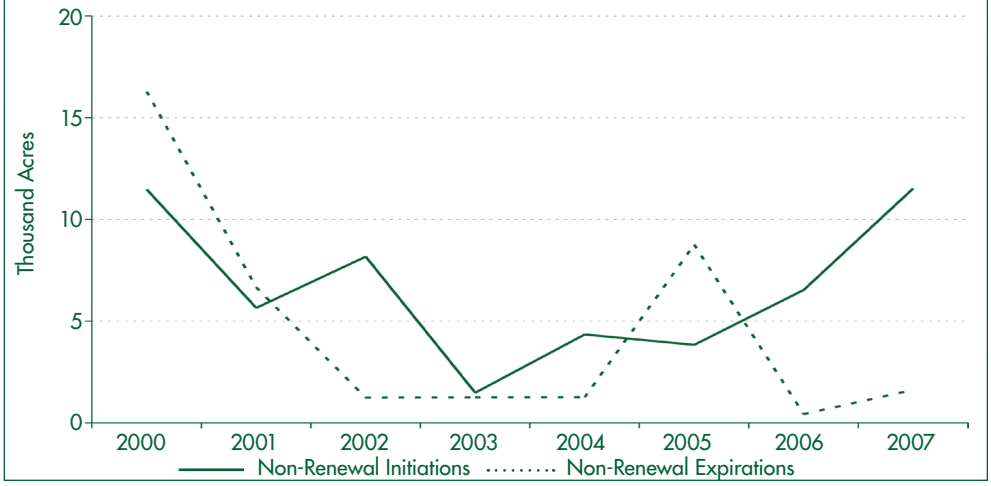


Figure 4. Bay and Central Coast Non-Renewal Initiations and Expirations



cumulative non-renewals. Most of the cumulative non-renewals since 2003 are non-renewal initiations.

The non-renewal initiation is for a landowner who begins the nine-year phase out of a contract, and non-renewal expiration is the termination of a contract as a result of completing the nine-year phase out. The plot of non-renewal initiations and expirations for the eight-year period is equivalent to showing the non-renewal initiations for sixteen years (eight years in the past and the eight years shown in the plot) and non-renewal expirations for sixteen years (eight years shown in the plot and eight years in the future). Preferably a full eighteen-year period would be shown by displaying the 1999 non-renewal initiations and expirations. Unfortunately, the 1999 non-renewal data are unavailable. Another look at Figure 2 indicates that non-renewal initiations prior to 2004 are comparable to recent historic levels, but after 2004 an unprecedented level of non-renewal initiations took place. This indicates that substantial loss of farmland is anticipated between 2014 and 2016.

The statewide plot of non-renewal initiations and expirations does not provide much insight into where the non-renewals are occurring. A policy response to the non-renewals would need to identify the regions with the most non-renewals since California is a geographically diverse state. The regions shown in Figure 3 for the spatial examination of the non-renewals include the Bay and Central Coast, Foothills and Sierra, North Coast and Mountain, Sacramento Valley, San Joaquin Valley, and the South Coast and Desert. Figures 4 to 9 show the non-renewal initiations and expirations for each of the regions.

The non-renewals for the Bay and Central Coast region show that recent initiations are well within historic levels of initiation, as illustrated in Figure 4. This is evident from the non-renewal

expirations plot being above the non-renewal initiations plot for a number of years. For the Bay and Coast region, the highest anticipated level of farmland loss occurred back in 1991. The similar finding of recent non-renewal initiations well within historic levels is shown for the Foothills and Sierra, North Coast and Mountain, and the Sacramento Valley regions in Figures 5–7. However, for each of those regions, there is an upward surge in non-renewal initiations in 2006 and 2007. Much of the early 1990s growth in the North Coast and Mountain region appears over, but the Foothills and Sierra and the Sacramento Valley regions appear to have more growth in store.

The story changes for the San Joaquin Valley and the South Coast and Desert regions, as illustrated in Figures 8 and 9. In the past few years, non-renewal initiations are well above the historic levels of initiation. The dramatic rise in initiations suggests that a shift toward farmland loss is occurring in these regions beyond the natural response to a housing boom. The counties in the San Joaquin Valley with consistent double-digit losses of farmland include Kern, Madera, and Tulare. The Highway 99 corridor threads through these counties that have the significant farmland losses; the existing population centers in the San Joaquin Valley are along the Highway 99. For the South Coast and Desert region, the significant non-renewal initiations are in Santa Barbara County and, most recently, Imperial County.

In spite of the pressure of urban influence in most regions of California, there remain counties where there is minimal pressure for farmland conversion. In August 1998, the Legislature enhanced the Williamson Act with the Farmland Security Zone (FSZ) provisions. The FSZ provisions offer landowners greater property tax reduction in return for a minimum 20-year rolling

Figure 5. Foothills and Sierra Non Renewal Initiations and Expirations

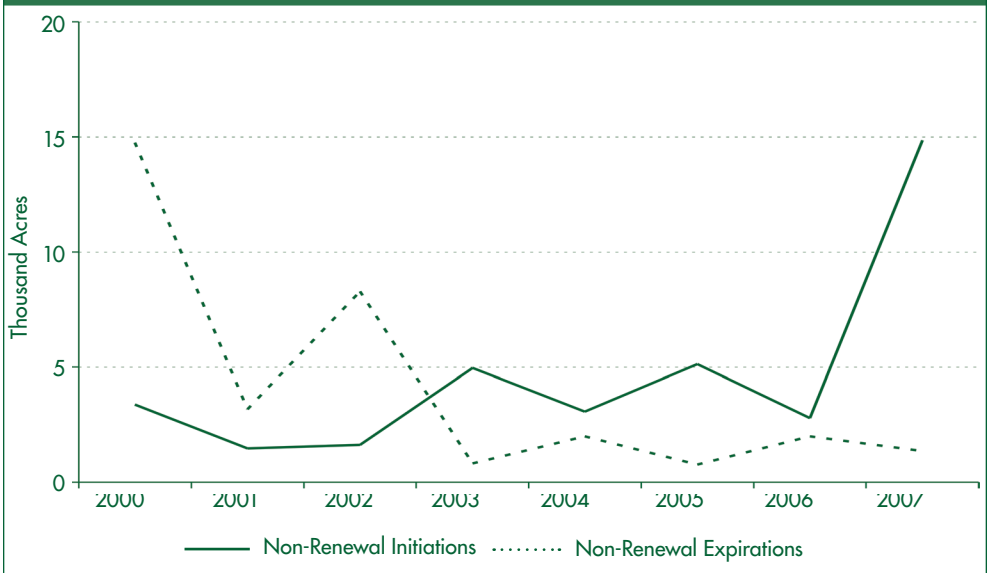


Figure 6. North Coast and Mountain Non Renewal Initiations and Expirations

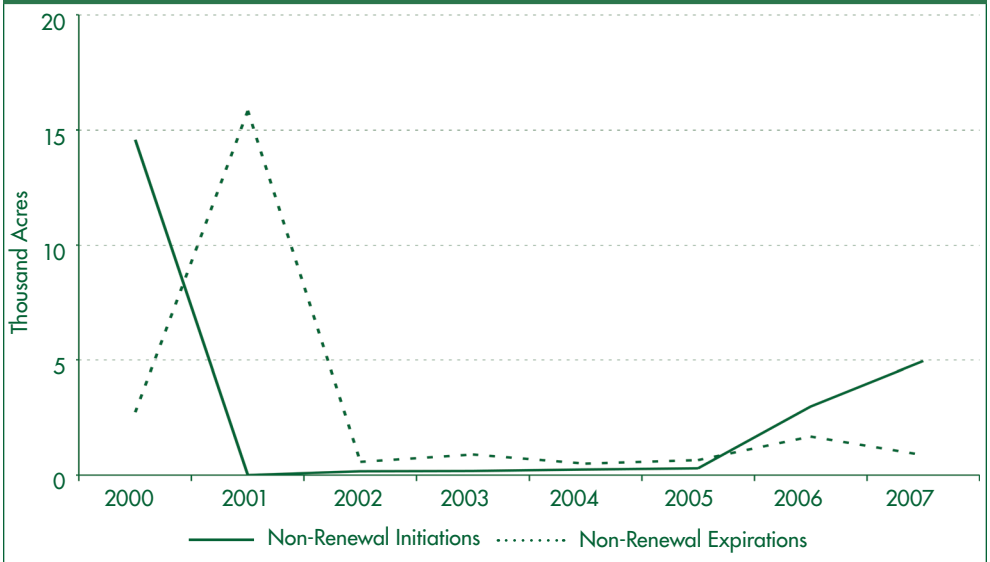


Figure 7. Sacramento Valley Non Renewal Initiations and Expirations

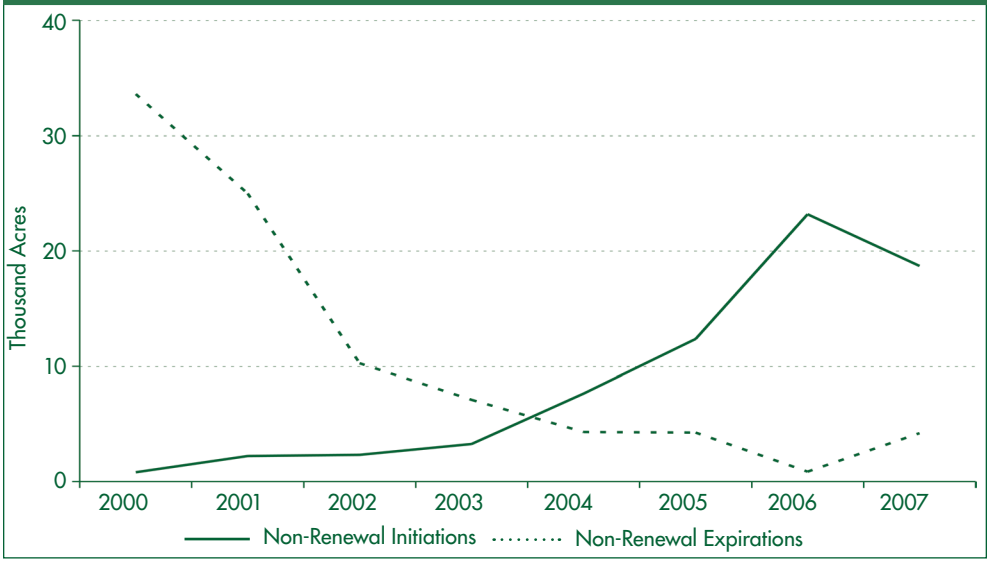


Figure 8. San Joaquin Valley Non-Renewal Initiations and Expirations

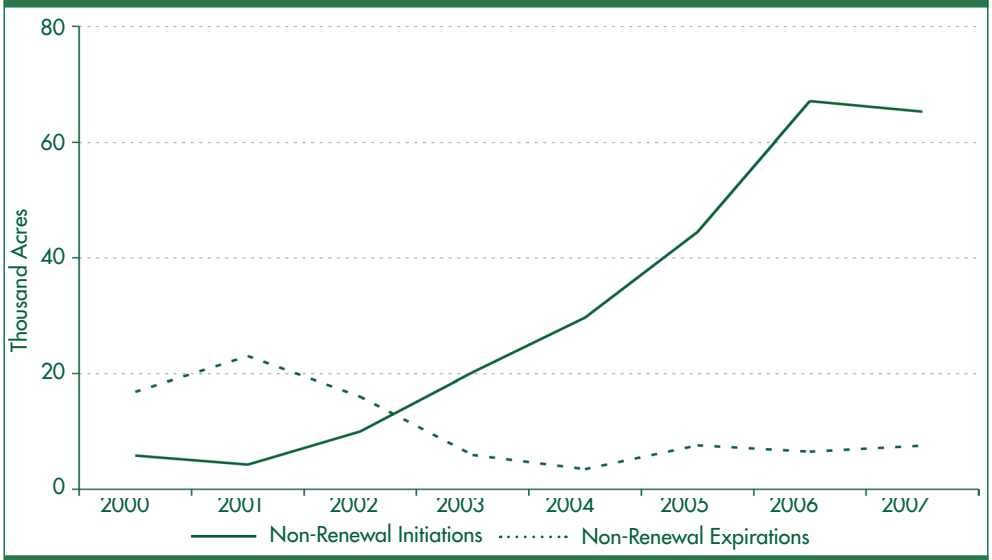
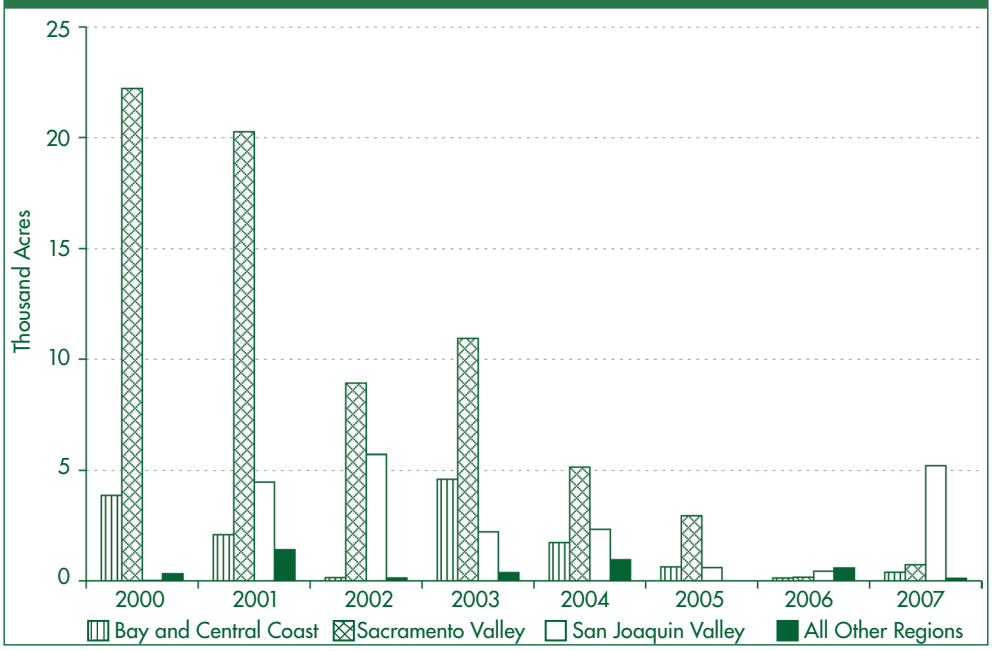


Figure 9. South Coast and Desert Non-Renewal Initiations and Expirations

Figure 10. Farm Security Zone Enrollment by Region



term contract. Figure 9 shows FSZ enrollment by region since 2000. Most of the FSZ enrollment from 2000 to 2003 is in Colusa and Glenn counties on the northeast side of the Sacramento Valley. There is also enrollment in Kings and Kern counties on the southeast side of the San Joaquin Valley. However, for the most part, landowners in California appear reluctant to enroll in the FSZ.

There seems no doubt that urban influence will continue to place pressure on agricultural land in California. In most regions the pressure of urban influence appears to follow the natural ebb and flow in the housing market, but the San Joaquin Valley is an exception. Over the next decade, there will likely be unprecedented growth in the San Joaquin Valley, and this growth will shift the traditional balance between agricultural and non-agricultural land uses. The cities along Highway 99 may want to revisit their planning codes to pro-actively identify how to handle the growth to come.

Kent Kovacs received his Ph.D. degree from the Department of Agricultural and Resource Economics at the University of California, Davis. Currently, he is a research assistant professor in the Department of Resource Economics at the University of Nevada, Reno. He can be contacted by e-mail at kkovacs@cabnr.unr.edu.

Source for Figures 1-10: California Department of Conservation, Division of Land Resource Protection.

For more information, the author recommends:

State of California Department of Conservation, Division of Land Resource Protection, "The Californian Land Conservation (Williamson) Act: 2006 Status Report." Available at www.consrv.ca.gov/dlrp/lca/stats_reports/Pages/2006%20williamson%20act%20status%20report.aspx.

Tietz, Micheal B., Charles Dietzel, and William Fulton. "How Will Urbanization Change the San Joaquin Valley?" Research Brief, Public Policy Institute of California, Issue #98, February 2005.

California's Water Problems: Why a Comprehensive Solution Makes Sense

Leo Simon and Susan Stratton

California's Sacramento-San Joaquin Delta faces a very uncertain future. Policymakers and stakeholders in the state are actively negotiating how to improve the health of the Delta ecosystem while protecting agricultural and urban water supplies. Using a bargaining-theoretic framework, we argue that failing to include above-ground storage and conveyance expenditures in the negotiations may distort the apparent trade-offs between other options.

Delta restoration expenditures improve the health of the Delta ecosystem and enhance the survival of endangered and threatened species.

Water use, water-related infrastructure, and methods of increasing the efficiency of water use are important policy concerns for California. The population is growing, as is the value of its (mostly irrigated) agricultural production, leading to an increased demand for water. Global climate change is projected to reduce the ability of California's existing infrastructure to capture the Sierra Nevada snowmelt, reducing available supplies. Much of California's water supply is routed through the Sacramento-San Joaquin Delta, leaving it vulnerable to saltwater intrusion in case of a major earthquake. Because the Bay-Delta is an environmentally sensitive ecosystem that is home to endangered and threatened species, environmental water uses have become increasingly important.

Early in 2007, Governor Schwarzenegger introduced a $4.5 billion bond measure that provided funds for conservation, underground storage, environmental enhancement in the Bay-Delta and elsewhere, and above-ground storage and conveyance. Gov. Schwarzenegger's initial proposal (carried by Senator Dave Cogdill) was not approved by the legislature for inclusion on the state ballot during the regular legislative session. The legislature met in a special session called by the governor in the fall of 2007 to attempt to pass a bond proposal to put on the February 2008 ballot for voter approval. Democrats and Republicans proposed competing bills but neither passed. In November, Gov. Schwarzenegger called for a joint effort to come up with a consensus proposal to put to the voters. The governor and various interest groups are preparing initiatives for the fall 2008 election through an alternative process, even while negotiations are ongoing. The size of the bond issue, its allocation, and the sharing of the financial burden among California taxpayers and water users are all topics of negotiation.

One of the primary points of disagreement among interest groups regards the future role of additional dams and above-ground water conveyance in California's water system. Since California voters rejected a major water infrastructure project in a 1982 referendum, the Peripheral Canal, proposals for the construction of additional major infrastructure designed to increase water supplies from surface water have been largely absent from the water allocation policy debate. Water allocation issues have been addressed through conservation measures, rationing, and some use of water markets. In the absence of augmented supplies, the reality underlying water policy is that one unit of water consumed by one use is not available for another (apart from reuse). This reality has made it difficult to negotiate changes in water use.

Gov. Schwarzenegger's proposed funding for above-ground storage was strongly opposed by some members of the legislature and many environmental interests. In response to criticism regarding the inclusion of above-ground storage in the bond measure, California Department of Water Resources director Lester Snow responded, "We have everything on the table from groundwater to conservation to waste water recycling." By broadening the set of policies in his initial proposal (the negotiation "issue space"), the governor increased the set of options for allocating water resources among competing uses.

Negotiation participants have commented on the importance of maintaining a broad issue space. The bill's author, Sen. Dave Cogdill, R-Fresno, remarked after the committee's vote, "I am extremely disappointed but not surprised by the Senate Democrats who voted against this critical measure. They are taking issues off the table and opting to address California's water needs using only a half-full toolbox."

Assemblyman John Laird commented, "I really believe it's too important to not come to some sort of an agreement. But if this is about dams, and nothing else, it won't happen. And if this is about water cleanup and conservation and leaving out the Delta, it won't happen. It's going to have to see where there's a place in the middle to give everyone involved the comfort level to move ahead."

Clearly, negotiation participants believe the set of options available will affect the outcome of the negotiations. We construct a very simple bargaining-theoretic framework to examine how Gov. Schwarzenegger's inclusion of funds for new water storage and conveyance infrastructure might influence the negotiation's eventual outcome.

A Bargaining-Theoretic Framework

Many stakeholders are participating in the political process underlying policymakers' debates and proposals. For simplicity, we lump these extraordinarily diverse groups into three categories of interests, each represented as a "player" in the negotiations: environmentalists, taxpayers, and water users, including both agricultural and urban users of water conveyed through the Delta.

For most purposes it would be completely unsatisfactory to group stakeholders so coarsely; here, we simply seek to represent one facet of the bond issue debate. We also note that the players constitute "interests" rather than sets of individuals. In reality, water users pay taxes and are concerned about the environment, to varying degrees. Environmentalists are also taxpayers, and many rely on water conveyed through the Delta.

Since California voters rejected a major water infrastructure project, the Peripheral Canal, in a 1982 referendum, proposals for the construction of additional major infrastructure designed to increase water supplies from surface water have been largely absent from the water allocation policy debate.

In our simplified bargaining framework, we consider three broad classes of issues: a list of categories for which dollar expenditures are earmarked, a scheme for sharing the burden of funding the earmarked expenditures, and an allocation of available water among competing uses. We limit attention to issues involved directly with north-south water transfers.

To construct our list of expenditure items, we draw from proposals put forth in Sacramento by various legislators. We identify three categories: Delta restoration expenditures, new above-ground storage and conveyance infrastructure, and water-use efficiency expenditures, including infrastructure improvement and other conservation measures for agriculture and/or urban users. Delta restoration expenditures improve the health of the Delta ecosystem and enhance the survival of endangered and threatened species. The latter two categories increase water supplies. New infrastructure increases available water. Water-use efficiency expenditures increase effective water, given the amount of available water.

For purposes of discussion we will assume that total expenditures are fixed. Responsibility for funding these expenditures will be allocated between fees paid by water users and the bond issue. The environmentalist is exempted from sharing the financial burden. The allocation of the water available based on the current water system and the negotiated expenditures is also negotiated.

Each of the players wishes to maximize his welfare, or "utility," which is dependent on the outcome of the negotiation. Water users' utility increases with the amount of water allocated to them, and decreases with the fees they pay to use the water. Their allocated water, in turn, increases with expenditures on new infrastructure and water-use efficiency measures.

Environmentalists' utility increases with the health of the Delta ecosystem, which in turn increases with the expenditures devoted to Delta restoration and with the water allocated for in-stream uses in the Delta. Environmentalists' utility decreases with the construction of new storage and conveyance infrastructure, due to the negative impacts on local ecosystems.

Taxpayers' utility decreases as the size of the bond issue increases. Taxpayers' utility increases as the water allocated to users increases because an increased user allocation increases economic activity. It increases as the health of the Delta ecosystem increases, and decreases as expenditures on new storage and conveyance increase, because better environmental quality is a public good.

Obviously, even in this very simple framework there are a number of conflicting interests. The user wishes to maximize the increase in water supply per dollar expended regardless of how the supply is generated. The environmentalist dislikes new infrastructure that may affect wilderness areas, and thus prefers water-use efficiency measures. The taxpayer and user's interest conflict directly regarding who should pay. The taxpayer is concerned to some extent with the

water allocated to both of the other players, while each of them is concerned only with his own water allocation. This means that the taxpayer will place a higher priority on increasing the supply of effective water through water-use efficiency expenditures, infrastructure expenditures, or both.

Implications

In this context, what are the implications of excluding above-ground storage and conveyance from the set of issues considered in the negotiation? There are two possible cases. In the first case, above-ground storage and conveyance always have a higher marginal cost per unit of increased supply than water-use efficiency measures. However, if the negotiated share of the cost paid by the user differs across expenditure categories, then above-ground storage and conveyance may emerge as part of the negotiated solution.

A player cares about how much he pays. He cares about what others pay only to the extent that it affects other dimensions of the negotiated solution. If, on the other hand, the negotiated share is the same for both types, then because the user cares about his supply and not about storage or increased use efficiency *per se*, and because the environmentalist is negatively affected by dams, above-ground storage and conveyance expenditures will not emerge in the negotiated solution.

In the second case, the cheapest way of obtaining an increase in supply involves a mix of both expenditure types. Thus, excluding one type of expenditure increases the cost of increasing supply. The implications of such an increase are two-fold. First, the scope for increasing the user's utility through the negotiation is reduced. Second, the scope for increasing the environmentalist's utility through the negotiation is reduced. Because the marginal cost of increasing total supply is higher, even if the environmentalist got to choose how every dollar was spent, the utility he would achieve by his preferred combination of in-stream flows and Delta restoration expenditures would be lower. Given that he must negotiate with a user and a taxpayer, both of whom wish to see increased supplies for the user, the higher marginal cost makes it more expensive to obtain an additional dollar for Delta restoration. Effectively, increasing the cost of one of the variables players care about means that a given amount of money has less potential for improving total welfare. The solution of a negotiation that excludes the possibility of expenditures on above-ground storage and conveyance will have less scope for improving social welfare than the solution of a negotiation that includes this possibility.

If a relevant issue is excluded from the negotiation, the relative prices of other items may be distorted.

What's included in the issue space plays a critical role in determining the success of the process, and the nature of the negotiated outcome. While sometimes the contribution of economics to policy debates is summarized as "everything has a price," bargaining theory demonstrates that the more accurate statement is "every negotiated variable has a value, and every relevant variable should be negotiated." If a relevant issue is excluded from the negotiation, the relative prices of other items may be distorted. Regardless of whether or not money for above-ground storage and conveyance is included in a state water bond proposal, introducing the option into the debate can only increase negotiators' flexibility. However, whether or not this flexibility will result in a more socially desirable solution will depend on whether there is a difference between who pays for different types of supply-enhancing expenditures. If there is a difference, then a player's decision will be distorted by the difference between the relative costs of the two types for him as compared to the relative costs of the two types for society as a whole.

Leo Simon is an adjunct professor in the Department of Agricultural and Resource Economics at UC Berkeley. He can be reached at simon@are.berkeley.edu. Susan Stratton is a Ph.D. Candidate in the ARE department at UC Berkeley who can be reached at stratto@are.berkeley.edu.

For additional information, the authors recommend:

Goldmacher, S. (2007) "Laird Talks Water in Q & A." Capital Alert, *Sacramento Bee*. Available at www.sacbee.con/1066/story/392067.html.

Lucas, G. (2007) "Sacramento: Senate Panel's Dems Vote Down Water Bond over Proposed Reservoirs." *San Francisco Chronicle*. April 25. Available at www.sfgate.com/cgibin/article.cgi?f=/c/c2007/04/25/BAG4QPEU3O1.DTL&hw=Lucas+water+GOP&sn=002&sc=881.

Agricultural and Resource Economics UPDATE

Co-Editors

Steve Blank
David Roland-Holst
Richard Sexton
David Zilberman

Managing Editor
and Desktop Publisher -
Julie McNamara

Published by the Giannini Foundation of Agricultural Economics

http://giannini.ucop.edu

ARE Update is published six times per year by the Giannini Foundation of Agricultural Economics, University of California.

Domestic subscriptions are available free of charge to interested parties. To subscribe to **ARE Update** by mail contact:

Julie McNamara, Outreach Coordinator
Department of Agricultural and Resource Economics
University of California
One Shields Avenue, Davis, CA 95616
E-mail: julie@primal.ucdavis.edu
Phone: 530-752-5346

To receive notification when new issues of the **ARE Update** are available online, submit an e-mail request to join our listserv to julie@primal.ucdavis.edu.

ARE Update is available online at http://www.agecon.ucdavis.edu/extension/update/

Agricultural and Resource Economics UPDATE
GIANNINI FOUNDATION OF AGRICULTURAL ECONOMICS • UNIVERSITY OF CALIFORNIA

Department of Agricultural and Resource Economics
UC Davis
One Shields Avenue
Davis CA 95616
GPBS