An Econometric Test of the Endogeneity of Institutions: Water Markets in the Western United States

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Abstract

In the western United States, the tremendous spatial and temporal variation in rainfall suggests that there are substantial gains from trade to be had through water markets. However, physical and institutional impediments to water transfers complicate the challenge of meeting the expanding population and environmental demands placed on water resources. Because of the variability in the relative importance of water supply uncertainty and trading impediments, markets are forming differently across the western United States. In many locations, trades take the form of short-term leases of water, where the underlying property rights remains unaffected. In other regions, transfers of permanent water rights predominate. Our econometric analysis of the determinants of 2247 transactions reported in the *Water Strategist* over 1993-2003 supports the conclusion that institutions have influenced not only whether water trades occur, but also whether trades are permanent water rights transfers or short-term leases.

Keywords: water markets, institutions, environmental costs, third-party costs, water rights
JEL: Q25

I. Introduction

Over the past fifteen years, state natural resource agencies in the western United States have increasingly turned to markets as a way to encourage efficient allocation of water among competing uses. All fourteen of the westernmost contiguous United States have passed legislation designed to facilitate water transfers from low-value water rights holders to higher-value purchasers. Many western states continue to enact laws that expedite water transfers in incremental but important ways. Since Hartman and Seastone (1970) demonstrated the theoretical efficiency gains possible from establishing water markets, much work has been done to quantify the efficiency gains realized in practice from implementing water markets (Vaux and Howitt, 1984, Hearne and Easter, 1997).

In this paper, we seek to explain patterns in the reported transactions in the western states, by examining the effect of water market institutions and measures of financial and physical scarcity on water transfer activity. According to neoclassical economic theory, in the presence of perfect markets and in the absence of transaction costs, purchasers of water should be indifferent between purchasing a permanent right, which grants the right to use water for all time, and purchasing the temporary use of water, in the form of a lease. In western water markets, several characteristics prevent parity between the two alternatives. First, sellers may require a premium to sell their permanent water rights, which in theory should equal the uncertainty cost to the buyer of repeated exposure to spot prices in the lease market. Second, several characteristics intrinsic to water substantially impede trade. These environmental and third-party costs vary between permanent sales and leases. Finally, potential water sales and leases often involve many parties, increasing negotiation costs above economic levels.

In many western states, it is clear that leases are not only frequent, but common. The prevalence of short-term leases in many states may be a second-best response to artificial impediments to the transfer of permanent water rights. Alternatively, leases may be the preferred type of transaction for purchasers responding to the uncertainty of water supply. Colby et al. (1993) have noted that legal restrictions on trading have led to significant price differentials between otherwise proximate water districts in New Mexico, Utah and Colorado. Brookshire et al. (2004) compared the responsiveness of quantity transacted to market price across three state-level water markets for permanent transfers using a structural model of supply and demand. They find that responsiveness is limited by local institutional characteristics, specifically high filing fees and long delays in regions where rights must first be adjudicated before they can be transferred. Hadjigeorgalis and Lillywhite (2004) compare a permanent rights transfer market and an annual spot market in Chile and conclude that the price differential between the two is due to legal restrictions on the transfer of permanent rights between water districts. We extend the analysis by exploring the possibility that the incorporation of physical, environmental and economic externalities into the water transfer approval process may contribute to a predominance of annual leases over permanent transfers.

We define institutions as the prevailing practices and styles of trading that occur throughout the western states. These are shaped by climate, hydrology, early settlement patterns and the subsequent development of water storage and transportation infrastructure, as well as the state laws and regulations under which trading takes place. This paper is made possible by collating data from the *Water Strategist*, which provides information to water market participants and observers on a monthly basis. The *Water*

Strategist contains information about water trading, water quality, and pending state and federal legislation and court cases affecting water users, buyers, and sellers. The *Water Strategist* is an institution that may itself have influenced water prices, quantity and contract terms through increasing information availability to market participants.

II. Background on Water Markets / Descriptive Statistics

Precipitation in the western United States is characterized by high spatial and temporal variation. This variation creates the heterogeneity among water users needed to induce trading. It also makes trading difficult, as water is cumbersome and expensive to transport. As an extreme example, the Metropolitan Water District of Southern California in 2002 paid approximately $250 for delivered water, 55% of which was the cost of conveying the water from northern California, through the environmentally sensitive San Joaquin –Sacramento Valley Delta, to the Los Angeles Basin.

The high cost of transport is but one of the significant impediments to water trading. Water is also characterized by a high degree of interaction among users. The pumping of groundwater affects the ability of one's neighbors to pump groundwater. The withdrawing of surface water upstream prevents users downstream, whether for consumptive use or augmenting instream flows (for fish migration, for example), from using the water. Western state law requires a finding of "no harm" on other users, when there is either a change of use or a change in the point of diversion from the waterway. This provides protection to other water rights holders but does not cover harm to the environment or the economy of the exporting region. Many states also require more stringent proof of no harm to the environment, whenever water is transferred (Getches, 1997). When such physical and environmental externalities are correctly incorporated

into the regulatory approval process, they may limit the number of trades that are economically efficient.

In addition to these physical/environmental externalities, there is a category of externalities which is more controversial. When water is transferred, there are often economic consequences in the exporting region. Agricultural water sellers often leave fields fallow when they transfer water, leading to a loss of jobs and income in the exporting region. These pecuniary externalities, or third-party effects, may not have standing in a strict neoclassical model, but they merit study nonetheless, since their existence is shaping water markets throughout the West. In California, for example, many northern counties have placed restrictions on groundwater exports, intending to limit job and income loss associated with transfer. Hanak (2003) determines that county-level blanket restrictions on exports have discouraged transfers, and recommends the adoption of groundwater basin management systems to protect local users without discouraging market activity.

In spite of these obstacles, water's increasing relative scarcity has intensified efforts to move water from low- to higher-value uses.[1] Table 1 provides descriptive statistics compiled from back issues of the *Water Strategist*, a monthly journal which reports permanent transfers and leases (including price, quantity, buyer and seller identification, buyer and seller use, and some additional contract terms) in 14 western

[1] As mentioned above, most western states continue to pass laws that facilitate water transfers in small but important ways. For example, this year, Idaho passed a law to authorize the Bureau of Reclamation to lease water for stream flow enhancement. Montana passed a law defining instream flow for fisheries as a beneficial use, an important distinction in states such as Montana which are governed by appropriative water law. As of April, the Nevada legislature was considering a bill that would support the adjudication of groundwater and surface water affected by interbasin transfers. Oregon passed a bill streamlining the process of transferring a forfeited right to another user within the same water basin (*Water Strategist*, 2005).

states.[2] The most striking feature within this table is the prevalence of short-term leases in most states in the sample. Only Nebraska, for which no leases transactions were recorded, and Nevada, reported more volume sold than leased. Table 1 also indicates that although water markets are growing, total volume traded remains small compared to overall consumption. In most states, less than 2% of water consumed is permanently transferred or leased each year (USGS, 2004). Arizona, California, Idaho, New Mexico, Oregon, and Texas move the most water as a percentage of total consumptive use. These states are, not coincidentally, the states which report the highest volume transferred through leases. Leases face less stringent legal restrictions and fewer restrictions due to environmental and third-party impacts, since water transferred once causes less disruption in the exporting basin and community than water transferred forever under a permanent transfer. Leases in response to fluctuations in water supply are more likely to occur during dry years, and in locations where fluctuations are larger.

Table 1 also compares lease and sale prices over the study period. There is huge variation in both prices and the capitalization rates implied by the ratio of annual lease to sale price, across states and years. Over the entire time period, the average implicit capitalization rate is 8%, which is somewhat consistent with expectations about the operating cost of capital. However, there is tremendous variation between states' implicit capitalization rates. There are several potential explanations for deviations in the implicit capitalization rates. The more important of these are administratively set prices, legal restrictions on permanent transfers, and the premium that urban water agencies may be

[2] The authors acknowledge Adams, Crews and Cummings (George State University) for initial assistance in developing the database.

willing to pay (and that agricultural entities may demand) for the permanent sale of water rights.

In addition to the surprising predominance of leasing and the remarkable variation in prices, the data also demonstrate some clear trends regarding buyer and seller characteristics. Lease and sale volumes have remained rather stable over time, but use proportions are changing markedly. Less water is transferred for agricultural use and more for municipal and industrial use and environmental use, over time. Municipal agencies are likely to be in the lease market when their own supply resources are subject to supply variability. State and federal agencies which are required to protect riparian habitat and runs of endangered and threatened fish are also likely to be in the lease market in dry years when resources are scarce. One clear trend over time has been the increased use of water markets to enhance instream flows. By 2003-2004, purchases for environmental use across the western United States were 43% higher than they had been in 1993-1994. In 1993-1994, they represented 14% of total transferred water. In 2003-2004, they represented 43%.

For permanent transfers, the pattern is less clear. Although purchases for agricultural use are low across the entire time period, there is no clear trend for sales to municipal or environmental use. It is probable that these purchases respond to legislative and regulatory circumstances peculiar to each state rather than to any clear time trend. It is common in some states for municipal water agencies to purchase a permanent water right and to lease the water back to the agricultural seller until the water is needed for projected urban growth in the future.

III. Theoretical Explanations for Transaction Patterns

In this section, we develop a framework to explain the relative predominance of sales versus leases within each state. The descriptive statistics presented in the previous section suggest two buyer types and two seller types. The first buyer type is a municipal water agency who wishes to secure long-term supply to meet projected future growth.[3] This water agency is risk averse, preferring to secure a permanent water right rather than exposing itself to the uncertainty of future water markets (through sequential short-term annual leases), ceteris paribus.[4] This municipal buyer's expected utility is higher under sales than leases, since the data indicate that it prefers sales to leases. The second buyer type is a high-value agricultural producer who is risk neutral and so indifferent between leases and sales. The environmental and third party costs associated with water rights purchases make it more likely that this risk neutral buyer will lease water rather than buy. Further, high-value agricultural producers are more likely to have existing supplies that fluctuate with general water supply availability; this buyer type is likely to be in the market only during dry years when its own supplies are low. State and federal environmental managers also match the profile of this second buyer type.

The sellers are agricultural producers who can either transfer permanent water rights or lease out water in dry years, preserving their ability to use the water as an agricultural input in wet and normal years. They may be risk neutral, essentially indifferent between leasing and selling water rights.[5] However, the environmental and

[3] The data demonstrate that like agricultural and environmental interests, municipal agencies also use leases in dry years, when their own resources are not sufficient to meet demand. The model abstracts away from this behavior.

[4] The municipal agency may in fact be risk neutral but behaving as if risk averse, due to nonlinearities in its cost function (e.g., extremely high water prices in drought years, damage to reputation caused by water shortages). We do not parse out the exact reason for the appearance of risk aversion here. Williams (1987) and Goldberg (1990) explore this possibility in greater detail.

[5] Under some circumstances, agricultural producers might prefer to lease out water because they, like urban buyers, wish to avoid future exposure to the spot market (Howitt, 1998).

third party costs to water transfers are greater for sales than for leases, since the latter is only a temporary disruption to the local environment and economy. This asymmetry may increase the effective price on permanent water transfers.

These buyers and sellers fit into the framework of a market-clearing trade model in which net social surplus is maximized subject to the requirement that no arbitrage opportunities among any buyer-seller pairs exist:

$$MaxNSS = \sum_{j=U,Ag}(\phi_j + .5\delta_j Pd_j)Pd_j - \sum_{i=L,P}(\alpha_i + .5\gamma_i Ps_i)Ps_i$$

subject to:

$$Pd_U - Ps_L - CR_U(Q_L) - CE_L \le 0 \qquad (1)$$

$$Pd_U - Ps_P - CE_P \le 0 \qquad (2)$$

$$Pd_{Ag} - Ps_L - CE_L \le 0 \qquad (3)$$

$$Pd_{Ag} - Ps_P - CE_P \le 0 \qquad (4),$$

where $CR_U(Q_L)$ is the risk aversion penalty function which represents the increased cost to urban buyers of leasing rather than buying water, and CE_i represents the environmental and other third party costs incurred with sales and leases. The problem generates inverse demand functions for urban and high-value agricultural buyers:[6]

$$Pd_U = \frac{-\phi_U}{\delta_U} + \frac{1}{\delta_U}Qd_U \qquad (5) \qquad\qquad Pd_{Ag} = \frac{-\phi_{Ag}}{\delta_{Ag}} + \frac{1}{\delta_{Ag}}Qd_{Ag} \qquad (6)$$

and inverse supply functions for agricultural producers who offer leases, and for agricultural producers who offer permanent sales.

[6] These are excess demand functions. Many municipal and agricultural producers have their own resources which they supplement through the market.

$$Ps_L = \frac{-\alpha_L}{\gamma_L} + \frac{1}{\gamma_L} Qs_L \qquad (7)$$

$$Ps_P = \frac{-\alpha_P}{\gamma_P} + \frac{1}{\gamma_P} Qs_P \qquad (8)$$

To simplify the problem, we assume that constraint (4) is slack; the agricultural buyer does not purchase permanent water rights. The agricultural producer's value of marginal product is significantly lower than the urban buyer's. For the agricultural producer, the environmental and third party costs are too great relative to the value of marginal product. The *Water Strategist* data supports this simplification; there are few permanent rights purchases by agricultural producers listed in the data.

We use these first-order conditions and complementary slackness conditions to gain insight into the behavior of market participants. First, an increase in municipal demand increases the probability of sales relative to leases. From (5), an increase in urban quantity demanded leads to an increase in the urban price, Pd_U. An increase in urban quantity demanded also leads to an increase in the risk aversion penalty function $CR_U(Q_L)$. From constraints (1) and (2), it is clear that the increase in $CR_U(Q_L)$ will cause Ps_P to increase by more than Ps_L, leading to a higher increase in Qs_P relative to Qs_L.

Second, an increase in the value of marginal product of the high-value agricultural buyer will increase its quantity demanded, directly from (6). Thus, all else being equal, an increase in the value of agricultural land will increase leases relative to sales, since it has been established that the agricultural buyer will not be in the market for permanent sales. Similarly, on the supply side, agricultural producers who experience a positive economic shock will reduce their supply of leases and sales Qs_L and Qs_P to the market, increasing prices Ps_L and Ps_P. If the economic shock is temporary reflecting year-to-year crop conditions, agricultural producers will reduce lease supply, causing sales to increase relative to leases. If the economic shock is of a more permanent nature, agricultural

producers will reduce supply of permanent water rights, causing sales to decrease relative to leases.

Third, year-to-year variations in precipitation will have an effect on the decision to lease or buy. The greater the variation, the more likely that leases will occur. Drought conditions increase the quantity of water demanded by urban and agricultural producers, which increases Pd_U and Pd_{Ag}. Leases increase more than sales in response. For example, in California, the probability of a critically dry year is approximately 25%. If capital markets are working smoothly, then the cost of a permanent sale is roughly four times that of a lease, making a lease the more appropriate response to supply fluctuations.[7]

Finally, the implementation of laws and regulations that incorporate environmental and third party costs into sale and lease prices will cause an increase in lease activity, all else equal. If the probability of a critically dry year is approximately 25%, then the environmental/third-party cost of a permanent sale is four times that of a lease, so that $CE_P > CE_L$. In sum, the equilibrium quantities of water transferred through sales and leases represents a tradeoff between risk (driving risk-averse buyers to sales) and physical externalities and third-party effects (driving sellers to lease rather than sell).

IV. Empirical Explanations for Transaction Patterns

The discussion thus far suggests several causal relationships. When the value of agricultural production is high, it is more likely that agricultural producers will use their water as an agricultural input rather than lease out. However, in areas where the value of

[7] If transaction costs are zero, then the purchaser of a right could lease out the water in wet years, making it indifferent between buying and leasing in the first place. However, transaction costs are likely not to be zero, whether it be from the thinness of water markets, risk aversion, or some other nonlinearity in the cost function.

agricultural land is low, farmers are more likely to sell their water rights rather than use the water as an agricultural input. Risk-averse buyers' preferences for sales rather than leases will increase the probability of sales. All types of buyers are responsive to year-to-year variability in precipitation. Agricultural producers, environmental managers and urban agencies seek to supplement existing supplies during dry years.

Third-party and environmental costs should increase with larger transacted sale volumes, consequently increasing the probability of leases. The greater the volume of water traded, the greater the effect on exporting communities. This in turn increases pressure on state legislative and regulatory bodies to pass legislation designed to incorporate the environmental externalities. In California, for example, short-term leases of less than a year are only required to file a negative declaration of impact on the environment. Longer-term leases and permanent sales, on the other hand, require the filing of an Environmental Impact Report under the California Environmental Quality Act of 1970, a substantial task.

To test these expectations, we use our database of water trades that have occurred from 1993 to the present, compiled from the Water Strategist.[8] The following econometric specification uses physical and financial scarcity variables and an index of state environmental laws affecting water transfers as explanatory variables:

Contract Type = (AGLAND, AGPRODN, BLD, PDSI, THIRD, FISH, INC, TIME)

[8] The implicit assumption in our analysis is that the *Water Strategist* data is, if not comprehensive, at least representative of trades taking place in western states.

The discrete dependent variable is equal to one when the transaction is a permanent transfer, and zero otherwise.[9] The variables AGLAND and AGPRODN (from the United States Department of Agriculture's National Agricultural Statistics Service) capture the statewide opportunity cost to agricultural producers of participating in the market. The variable BLD (from the Department of Housing and Urban Development) is the number of building permits issued for each state in the sample, weighted by state population. This variable represents the increased pressure on municipal areas to meet the water needs of a growing urban population.[10] The National Oceanic and Atmospheric Administration's Palmer Index, which incorporates the effects of precipitation and temperature on drought severity given local conditions, is our drought variability measure, PDSI. (Lower PDSI values indicate more severe drought conditions.) The third party impacts variable, THIRD, is equal to 1 when third parties have standing in the approval process. The variable FISH is equal to 1 in states where fish and wildlife was designated as a beneficial use as of 1997 (Getches, 1997). The variable INC from the Bureau of Economic Analysis controls for variation in income across states. A time trend is also included in the econometric specification.[11]

The results, presented in Table 2, are consistent with the theoretical expectations. All coefficients have the expected signs. Six out of nine of the coefficients are significant at the 1% level, and two more are significant at the 5% level. The financial scarcity

[9] We also ran another set of regressions with the dependant variable as the length of the contract rather than the type of contract. The results do not differ significantly from those presented here.
[10] Generally speaking, only urban areas require developers to acquire permits. The U.S. Census Bureau estimates that less than 2 percent of all privately owned housing units constructed are built in areas that do not require permits, and only 3 percent of houses built in permitting areas are built without permits (U.S. Census Bureau, 2005). Hence, BLD is a good estimate of the new demands placed on municipal agencies.
[11] We also hypothesized that the annual percentage of water consumed within a state, as an indication of the likelihood of market participation of any sort, would have an effect on the probability of sale versus lease transaction. The variable did not have a significant effect, so it was removed.

variables are as expected. The coefficient on AGPRODN is positive and significant, indicating that farmers lease rather than sell their water in response to temporary financial shocks. However, in response to longer-term shocks as represented by the value of agricultural land, farmers are more likely to sell their water rights. Thus, the coefficient on AGLAND is negative and significant. The coefficient on BLD is positive and significant, representing increased urban need to secure permanent water rights. Risk-averse buyers' preference for a sale rather than a lease does appear to increase the probability of sales. This finding is also consistent with descriptive statistics and anecdotal evidence gleaned from the *Water Strategist* transaction descriptions indicate that municipal agencies prefer to purchase water rather than lease, in response to projected growth.

The physical scarcity variable PDSI also behaves as expected. It is positively related to the probability of permanent sale; in drought years, leases are more likely to occur than during wet and normal years.

Finally, the fact that the data set covers multiple state jurisdictions allows us to parse out the effects of laws to benefit the environment and third parties from the other variables affecting lease and sale patterns. The coefficients on the third party impacts and environmental law variables are positive and significant. Thus, the greater the environmental and third-party costs within a state, the higher the probability that transactions will be leases rather than sales.

V. Conclusion/Further Research

The empirical specification bears out our theoretical expectations about market patterns. Although we remain concerned that the data may be incomplete, this analysis

supports the idea that transactions reported by the *Water Strategist* are reasonably representative, since the estimation results match our theoretical expectations.

In the future, we intend to separate out the time-invariant explanatory variables from the explanatory variables that fluctuate from year to year in response to economic and hydrological conditions. For example, agricultural production influences whether farmers lease out water from year to year, whereas the underlying value of agricultural land affects whether farmers sell. These variables combined influence the agricultural producer's decision to lease or sell. Similarly, a long-term index of average variability should influence buyers' and sellers' decisions to seek out a permanent water right transaction. Buyers and sellers enter the lease market in response to expected (and subsequently realized) annual variability in precipitation.

The analysis would be better performed at the basin level rather than at the state level. Lack of inter-basin conveyance infrastructure and within-state weather variability confound the relationships we seek to identify. However, the data are not as conducive to analysis at the basin level, and, the results are already significant at the state level. This analysis is a first step towards a quantitative measure of the effect of state institutions and scarcity values on the type and extent of water markets. As such, this analysis provides a foundation for additional measures of the process of endogenous institutions.

Bibliography

Brookshire, D., B. Colby, M. Ewers and P. Ganderton. (2004). Market prices for water in the semiarid west of the United States. *Water Resources Research*, 40(9).

Colby, B., Crandall, K. and Bush, D. (1993). Water rights transactions: Market values and price dispersion, *Water Resources Research* 29 (1565-1572).

Getches, D.H. (1997). *Water law in a nut shell.* West Publishing Co.: St. Paul, MN.

Goldberg, V.P. (1990). Aversion to risk aversion in the new institutional economics. *Journal of Institutional and Theoretical Economics* 146, 216-222.

Hadjigeorgalis, E. and Lillywhite, J. (2004). The impact of institutional constraints on the Limari River Valley water market. *Water Resources Research*, 40(9).

Hanak, E. (2003). Who should be allowed to sell water in California? Third-party issues and the water market. Public Policy Institute of California, San Francisco, CA.

Hartman and Seastone. (1970). *Water transfers: Economic efficiency and alternative institutions.* Baltimore: Resources for the Future, Johns Hopkins Press.

Hearne, R. and K. Easter (1997). The economic and financial gains from water markets in Chile. *American Journal of Agricultural Economics* 15, 187-199.

Smith, R. (2005). Legislative report. *Water Strategist*. April, 2005, 8-21.

Smith, R. (ed.) 1993-2005: *Water Strategist*. Claremont, CA: Stratecon.

U.S. Census Bureau, "Building permits survey documentation." U.S. Census Bureau, Manufacturing and Construction Division, Washington, D.C. 20233-6900. <http://www.census.gov/const/C40/Sample/placeprt.pdf> (24 February 2005).

Williams, J. (1987). Futures markets: A consequence of risk aversion or transactions costs? *Journal of Political Economy* 95(5), 1000-1023.

Table 1: Volume and Volume-Weighted Prices for Reported Water Transactions, 1993-2004

	Volume					Price (in 2004 Dollars)		
State	Lease	Sale	Total	Lease/ Sale Ratio	Transactions as % of Total Use	Lease	Sale	Implicit Rate of Return
	(Thousand acre-feet)					($/acre-foot)		
AZ	4,887	204	5,092	23.91	5.63	62	1,036	0.06
CA	6,972	280	7,252	24.90	1.43	113	1,131	0.10
CO	357	303	660	1.18	0.38	174	4531*	0.04
ID	2,516	30	2,545	84.45	1.02	9	177	0.05
KS	9	1	10	10.06	0.01	50	503	0.10
MT	11	1	12	14.54	0.01	9	-	na
NE	-	32	32	-	0.02	-	-	na
NM	304	23	328	13.08	0.73	70	1,384	0.05
NV	16	112	128	0.15	0.35	79	2,320	0.03
OK	16	0.03	16	470.79	na	278	639	0.44
OR	814	605	1,419	1.34	1.47	202	361	0.56
TX	1,535	709	2,244	2.16	0.68	74	642	0.12
UT	101	19	119	5.36	0.19	27	1,748	0.02
WA	87	92	179	0.95	0.22	49	122	0.40
WY	218	18	236	12.35	0.32	30	-	na
Total	17,843	2,428	20,272	7.35	0.96	84	993	0.08

*CBT sales of 66 thousand acre-feet omitted. If included, Colorado sale price increases to $5763 and total sale price increases to $1288.

Source: Data from the *Water Strategist*.

Table 2: Determinants of Water Trading Patterns In Western Water Markets (1993-2003)

Dependent Variable=1 if Permanent Sale, 0 if Lease

Variable	Description	Coefficient	Significance
VOL	Thousand acre-feet transferred	-0.0186	(1.46)
AGPRODN	Value of agricultural production	0.5646	(4.82)**
AGLAND	Value of agricultural land	-1.798	(5.23)***
BLD	Building permits issued	0.0219	(6.26)***
PDSI	Palmer Drought Severity Index	0.0868	(2.50)**
ENVTL	Environmental/third-party impacts law index	-1.0756	(4.13)***
FISH	States with fish and wildlife as a beneficial use as of 1997	-2.0342	(6.20)***
INC	Per capita income	0.5575	(10.62)***
TIME	Time trend	-0.6183	(8.60)***
Constant		-9.8795	(12.89)***
Observations		2247	
Pseudo R^2		0.467	

Absolute value of z statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%