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Impact of Irrigation Water on Business Economics

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Abstract

Where water is scarce but demand is growing, water markets offer an opportunity to in-crease economic efficiency by enabling the reallocation of water among users and sectors. While buyers and sellers willingly enter into such transactions, indirect impacts on agricultural communities can be devastating, as intersect oral transfers may substantially alter the nature of the community's underlying economy. This study investigates the potential economic impacts of irrigation water transfers on Uvalde County, Texas, accounting for the indirect and induced effects that crop mix changes have on agricultural input industries and labor, as well as positive impacts resulting from the influx of water permit payments into the local economy. Results from modeling these impacts using locally-produced crop budgets versus the model's aggregate production functions are compared. Overall we find that water transfers negatively affect the county's employment, labor income, and output significantly, and that labor income changes are particularly sensitive to the use of crop budgets as opposed to aggregate production functions.

Keywords: *Irrigation Water, Business Economics, Growing, Water Markets, Economic Efficiency*

INTRODUCTION

Population and economic growth in the south western United States have put increasing pressure on water resources in many areas (Glennon, 2005). As rivers, aquifers, and spring flows have declined, conflicts among environmental and human uses of water have emerged or grown in

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intensity (Molle&Berkoff, 2009; Glennon, 2005). While historically water planners looked to augment water supplies to satisfy growing demand, new opportunities for enhancing supply are limited (Griffin, 2006; Glennon, 2005). Instead, policy makers now focus on rebalancing sectoral allocations to align with changing social values, preserve environmental flows, and achieve optimal economic returns (Glennon, 2005; Griffin, 2006; Molle&Berkoff, 2009). Water used for agricultural irrigation is often viewed as the source for growing urban area water demand, as data suggest that small reallocations from agriculture to urban uses could satisfy demand for decades (Shupe, Weatherford, &Checchio, 1989; Howe, Lazo, & Weber, 1990). Yet the apportionment of water is fraught with trade-offs among communities, the environment, economic activities, and current and future generations. Over the last 30 years, the application of economic principles to water allocation, particularly tradable permits, has grown in popularity (Gillig, McCarl, Jones, &Boadu, 2004). Economic theory holds that tradable permits are capable of improving economic efficiency by moving water from lower-valued uses to higher-valued uses, thereby maximizing aggregate social welfare and facilitating economic growth (Saliba& Bush, 1987; Michelsen, 1994; Griffin, 2006; Glennon, 2005). When adequate permits are assigned to environmental uses, such a system can also protect ecosystem needs, such as in-stream flows, while preserving flexibility in allocation among human uses. Water transfers constitute a market when property rights to water permits are fully specified, transaction costs are minimized, and a sufficient number of agents are active in the trade of permits (Saliba& Bush, 1987). Markets promote economic efficiency by enabling exchange between willing buyers and sellers, but they can have disadvantages, particularly when impacts from the transfer are felt by more than the buyer and seller. It has been argued that the property rights for water are not fully specified, as benefits and losses from reallocating water supplies may be felt by entire communities, not only individual appropriators.

EDWARDS AQUIFER WATER MARKET

This study investigates Texas' first groundwater market and considers potential indirect economic impacts of groundwater transfers on Uvalde County, a rural agricultural area in South Central Texas. The accounting stance is the county level only local economic impacts are

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considered, whether or not these impacts are offset at the regional level. South Central Texas, home to San Antonio and a large agricultural community, is among the fastest growing regions in the state. The region's population is projected to grow 76% between 2010 and 2050, with a corresponding increase in water demand of 286,000 acre-feet(Texas Water Development Board, 2010; Texas Water Development Board, 2002). The region relies heavily on the Edwards Aquifer for municipal, industrial, andagricultural water, but recharge has not kept pace with demand (McCarl et al., 1997). The problem is intensified by the presence of several endangered species whose habitat depends on spring flows from the Edwards Aquifer. While the majority of groundwater in Texas is governed by the rule of capture, a 1991 lawsuit against the state of Texas for failure to enforce the Endangered Species Act to protect aquifer-dependent species led to a turning point in how the Edwards Aquifer is governed. In 1993, SB 1477 created the Edwards Aquifer Authority, an agency responsible for establishing a cap on aquifer pumping and issuing pumping permits. The bill also created means to market groundwater rights by making permits transferable (Boadu, McCarl, &Gillig, 2007; McCarl et al., 1999). In many water markets, water moves from agricultural irrigation (where it generates fairly low returns) to municipal and industrial uses where a higher value is attached to it (Saliba& Bush, 1987). This is currently happening in South Central Texas, where water is moving from rural, agricultural areas to urban areas for municipal and industrial use. Bexar County, where San Antonio is located, is the dominant purchaser of water leases and rights to irrigation water. Uvalde County is a prominent source of irrigation water permits.

LITERATURE REVIEW

Transfer of water has occurred in many of the western states, including Nevada, California, Colorado, New Mexico, Idaho, and Arizona (Saliba& Bush, 1987; Charney& Woodard, 1990). Indirect economic impacts resulting from such transfers are well documented in the literature. However, evaluation of indirect economic impacts depends crucially on one's accounting stance. At the regional or state level, local losses are frequently more than offset by gains in other areas and may appear inconsequential (Howe, Lazo, & Weber, 1990). Further, economic theory generally assumes full factor employment and complete mobility, positing that factors of production that become unemployed will relocate to find

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employment elsewhere (Hamilton et al., 1991). However, Howe, Lazo, and Weber (1990) argue that this theory does not always accurately describe all situations and that permanent income losses to factors of production can and do occur. They write, "In the presence of persistently depressed rural conditions, factors of production left unemployed in agriculture, in agricultural supplying activities, and in agricultural processing activities can be idled for long periods, leading to real national efficiency losses" (p. 1201). In addition, the authors acknowledge the deep economic and psychological costs incurred by these parties. Input output analysis is often used to estimate the effect that a change in direct economic expenditures has on a given region (Mann, 2002). Models such as IMPLAN (IMpact Analysis for PLANning) and REMI (Regional Economic Models, Inc.) have been used to estimate the impacts that decreased irrigated agriculture can have on regional economies due to a reduction in farm input expenditures. In Howe, Lazo, and Weber's 1990 analysis of the Arkansas River in southeastern Colorado, the authors used IMPLAN to calculate that each acre-foot of water transferred resulted in an estimated loss of state net income of $53, although cost savings to cities far exceeded this amount. Charney and Woodard (1990) conducted a study of water transfers in La Paz, Arizona, using a statewide econometric model. They found that every 1,000 acres of agricultural land retired due to water sales resulted in a loss of 17 jobs.

In order to more accurately simulate water prices and the positive effect that payments for water may have on the economy, Seung et al. (1998) used a computable general equilibrium model to examine the impacts of reallocating agricultural water to recreational use in Nevada and California. The authors found that the combined effect of water payments and increases in recreation did not offset the losses in the agricultural sector. Several studies have attempted to quantify the impact that reductions in irrigated agriculture would have on Uvalde County's economy. Lee et al. (1987) explored potential economic impacts resulting from overpumping the Edwards Aquifer. The authors predicted likely replacement dryland cropping mixes using a linear programming model to maximize net returns to land, labor, and water, and then modeled the economic impacts of the resultant cropping mixes using an input output model. Their analysis found that Uvalde's economy would contract by approximately $23 million (more than $43

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million in 2008 dollars) by shifting from irrigated agriculture to dryland agriculture as the aquifer's water elevation dipped below economically recoverable levels.

METHODS AND DATA

The initial step in this analysis was to determine a baseline of irrigation permits in Uvalde County, the average amount of irrigation water pumped, and the typical crop mix. The year 2000 was selected as the baseline against which to measure changes in the local economy due to irrigation water transfers.

(i) Baseline irrigation permits- Irrigation permits were typically allocated to historically irrigated farmland at a rate of two acre-feet per acre of land. Of these two acre-feet, one acre-foot was transferable, while the other was to remain with the land, referred to as the "base" acre-foot. The process of issuing irrigation permits has been long, with initial permits issued beginning in the late 1990s and nearing completion by 2006. During this time period, permits were also leased and sold, making it difficult to establish a baseline.

(ii) Baseline crops and irrigation water used- To approximate the baseline acres of crops planted in Uvalde County prior to significant water market activity, we averaged harvested acres of crops reported in the 1997 and 2002 USDA Census of Agriculture, and adjusted these acres to planted acres using data from the National Agricultural Statistics Service. According to these statistics, 55,276 acres of land were irrigated in Uvalde County, of which 7,974 acres were double-cropped. The primary irrigated crops were corn, winter wheat, sorghum, cotton, vegetables (cucumbers, cabbage, spinach, onions), forage and hay, oats, and pecans. The average value of crops grown in Uvalde County in 1997 and 2002 exceeded $53 million (2008 dollars) (Texas AgriLife Research and Extension Service, 2003), representing nearly 5% of Uvalde County's output.

(iii) Crop mix and input changes- Our analysis assumes that Uvalde County farmers keep the total acreage of agricultural land constant, but upon transferring water permits, water intensive crops are traded for a mix of the most profitable dryland crops. The selection of dryland crops to replace irrigated crops was based on an analysis of crop profitability, risk mitigation, historical cropping patterns, and agronomic considerations.

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(iv) Payments for water permits- Payments to Uvalde County residents for water permits were calculated under two scenarios. The first assumed that all water permits would be transferred at a price of $135/acre-foot, based on estimates from the South Central Texas Regional Water Plan for 2006 (South Central Texas Regional Water Planning Group, 2006). The second method calculated the minimum price at which a farmer would sell their water permit, based on the difference between the irrigated crop's marginal profit and the dryland crop's marginal profit, and the water consumption of the crop. This payment scenario assumes the farmers own the permits to their irrigation water and therefore internalize the opportunity costs associated with irrigated agriculture and water transfers.

(v) Modeling economic impact- Secondary economic impacts resulting from conversion of irrigated crops to dryland crops can be estimated using an input-output model such as IMPLAN. Input-output models are constructed using internally consistent datasets that describe an economy's inter-industry linkages and adjust for trade through regional purchase coefficients (Shaffer, Deller, & Marcouiller, 2004). IMPLAN estimates the cumulative impact of a "shock" to one sector of the economy on the economy as a whole. The cumulative impact is measured by summing direct impacts (e.g., changes in industry output), secondary effects on suppliers of an industry ("indirect impacts"), and the effects resulting from changes in household income ("induced impacts"). Thus input-output models trace the flow of money as it circulates through an economy (Miller & Blair, 2009; Shaffer, Deller, &Marcouiller, 2004; Stynes, 1999). One method used to estimate the impacts of eliminating irrigated crops is to reduce the output of those sectors in the input-output model by the net change in market value of the crops (value of dryland crops less value of irrigated crops). However, IMPLAN com-bines multiple crops with very different production functions into general categories such as "grain farming" and "vegetable and melon farming." Changes in output level from a crop is modeled using an aggregate sectoral production function, which averages several different crops' production functions. Additionally, these sectors do not reflect the difference in production functions for a crop grown under irrigation compared to a dryland crop. In our study this would lead to skewed results, as, for example, the weighted average value of inputs for irrigated grain crops removed

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from production is $490, while the weighted average value of inputs for the dryland grain crops introduced is only $157 a substantial difference which may not be fully captured by simply introducing a shock to IMPLAN's aggregated crop sectors. For these reasons, we calculated changes in intermediate inputs for each sector as well as changes in farm proprietor income and used these as the shocks to the county's economy, rather than simply modeling a shock to IMPLAN's aggregated crop sectors.

POLICY IMPLICATIONS

Impacts resulting from the transfer of Edwards Aquifer permits are not borne equally by Uvalde County residents. Labor income in Uvalde County is reduced by more than $15 million, yet water permit holders receive payments totaling approximately $10 million for the transfer of their groundwater. These payments generate only $1.2 to $1.4 million in induced labor income, indicating that their effect on the overall economy is relatively small and that those who stand to gain from the transfer of water permits are largely distinct from those who are negatively impacted. Moreover, permit payments will not be evenly distributed among Uvalde County agriculturalists, as one third of irrigated farms in Uvalde County account for 75% of the total irrigated land (United States Department of Agriculture, National Agricultural Statistics Service, 2002). The replacement of high return, labor-intensive agriculture (such as vegetables) with low-labor crops (such as winter wheat and sorghum) has the potential to greatly reduce the number of jobs available in agricultural support services in Uvalde County. Our results indicate that more than 750 jobs may be lost in these sectors, due to a decline in demand for agricultural inputs of approximately $34 million. However, further research is needed to explore alternative non irrigated land uses, such as ranching or recreation, which may have significantly different impacts on the local economy. Additionally, it is unclear how quickly the impacts described above would be felt, particularly if the conversion from irrigated agriculture to dryland agriculture occurs over an extended timeframe. To date, an average of only 3,700 acre-feet of water have been transferred out of Uvalde County annually. If the rate of transfers does not increase, irrigated agriculture will persist in Uvalde County until 2035, thereby greatly diminishing the annual rate of job losses. Despite the potential negative impacts on Uvalde County's economy, it is unclear what role, if any, policy should play. The transition away

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from irrigated agriculture could result in output in Uvalde County contracting by approximately 3%. The number of jobs would likewise be reduced by 6%. While this is a significant impact, it is not necessarily more than the economy can absorb, particularly if it is spread out over many years or if revenues from water transfers are invested in new or expanding industries. In addition, these losses may be more than offset by output and employment increases in San Antonio as a result of increased water availability.

CONCLUSION

In terms of compensation to parties affected by the transfers, McCarl et al. (1997) argue that compensation to third parties is rare when owners of private assets or businesses suspend economic activity in an area. For example, they note that "over the last hundred years, technological developments in agricultural and industrial sectors have created mass migrations of people from rural areas to urban areas with no attempt made to compensate the rural areas…. The economic argument against compensation has been that resources are mobile and, if displaced… will find employment elsewhere". However, it is important that the community maintains an awareness of the potential negative impacts of water transfers in order to best prepare for and mitigate them. A potential policy option is to levy a tax on water leases and sales that is diverted to a fund to assist those suffering job losses or seeking job retraining due to reductions in irrigated agriculture. Alternatively, such revenue could be directed to promote other sectors such as outdoor recreation along the county's rivers and prime wildlife areas. Although the decision regarding whether or not to transfer water ultimately lies with the individual buyers and sellers, community stakeholder discussions regarding third-party impacts and visions for the community's future could influence permit holders' decisions. At a minimum, such discussions will enable the community to proactively develop economic development priorities and strategies useful for navigating an altered economic environment.

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