Is California's Water Market Supply-Constrained? Insights from a High-Resolution View

Anita M. Chaudhry and Dean H.K. Fairbanks*

Abstract: Climate change and population pressures continue to increase competition over limited water supplies. In California, as elsewhere, markets in water have been facilitated to improve allocations of existing water supplies from lower to higher-valued uses. But today, after three decades of market development, volume of water traded in the market remains lower than desired. Using a novel purpose-built data from a sample of California irrigation districts participation in water sales over 1991-2019, a period that covers the development of California water market from its inception to relative maturity, we show how some of the policies intended to protect multiple water users from harm have also restricted water sales. Low sale activity is a result of farmers responding to the conflicting pressures of drought-induced high-water prices against the need to support local agricultural economy and the environment. We highlight important questions for further research that could affect the future potential of water markets in easing structural and drought-induced water scarcity in California.

Key Words: Drought Water Bank, Groundwater, Fallowing, Remote sensing

*Chaudhry is Professor in the Department of Economics and Fairbanks is Professor in the Department of Department of Geography and Planning, at CSU, Chico. Please direct correspondence to achaudhry@csuchico.edu

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1. Introduction

Organized in irrigation districts, farmers hold the majority of senior water rights in the Western United States. During droughts, when competition over scarce supply intensifies, water markets can give farmers a a strong incentive to conserve water use on lower-valued agricultural production and redirect it towards environmental, urban or higher-valued agricultural uses and thus help mitigate overall losses to the economy and the environment. Economists have long advocated water markets as a least cost way to reallocate scarce water supplies from lower- to higher-valued uses (Anderson, 1983; Howe et al., 1986; Vaux and Howitt, 1984; Culp, 2014). But despite the obvious economic and environmental benefits of water markets, a persistent puzzle is that volume of water traded in the market remains low compared to the total water used. In California, water trades account for just around 2% of the total water supply, having decreased slightly over the past decade (Schwabe et al., 2020).

Are transaction costs of water transfers too high and responsible for the “thin” water market? Transactions costs refer to the myriad costs that buyers and sellers face to negotiate and complete water transfer contracts. These include the time and effort in matching buyers and sellers, negotiating contracts, carrying out environmental or legal reviews and or dealing with policy-induced uncertainty or other procedural hurdles. Recent literature on water markets has focused on the sources and implications of transactions costs in water markets. Regnacq et al. (2016) showed that transfer costs, proxied by the distance between water trading irrigation districts as well as the cumbersome transfer approval process or local policy changes, play a significant role in inhibiting water trades. Libecap (2011) focused attention on the nature of prior appropriation water rights in the Western U.S. arguing that the current ownership of water use rights, i.e., surface water rights held by farmers organized in irrigation districts, is an obstacle to transferring water out of the agricultural sector. Irrigation districts are semi-autonomous or private entities that manage most of the irrigation water in the West, were initially organized with the view to solving free riding and hold up problems in managing capital, but are not prepared for the challenges of internal reorganization for water sales (Rosen and Sexton, 1993). In a Texas case study, Griffin (2014) indeed found that farmers within irrigation districts are less likely to transfer water than farmers outside irrigation districts. Arguments are made that if such costs are reduced, volume of water traded would increase, leading to significant allocative efficiency gains, particularly during droughts (Libecap, 2011, Brewer et al., 2008 and Culp et al., 2014). Farmers’ private financial gains from participating in water sales can be quite significant as shown by Bigelow et al., (2019) so the issue of why markets are not moving more water poses quite a puzzle.

In this paper we explore the determinants of water sales by irrigation districts to understand why water sales are low. Using a novel, purpose-built data on district participation in water sales over 1991-2019, we demonstrate that certain State and local water policies have become binding constraints on the volume of water sold by irrigation districts. The restrictions on groundwater-substitution land fallowed for water sale were intended to reduce negative externalities of water trades which themselves are a result of the very nature of irrigation water use—with its multiple and simultaneous users of water--that creates a difficulty in carving out private property rights in water. While these restrictions may have temporarily assuaged concerns about excessive local negative externalities by constraining water supply in the water market, we will posit that the underlying question of the distribution of benefits and costs of waters sales in rural communities is still outstanding and needs to be addressed carefully if water markets are to achieve their full potential. Given the complexity of the water trading processes, and the diversity of irrigation districts that participate in water markets, we demonstrate the role of these restrictions with the help of an in-depth case study of three irrigation districts in northern California that have frequently participated in water sales. We cover the entire time period of 1991-2019, which spans the entire history of water market activity in California, in order delineate the role of changing local and State policy environment during successive droughts in affecting water market participation and district's adaptation to these policies.

2. Restrictions on Water Sales: Transaction costs or Pigouvian tax?

Water marketing refers to the temporary or short-term, long-term, or permanent transfer of rights to use water in exchange for compensation (Hanak, 2015). In this paper, we focus on short-term water transfers, also referred to as one-year leases of water allocations from water districts to interested buyers away from the districts.[1] As research on water market activity has shown, most trades in water are short-term leases with substantial variation across States (Brewer et al., 2008; Schwabe et al., 2020). In California, short-term transfers ("transfers" from here onwards) represent an important tool to cope with droughts and constitute 25 – 75% of all volume traded in a year (Hanak and Stryjewski, 2012).

Local public agencies or irrigation districts, and some municipalities hold most of the water rights (Griffin, 2012; Libecap, 2011).[2] In the Western United States, irrigation districts supply water to half of all irrigated acreage, and 68% of all irrigated acres in California (Thompson, 1993). Farmers in irrigation districts with senior entitlements or water rights may find that their water supply is not curtailed in a drought year and have the opportunity to transfer their surface water allocation in exchange for compensation. In California, there are two kinds of water sellers in a temporary water market: farmers who are "conserving" water by not planting crops for a season or fallowing, and farmers who have access to groundwater, and choose to substitute groundwater for agricultural production and sell their surface water allocation (CDWR, 2015).[3]

Hanak (2015) notes three distinct phases of water market development in California: the early drought period, 1988-1994; an intermediate phase when environmental concerns drove continued growth, 1995-2002; and the most recent phase, 2003 onwards that is marked by two

[1] We focus here exclusively on water transfers out of irrigation districts. Water transfers or exchanges amongst farmers within a district are all too common leading some to argue that Districts have achieved Coasean equilibrium in water allocation (Ruml, 2005).

[2] Legally, some of these agencies hold long-term contract-entitlements rather than rights to surface water. These entitlements, governed by the state's original Gold Rush era water law "first in time, first in right", are allocated on the basis of seniority or priority in initial date of appropriation.

[3] A third type of water transfer is when there is excess water in a reservoir and reservoir operator releases water in excess of water that would be released annually under normal operations (CDWR 2015). In dry years, this last option is often not available and therefore farmers who can fallow or substitute with groundwater are the main suppliers in the water market.

distinct trends: a shift toward long-term and permanent trades and a lowering of overall growth in trades. The early phase of water market was spurred by a long period of drought between 1987 and 1992. In 1991 and then again in 1992, the California state government developed Drought Water Banks (DWB) to facilitate a re-allocation of water from senior users with lower valued uses such as field crops and pasture to higher valued uses such environmental or urban users (CDWR 2015). These DWBs were significant policy innovations in that they were the first large scale temporary water market set up and run by a State government. The intermediate phase of water markets was dominated by the Dry Year Water Purchase Programs in 2001 and 2002 that essentially performed like a DWB in that the State) purchased water allocations from willing sellers and sold it to interested buyers. Each of these State-sponsored water purchase programs was different in its operational detail, offered water price, and volume of water transferred. For example, in the 1991 DWB about half of the water was supplied by farmers who fallowed their land (i.e., did not plant a crop) and one-third of the water was supplied by farmers who sold their surface water allocation but substituted with groundwater to continue farming (Israel and Lund, 1995). In DWBs of 1992 and 1994, however, more than two-thirds of the water was sold by groundwater substitution (Israel and Lund, 1995; Clifford et al. 2004). State-sponsored water banks acted as "training wheels" for the farmers as they all essentially provided farmers with an institutional mechanism and access to public conveyance infrastructure to sell their water allocations by fallowing or substituting with groundwater.

The most recent or the mature phase of water markets is marked by Districts' engaging in independent negotiations amongst each other. Following the 2009 DWB many water transfer stakeholders requested CDWR and the federal Bureau of Reclamation (for the Central Valley Project) to only facilitate (convey) water transfers but to not operate a DWB as the drought continued in 2010. Since 2009, CDWR has facilitated water transfers by conveying transfer water through State Water Project facilities (i.e., canals and pumps); however, it has not acted as a purchaser or broker as in a DWB (CDWR 2015). As farmers and their irrigation district management have learned how to best use water sale opportunities after experience with successive DWBs, the nature of water markets has evolved from active state participation as a broker to state's role being reduced to a facilitator and water conveyor.[4] In some cases buyers and sellers are matching with each other independently, creating a need to regulate these transfers to minimize adverse environmental and economic effects and these restrictions can be interpreted as a response to that need. Next, we focus on two specific restrictions that have been introduced to prevent water source area's economy and environment from harm.

2.1. *<u>Restrictions on Irrigated Area Fallowed for Water Sale</u>*

California Water Code §1745.05 (b), states that no more than 20% of irrigable area within a District can be fallowed for water transfers (CDWR and USBR, 2013).[5] Introduced by the State

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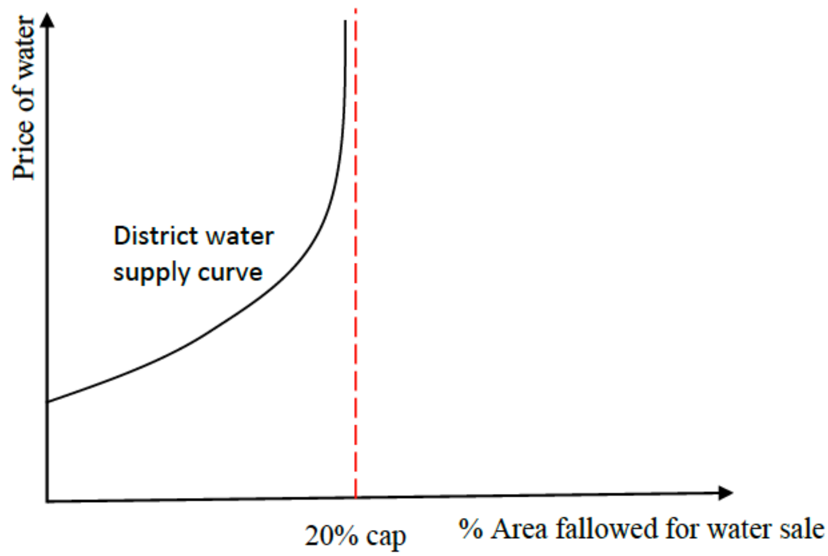
[4] See Hanak (2015) for an excellent review of Drought Water Banks and other water transfers in California.

[5] California Water Code §1745.05 (b) states "The amount of water made available by land fallowing may not exceed 20 percent of the water that would have been applied or stored by the water supplier in the absence of any contract entered into pursuant to this article in any given hydrological year, unless the agency approves, following reasonable notice and a public hearing, a larger percentage." This Code applies to the agency or district level i.e., a farmer participating in the sale may fallow 100 percent of her parcel to sell water but the district as a whole cannot

legislature in 1992—around the first series of DWBs--it was intended to limit adverse socioeconomic effects to local agricultural economies from loss of economic activity in the water-selling regions. For a fallow-and-transfer of greater than 20% of the irrigable area a local hearing is required to ensure the external effects are not excessive. This restriction effectively increased the transactions cost of transferring more water than a 20% fallowing of agricultural land within a district would provide. Figure 1 shows that this restriction makes District's water supply curve highly inelastic as the area fallowed for water transfer approaches 20% of the District's irrigable area. As a result, in severe droughts, increase in demand of water would translate into higher water prices without moving more water from the Districts.

Figure 1: Hypothesized Effect of a Cap on Area Fallowed on Water Price



It is noteworthy that the cap is placed at the level of the irrigation district, not at the level of the county or watershed. A local agricultural economy with several irrigation districts located close together could potentially lose much more agricultural production, and suffer losses in the local agricultural economy if all districts maxed out their 20% cap. Also, this rule does not distinguish amongst the crop planted, rice or alfalfa or corn—because each would have different linkages in the local employment and economy. There has not been any modification in this rule since its inception and there has not been much policy or academic discussion on the effect of increasing or lowering this cap.This is essentially a rule of thumb and there have been no analyses on identifying the threshold points where the benefits would exceed the costs (Hanak, 2003).

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fallow and provide more than 20 percent of the water "that would have been applied [..] in the absence of the contract". Cropland idling programs have stayed well below the 20 percent of water delivery threshold for a hearing (CDWR and USBR, 2013). This means that decision to stranffer is a two-part decision, the first whether the offer is good, and the second, which parcels (landowners) to fallow for transfers, the District management has to choose to enroll acreage in the water transfer program

2.2. *Restrictions on Groundwater Substitution*

As noted earlier in section 2, the DWBs of 1992 and 1994 relied on surface water transfers by rice farmers based on groundwater substitution. This led to increased groundwater pumping and a subsequent drop in the groundwater levels in the surrounding areas and created the political momentum for a local county-level ordinance that restricted such transfers (Hanak, 2003; Msangi and Howitt, 2006; Khokha, 2014). By mid- to late-1990s, 22 of the California's 58 counties required a permit from the County government—in which the district is located-- for groundwater export or substitution-based transfer-- representing a significant local policy change for water transfers, and again an increase in transactions costs of substitution-based transfers. As expected, this ordinance became a highly effective deterrent for groundwater-substitution based transfers.

Groundwater is a common property resource in California whereas the "no-injury" clause intended to protect third-parties from unmitigated harm only applies to surface water. As Hanak (2003) documents, these ordinances varied in their form and scope but generally farmers interested in groundwater substitution to continue crop production as they sold surface water allocation, now needed a permit from their respective county government County governments used their regulatory power to protect their residents from harm and effectively reduced the expected net gains of farmers from groundwater sales by introducing transaction costs, via delays in approvals or risk of local controversy, in water sales. Hanak (2005) constructed a county-level panel of volume of water exported over 1990-2001 and finds that the ordinances significantly reduced water exports from these counties. Groundwater levels have since recovered but the restriction is still in place and is likely to be grandfathered in the new groundwater laws being written under the 2014 Sustainable Groundwater Management Act.

3. Data

We select three irrigation districts (Districts from here onwards) in California's Sacramento Valley and compile data on their participation in water sales volume, price, and area fallowed over the period 1991-2019. The sample Districts nearly exclusively grow rice and have senior appropriative surface water rights on the Feather River that pre-date 1914.[6] Sacramento Valley, which refers to the northern part of the California Central Valley is relatively water abundant and a source of water supplies for the relatively water scarce southern San Joaquin Valley. Fallowing of the annual rice crop is often a source of water transfers.[7] Sample Districts are a fair representation of the rice-growing water districts in the Sacramento Valley.

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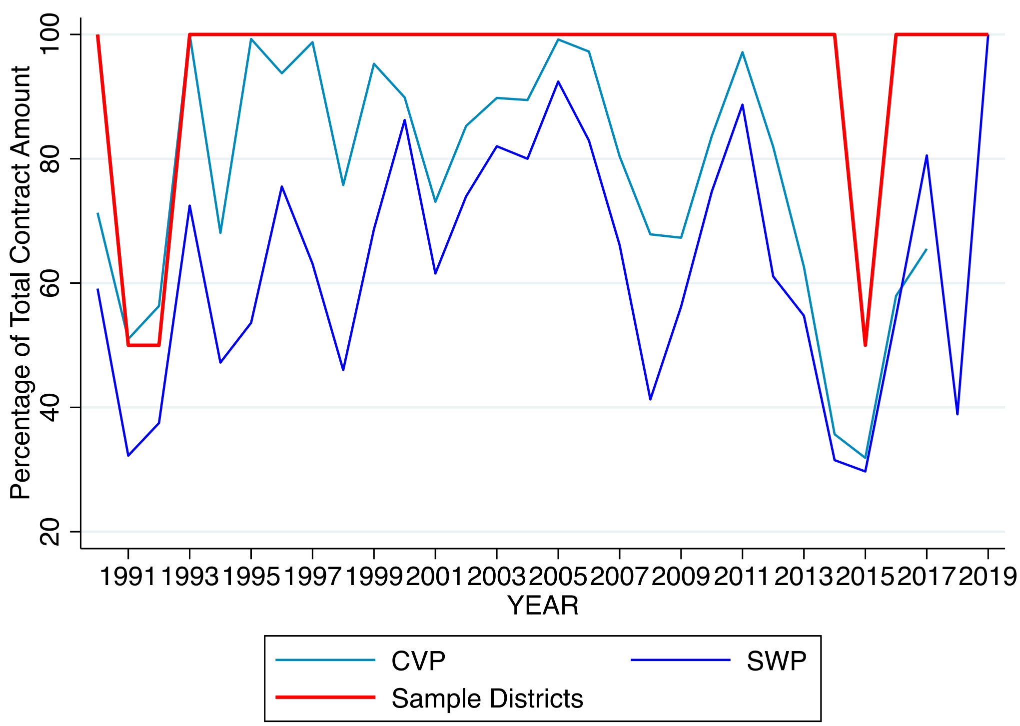
[6] Over 1999-2014 District #2 has less than 1% of its area in crops other than rice, District #3 has 6% of its area in other crops, and District #1 has 15% of its area in other crops. We focus on parcels under rice cultivation and are eligible for participation in fallow-based transfers.

[7] Water allocations or "water duty" is fixed for each crop, and when water allocations are sold only the consumptive use of water for the crop can be transferred to protect other users from harm. Only that portion of the proposed transfer that is determined to represent real water is transferrable. Depending on the measures used to make water available for transfer, real water consists primarily of the transferor's reduction in the

Having pre-1914 water rights means that in drought years farmers in these Districts have far less uncertainty of receiving their full water allocations than other users of the State Water Project system. Also, pre-1914 rights are subject to a much less scrutiny and regulation by the State when being transferred in short term water markets, which makes these Districts an even more attractive sources of flexible water supply.[8] Water supply to the sample Districts was curtailed only three times in our time frame, in 1991, 1992, and 2015—all critically dry years in California.[9] How do we measure the demand of water from the sample districts in California's water market?

Figure 2: Sample Districts, CVP, and SWP Final Allocations



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evapotranspiration of applied water (ETAW), reduction in applied water lost to saline sinks or to other unusable sources, or increased releases from storage reservoirs. Water duty in sample Districts is 4.2-5.5 acre-feet per acre ETAW for rice is 3.3 acre-feet per acre (CDWR and USBR 2013).

[8] For example, in 2014, while California was experiencing the worst drought in the last 1,200 years (Griffin and Anchukaitis, 2014) our sample Districts received their full water allocations, and then sold some of it by fallowing to buyers facing severe water shortage in the San Joaquin Valley (Hacking 2014).

[9] The water allocation curtailment is triggered on the basis of two clauses: The first one can be referred to as the 'Critically Dry Year' clause which states that water deliveries, can be curtailed if on April 1st of each year the determines that the Oroville Reservoir is receiving less than 600,000 ft^3/sec from the Feather River (CDWR, 2013). This clause was in effect in 1977 and 2015—neither of which are in our sample. The second clause can be called the 'Consecutive Dry Year' clause which states that if the cumulative deficit in the Oroville Reservoir is 400,000 acre-feet, then their allocation can be cut. This was in effect in 1991 and 1992, both are in our sample and in both years, there was a DWB in place and sample Districts sold their water allocation. The next curtailment of water allocation was in 2015 due to continuing drought conditions (Hacking, 2015b).

Given that water buyers are located in the San Joaquin Valley, the southern part of California's Central Valley, we use the San Joaquin Valley Water Year Hydrologic Classification as our measure of drought in water buying areas. This index assigns each year one of five classifications: Wet, Above Normal, Below Normal, Dry, and Critical (CDWR, 2014). We also use percentage of actual to contract deliveries by the State Water Project and Central Valley Project as a measure of water demand in water buying areas. High percentage means lower demand of water. State Water Project reports Table A water delivered and we used this as an alternative to drought. Figure 3 shows the temporal pattern of water supply to the Districts and water demand faced by the district from 1991-2019.

A publicly available database on water transfers does not exist. Therefore, we used annual satellite imagery of the sample districts to calculate rice cropped area fallowed in each year 1991-2019 and then used government and Districts documents, local newspaper coverage, and conversations with District managers, to verify the year of and volume transferred. The detail on how we triangulated the data sources is contained in the Data Appendix . Also in November 1996, voters in the home County of the three Districts passed an ordinance to restrict transfers of groundwater outside of the county, or transfers of surface water made on the basis of groundwater substitution. No permits have ever been filed with the County government for such transfers Groundwater-substitution based transfers (Thomas, 2001). As a result, water transfers by districts have been fallow-based since 1992—which makes it easier to rely on satellite data of land fallowed to verify the volume transferred.

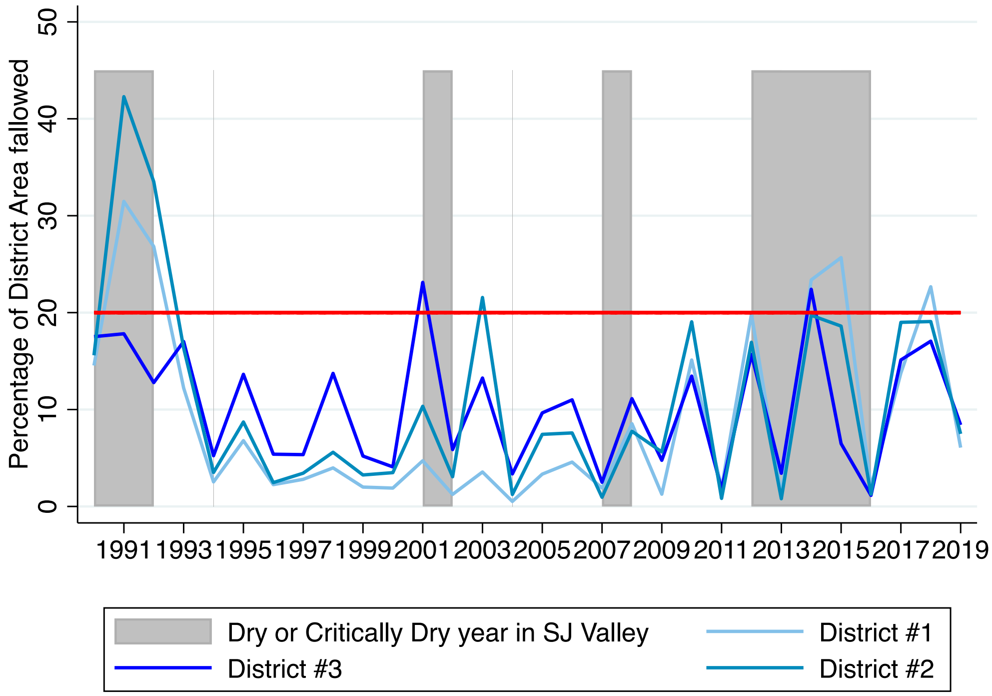
Over 1991-2019, some of sample Districts participated in DWBs in 1991, 1992, 1994 and 2009. In 2001, sample Districts participated in Dry Year Water Purchase Programs, similar to a Drought Water Bank. Also, Districts privately negotiated water transfers with buyers in the San Joaquin Valley in 2003, 2010, 2012 and 2014, and 2018. There are 9 drought years in San Joaquin Valley when water sales were made and 7 when no sales were made.

4. Results

4.1. Patterns in Fallowing and Water Transfers, 1991-2019

Observing the temporal trend in acreage fallowed gives important insights into the Districts' decision-making of participatioin in short-term fallow-based water sales. Figure 3 shows that the percentage area fallowed fluctuated from year to year. In some of these years, water is transferred by land fallowing, while in other years fallowing does not accompany a Districts' water transfer decision. Some baseline land fallowing is always going on for Districts' local farm management reasons. For example, 2003 and 2010 were not drought years but farmers in District #2 fallowed 20% of the District's area. Water markets have turned this local farm management into an opportunity to transfer water to out-of-District buyers. Particularly since 2009, when Districts have been negotiating water sale contracts independently, without a state-sponsored DWB, we notice that baseline fallowing has decreased, but fallowing for sale has increased in successive years, peaking at 20% of the area in years when there is a water transfer. Clearly, the 20% restirction is a binding constraint on volume of water transferred. Also, we notice that Districts do not participate in water sales in consecutive years.

Figure 3: Percentage of Irrigated Area Fallowed in Sample Districts



For example, in the multiyear drought of 2012-2016 when water demand was very high, Districts transferred only in 2012 and 2014. Their own allocation was cut in 2015 (see Figure 2) and District managers cited concerns for the local economy in their decision to not sell in 2015. The data strongly suggest that given the nature of fallow-based sales, sample Districts are selling the maximum volume they can in years they do sell and then choose not to sell in consecutive years. Overall, observing the patterns in fallowing and water sales in 1991-2019, we think that the sample Districts are at their maximum capacity of water sale participaton in short-term fallow-based water market.

The limits of short term or lease fallow-based markets are also evident with the experience of the Districts in 2015, when negotiaions for water sales were underway but then districts pulled back when they learned that their allocaton would be reduced by 50%. There was some groundwater use to offset the surface water allocation cutback but no transfers of water out of the ditristc occurred. Distict managers cited concerns for the local economy. The observed fallow percentage exceeded and reached 25% for BWG and 22% of RV.[10] If they go ahead and sell when their allocation is cut, Districts have to make a decision to allocate the scarce supplies in such a way to allow some farmers to grow, some to force into fallowing and some to fallow to sell. How districts allocate scarcity within member farmers is an important

[10] It is possible that production programs were already being adjusted for the fallowing programs were already in place and once the water sale fell throught, farmers went ahead with their fallow program.

question and needs more detailed data. Also, would be hard to meet the 20% district-level cap. justify *ex post* which parcel was fallowed for the transfer the fallowing was for water transfer or induced by the water cut.

Another intereting result is that the three sample Districts seem to have synchronized the timing of their participation in water sales. District #1 was a relatively late comer to the water market, compared to Dsirtcst #2, and #3 that have participated since 1991. The pattern is suggestive of collaboration amongst Districts and learning-by-doing with the accumulated experience of negotiating water transfer conrtacts, and enrolling of landowners withing the Disrtcit in the water sale decision as well as navigating the complex terrain of local and state level regulations of water transfers.

Finally, what can be gleaned about the effect of groundwater-substitution restriction that was in effect for sample districts since 1996? We observe that since the ordinance all water sales are fallow-based, rather than groundwater-substitution based. One of the most important insight from this is that the groundwater ordinance has not deterred Districts from selling water, but has altered the nature of sales. Figure 3 showed that the groundwater restriction, in our study area, has altered the form of water sales, but the volume sold has risen in the most recent drought. Given current restrictions on district-level water sales, rice farmers in our sample have reached their maximum possible water supply for short-term markets (20 percent at the District-level) and further supply would necessitate relaxing water constraints, such as the groundwater substitution restriction, or a change in crop or irrigation technology.

4.2. Effect of Drought on Water Transfer

In order to rigorously test the responsive of the districts to the opportunity cost of rice price and water supply to the districts and the demand of water in the water market, we estimate a following model:

$$Y_{jt} = \alpha_j + \beta P_{t-1} + \gamma S_t + \delta D_t + \varepsilon_{jt} \qquad (1)$$

where Y_{jt} is an indicator variable which takes a value of 1 if water was transferred by District *j* in year *t*, and 0 otherwise. The explanatory variables include price of rice known at the time of planting, P_{t-1}. We include a measure of water demand in water-buying areas, D_t, and a measure of water supply, S_t, to the Districts. We include α_j district-specific fixed effects that controls for time-invariant features of each District such as district management practices or local environmental factors that could affect water transfer decisions. Water demand is measured by the drought conditions in the water buying areas or the percent allocations of the SWP as shown in Figure 2. Water supply to the districts is fairly inelastic, so we express it as an indicator variable which take a value of 0 in years when water supply was curtailed and 1 otherwise. Finally, ε_{jt} is an idiosyncratic error term. We expect that higher price of rice increases the opportunity cost of fallowing and will lead to lower sales, $\beta < 0$. We also expect that higher water demand is likely to increase water sales, $\delta > 0$, but a reduction in water supply to the Districts would lead to a lower likelihood of water sale by the Districts, $\gamma < 0$.

Table 1: Results of Model (1)

Dependent Variable: Sale by District (If water sold = 1, No Sale = 0)

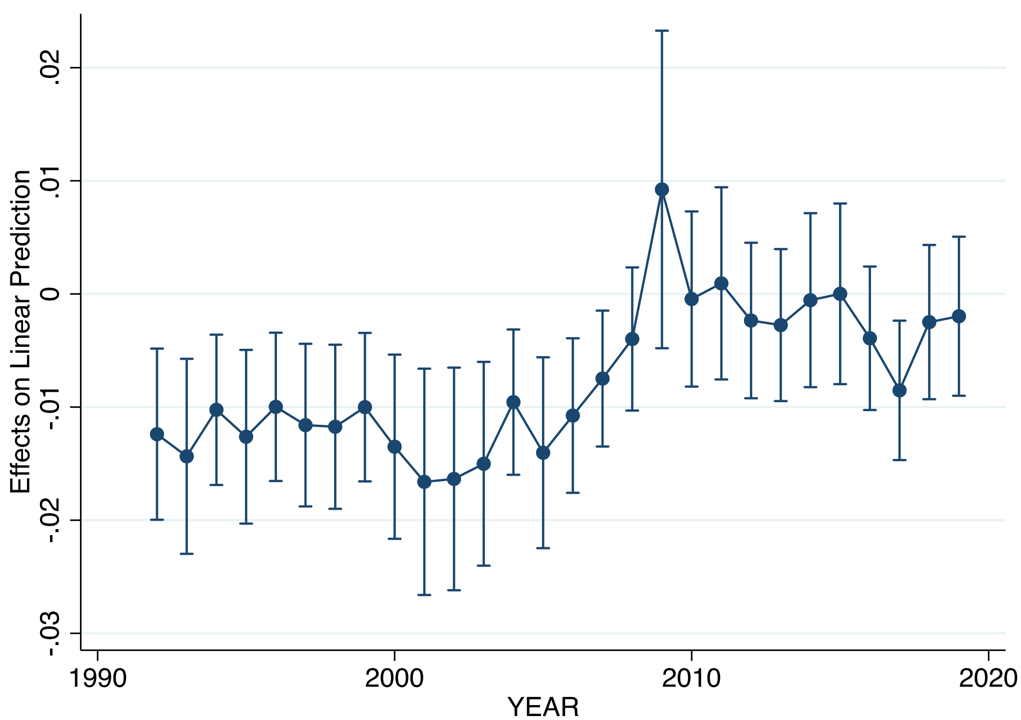
Independent Variables	(1)	(2)
Rice Price	-6.958**	-11.42**
	(3.192)	(4.576)
SWP Percent allocations	-0.0239***	
	(0.00769)	
Rice Price x SWP Percent allocations	0.113**	
	(0.0464)	
Districts' water curtailment	-0.136	-0.240
	(0.183)	(0.183)
SJ Water year index = 1 (Wet) *Base Case*		
SJ Water year index = 2 (Above Normal)	0.379***	0.295**
	(0.141)	(0.140)
SJ Water year index = 3 (Below Normal)	0.786***	0.681***
	(0.166)	(0.156)
SJ Water year index = 4 (Dry)	0.246**	0.0989
	(0.121)	(0.123)
SJ Water year index = 5 (Critical)	0.396***	0.291**
	(0.147)	(0.132)
Oroville Storage in April		-1.041***
		(0.304)
Rice Price x Oroville Storage in April		4.474**
		(1.701)
Constant	1.556***	2.910***
	(0.536)	(0.862)
Observations	84	84
R-squared	0.430	0.459
Number of District	3	3
District fixed effects	Yes	Yes

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Estimation results of model (1) are presented in Table 1. As shown in column (1), we find that higher demand of water in water buying areas significantly increases the likelihood of transfer. The coefficient of water curtailment is statistically insignificant, which is not surprising because districts sold water two of the three times water allocation was curtailed. Also, higher rice price significantly lowers the likelihood of the water sale which is in line with our hypothesis that rice prices act as an opportunity cost of land fallowing water sale. Higher demand in water areas also increases the likelihood of sales. Higher water supply to the districts lowers their area fallowed, as expected. In column (2) we represent the results of using relative storage in the Oroville reservoir as an alternative measure of drought conditions and water demand by SWP users. The results are similar to the use of overall SWP allocations. Districts are more likely to sell water during drier conditions amongst water buyers.

Using the results in column (2) of Table 1, we examine the effect of SWP allocations on Districts' water sale decision have evolved 1991-2019. The annual average marginal effects are shown in Figure 4 which shows that before mid-2000s, the effect was negative and statistically significant, but after mid-2000s the effect has become smaller, closer to zero (the 95% confidence interval includes 0). This result in insightful in because it shows that in recent years, districts have transferred even in years when percent SWP deliverers were not very low, perhaps addressing structural imbalances of water allocations not just drought-induced scarcity.

Figure 4: Average Marginal Effect of SWP Allocations on Districts' Water Sale Decision



5. Discussion and Conclusion

We started with the puzzle of thin water markets. We have shown that in spite of the restrictions rice-growing districts are in fact highly responsive to drought-induced high-water demand in the market and are showing what looks like the maximum possible volume and frequency of water transfers in the short-term water market. We demonstrated that the local and State-level restrictions are a binding constraint on their water supply in the State-wide water market. So, are these restrictions achieving their desired ends? Is it worth having these restrictions at the cost of a thin State-wide water market? Some would argue that in the complex arena of physical and pecuniary externalities from water transfers, they are a reasonable albeit imperfect solution. As Colby (1990) has argued that if policy-induced transaction costs can act as a Pigouvian tax on transfers they can force water sellers to consider the external effects of their water sale decisions and increase the efficiency of transfers. But unlike a tax that can raise revenues to compensate the parties affected by water sale, these restrictions do not raise revenues. The groundwater-substitution restriction has in effect shifted the incidence of external costs from groundwater users to agricultural service providers in the rural community. The increased reliance on fallow-based transfers since the ordinance was passed may have caused higher negative effects on local agricultural service providers than if groundwater substitution was possible and farmers could continue agricultural production while selling surface water allocations. In other words, groundwater restrictions may have redistributed, rather than reduced, the third-party costs of water sales in rural communities.

Perhaps the underlying issue behind a thin water markets is not just about the volume or frequency of water transfers, but about a fair and transparent distribution of costs as well as gains of water transfers in rural areas. Both restrictions are framed to reduce costs of transfers, rather than a broader sharing of the benefits of the water transfer. Participation in water sales can bring quite significant financial gains to water right holders. As Bigelow et al (2019) showed groundwater-substitution restrictions had significant effects on land values, where lands in Districts not subject to these restrictions profited from an increase in land values. As we showed, the 20% cap may further *increase* the price of water in the water market, exacerbating the distributional consequences. This, in our view, is an important but as yet unresolved issue in the supply side of water markets: how rural communities would choose to share the costs and benefits from water sales, especially as they affect the common pool resource of groundwater. The emotions surrounding groundwater exports, and the resulting local groundwater ordinances, suggest that water sales were unpopular in areas-of-origin not only because of the magnitude of the losses, which were relatively small as some analysts showed but because of the fairness of their distribution among community members, especially for those that had no voice in the Districts' water sales decisions. This clearly means that water transfers affect different section of rural economy different. The distribution of third-party costs within the rural community is affected not only by the volume of water sold and transferred out of the region, but also the form of water transfer itself. For example, agricultural activity is reduced when water is sold by fallowing land, but a sale of surface water with additional pumping of groundwater to continue agricultural production will not reduce agricultural production but may affect other groundwater users in the basin. But it is hard to see how either of the policies has addressed the underlying problem that led to these policies in the first place. That of a need for a fairer distribution of gains and costs from water trades. We think a careful consideration of the roles of agricultural districts in local agricultural economy, to the sensitivity of the local economy to modifications in the 20% cap based on crops grown and the number of districts in the local economy, is needed. As Wyman (2019) suggested, the reasons why efficiency gains have not materialized in the water markets may lie beyond transaction costs but in the very incomplete nature of private property rights to irrigation water.

In December 2014 the State of California passed the Sustainable Groundwater Management Act (SGMA) which establishes the first statewide requirements for groundwater management in California, although it offers local agencies considerable flexibility. A key feature of SGMA is that it places groundwater management authority at the local level—the locus of the unresolved distributional issues. Since the passage of SGMA, local agencies have grappled with the creation of new governing bodies that, for the first time, may exercise authority to control groundwater extractions. The newly formed local water agencies will have to decide on both restrictions and current evidence suggests that both restrictions will be grandfathered into the new local SGMA laws. But the effects of water sales on local economic and hydrologic conditions, on the distribution of these effects on different groundwater users, and mechanisms to mitigate them, have to be studied more carefully if water right holders are to continue to be back-up sources of water in dry years.

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