From Communal Irrigation to Irrigation Districts: An Economic Assessment of New Mexico's Transition

by

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Abstract:

Praised for their ability to overcome transaction costs and reduce externalities of water distribution, irrigation districts formed rapidly throughout the United States in the 20th century. To better understand and quantify the gains, I compare and contrast the smaller *acequia* organization with the large centralized irrigation districts in New Mexico. Utilizing the Social-Ecological System framework, I highlight the distinction between irrigation districts and *acequias*. Next, I conduct a hedonic difference-in-difference analysis comparing counties that formed irrigation districts to those that continue irrigating under decentralized *acequias* from 1910 to 1978. I find the central districts increase agriculture land values by nearly 12 percent.

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INTRODUCTION

Settling and cultivating the arid portion of United States, generally delineated as west of the 100th meridian, required the use of irrigation. Irrigators faced issues of developing and sharing common sources of surface water. As Americans moved into the frontier, government settlement programs struggled due to poor irrigation infrastructure and institutions (Coman 1911). Stephen Bretsen and Peter Hill (2006) highlight the imposing transaction costs that make the endeavor difficult due to disparities in the optimal sizes of farms and irrigation systems of which a number of irrigation organization attempted to address. Elinor Ostrom (2011) calls attention to the lack of trust between the new users and poor institutional design. As the 20th century began, irrigation and conservation districts formed to solve many of the transaction costs (Bretsen and Hill 2006; Libecap 2011). These districts now deliver around 50 percent of western irrigation water (Bretsen and Hill 2006). By the 1970s, nearly 30 percent of irrigated acres in the West received water from an irrigation district. However, nearly 50 percent continued to be served by smaller communal systems (Leshy 1982). I examine whether the smaller systems may be better served by a larger, centralized irrigation organization.

New Mexico irrigation provides a unique setting to explore this question. Settlement of *Nuevo Mexico* by Spain (1600-1821) developed irrigation with success, transplanting the communal ditch system of *acequias* from Spain. Over 700 *acequias* remain today serving as counter-examples to the oft prescribed "tragedy of the commons" (Hardin 1968). However, successful avoidance of the "tragedy" is not indicative of efficiency or optimality. Overtime, New Mexico has lost nearly half of the 1,400 historic *acequias,* many of which being agglomerated into one of its 14 irrigation districts. Leveraging New Mexico's partial transition from communal management to centralized management of irrigation districts (IDs), I assess the advantages and disadvantages of IDs in comparison to alternative communal enterprises. Other Western States adopted IDs, but few replaced well-established alternatives, yielding scant counterexample data. My primary interest is whether the central management and decision making improves water usage, but the distinction between the two organizations extend beyond this.

In what follows the institutional differences and correlated distinctions of IDs and communal ditches are discussed through a Social-Ecological System (SES) framework (Ostrom 2009). Building on Michael Cox's (2014) application of the SES to *acequias*, I highlight the variables altered when moving to an ID. From 1910-1960 New Mexico experienced an increase in IDs with *acequias* losing local autonomy and becoming pieces of a larger irrigation institution. To quantify the benefits and costs of IDs, counties that make the transition are compared to counties where smaller communal systems persist using US agricultural census data from 1890-1987. The primary analysis is grounded in the Hedonic pricing methodology, relying on the assumption that agriculture land prices will capitalize the net value provided by the ID. Non-ID counties are used in a Difference-in-Difference (DiD) framework to provide a plausible counter trend conditional on a number of controls. My findings suggest the irrigators found IDs valuable, driving farm land values up nearly 12%. To disentangle some of the benefits and costs, I consider additional outcomes within the DiD framework, finding that crop production increased while irrigation costs and debt also increased.

THEORETICAL BACKGROUND

Issues

IDs vary in specifics and are viewed by some as self-governed systems. However, on the spectrum of communal property and public property, the districts lean heavily towards the public end. Top-down water management decisions come from a central authority over large areas of irrigated land. Accordingly, I use centralization not to indicate a level of government, but rather a scale of reach and power.[1] The question is whether this governance structure better serves the irrigator over the bottom-up decentralized system.

The choice of organization is not random, driven by the expected net gains of internalizing decisions compared to the current transaction costs of decentralized management (Coase 1937; Libecap 1989). Irrigators drawing on a common source of water face two distinct common-property dilemmas. The first of which is appropriation. Water's fugitive nature makes it costly to define property rights to provide exclusion while one user's consumption reduces the amount of water available to others, yielding conditions ripe for negative externalities and over appropriation. Second, users struggle with provision of any shared infrastructure, whether

[1] In the decentralization literature, a developing country divests power to more regional entities, varieties of which are summarized by Rondinelli et al. (1983). The process explored here does not fit this typography well as both acequias and IDs are local forms of government. Centralization should be thought of as the ratio of irrigators/elected officials increasing, providing a measure of scale.

physical or institutional. This second issue presents a public good problem in that the infrastructure is non-excludable and non-rival, providing temptation to free-ride. The theory set out below provides guidance as to those more likely to adopt an irrigation district, driven by factors that exasperate these appropriation and provision issues.

Theory

The decision to form an ID ultimately falls to eligible voters within the proposed borders. Often a simple majority, though the votes can be counted on an acreage basis. Those subject to larger externalities and greater transaction costs should favor IDs. As an application of the Coase Theorem, some of the decentralized *acequias* have addressed the issues by negotiating agreements. However, the Coase Theorem also states that sometimes transaction costs are too great and bargains cannot be struck easily. Negotiation becomes increasingly difficult with more users (Ostrom 1990; Coase 1960). For provision of public goods, free riding incentives are exasperated by an increased number of beneficiaries. Therefore, one would expect counties with more farmers to have greater desire to form an ID, though this should be qualified at the county level. Farmers are only impacted by those who share a water source. Having more creeks reduces the need to organize into a centrally managed regime, as the biophysical nature is itself decentralized. Beyond the cooperative dynamic of physical connection, the gains of infrastructure improvements are likely larger where water is more centralized.

In specific context at hand, *acequia* farmers tend to oppose the large districts. The Hispano farmers target subsistence more than production for market. The historic irrigators fear not only the loss of local control, but also the financial demands that may accompany the ID formation (Rivera 1998). Given the institutional details, counties with greater population may also wish to form an ID. IDs are able to tax all those who benefit, which can easily be defined as non-irrigators. Therefore irrigators may be able to subsidize their needs, especially when voting is quantified on a per-acre basis.

Empirical Support

Using data from the 1910 Census, the above predictions are tested empirically at the county level in New Mexico.[2] Utilizing a simple linear probability model, I test what 1910 factors

[2] The data used is more fully described below in the data section.

predict the later formation of an ID. Given the even mix of treatment (12 non-district to 14 district counties), the use of the linear model can be expected to perform well.[3] Presented in Table 1, the results largely support the theory. Counties with more farms and fewer creeks are more likely to form an ID. To emphasize this, the second column reports the regression using farms per creek. A county with more irrigated farms, as a fraction of all farms, is more likely to organize into an ID. Interestingly, fewer irrigated acres as a fraction also increases the odds of forming an ID. Combined, these two results indicate that when many irrigating farmers are currently irrigating relatively few acres, they see an opportunity to expand and desire the ID to overcome the provision externalities. The fraction of farm acreage in the county increases the odds, as this increases the set of beneficiaries.

The remaining factors are statistically insignificant. Importantly, the land valuation in 1910 does not serve as a good predictor. I provide additional evidence, but this supports ID formation being exogenous to the primary outcome considered below. The total population is imprecise providing no evidence of large farms capable of adopting IDs to compel non-farmers to pay. The number of historic *acequias* also provides little predictive power. The empirical result is not surprising; more *acequias* indicate more irrigation but possibly more opposition to alternative irrigation organizations. Finally, geographic position (general north/south and east/west position) offers no additional predictive power.

NEW MEXICO IRRIGATION

New Mexico's Development

Spanish colonization of *La Provincia del Nuevo México* began in 1598 with a settlement effort led by conquistador Capitán General Juan de Oñate. Following a brief native uprising, the Spanish colonization resumed in full force from 1695 until 1821, at which point Mexico gained its independence from Spain. The settlements were guided by the Laws of the Indies issued by the Spanish crown, stating access to water as essential for the formation of a community. Once officials inspected the land, confirming its promise to provide for the settlement, a land grant would be conferred and the settlers would begin work. The irrigation canals were essential to the

[3] The alternative logit model (unreported) is qualitatively similar but limited in the number of regressors included due to the small sample and statistical methodology. It predicts 88.86% of the observations correctly.

survival of these early pioneers traveling miles into the arid climate and were typically the first undertaking, even prior to building the local church or government buildings (Rivera and Glick 2002). Growth and development of irrigation continued through the Mexican period (1821-1848). Sovereignty of the region transferred to the United States of America with the Treaty of Guadalupe Hidalgo, ending the Mexican-American War in 1848.[4] Initial legislation in the territory focused on water law and placed many *acequia* customs into statute and the organization continued to grow, but began to drift as Anglos sought economic gains (Smith 2014).

At the turn of the 20th century New Mexico was working to "modernize" its water laws, most markedly with the 1905 and 1907 water code with an eye towards large scale irrigation projects with federal assistance. The water code adopted the prior appropriation doctrine, in which water rights are private, severable from the appurtenant land, measured by volume and based on seniority—conceptually orthogonal to Spanish practice of communal water, divided by time on a basis of need. Additionally, the water code established the Office of the State Engineer, charged to adjudicate and administer the newly created water rights.

New Mexico enacted its first ID law in 1909, followed by two more in 1919 to offer more structure to those wishing to contract with the Federal Government. This was followed in 1923 with legislation to form conservancy districts. Subsequently the use of the special water districts grew, expanding from 13,398 acres irrigated by such operation in 1910 to 190,518 acres by 1950—an average growth rate of 6.9 percent per year. Table 2 provides a list of the districts, when they formed, and the counties they span.

Acequias

Acequias are characteristically similar to mutual ditch companies found in other states. However, they do maintain a distinctive legal space in New Mexico as political subdivisions of the state rather than a corporation. The communal irrigation system typically relies on diverting streams via simple earthen head gates and utilizing flood irrigation prior to letting the excess water return to the stream for other downstream users. The communal ditches tended to serve relatively small group of neighbors who joined together to dig the ditch. Historically a

[4] US military occupation began as early as 1846, though the Kearny Code of that year claiming the area remains legally dubious.

mayordomo, elected by members, would oversee the operation and irrigation schedule, often delivered on rotation. Today, the ditches operate in a similar fashion.

Irrigation Districts

Each ID is unique in its organization, making the institution somewhat difficult to generalize. The broad concept is used here to refer to conservancy districts as well, which are broader in scope, but often seen under the same legal umbrella (Getches 2009). Wells Hutchins (1931) defines IDs as a "public or quasi municipal corporation organized […] for the purpose of providing a water supply for the irrigation of lands embraced within its boundaries" (p. 2). They have well defined geographic boundaries and are formed under authority of State legislature with the consent of a designated fraction of the land owners. With the ability to place assessments on the land, once formed it is possible to extract funds in order to invest in large infrastructure, providing a mechanism by which farmers can engage in larger irrigation projects by compelling dissenting minorities to pay (Hutchins 1931; Leshy 1982).

While varying state to state, most ID legislation is similar to The Wright Act of California of 1887. Objectors of early districts questioned the constitutionality of institution, but in 1896 the US Supreme Court confirmed its legality, arguing the development of the private land being of public interest. Following this ruling, other states adopted similar legislation, including New Mexico.

From 1890-1928, the number of districts formed in the US grew from just 17 to 801, though by 1928 nearly 300 were inactive. The failure of districts occurred much more often where entirely new development was the goal (Hutchins 1931).[5] By 1970, these special districts accounted for half of the water used in the 17 western states and around a third of all the irrigated land in the West (Leshy 1982). In 1922 the federal government strengthened the power of IDs by allowing them to be the local contracting party for Bureau of Reclamation Projects. In 1926, they became the only legal contracting party under the Warren Act.

The appeal of IDs as contracting parties was financial: 1) they have the legal ability to tax the landowners, providing a single central and reliable source for repayment; and 2) they have the ability to issue bonds, providing a mechanism to take on debt for such projects. Indeed, while

[5] Failures occurred for a number of reasons, often insufficient capital or inability to deliver on bond payments due to agricultural production and price fluctuations.

early districts were formed to secure internal financing through assessments, later districts often formed to secure external financing through bonds (Leshy 1982). Overall, they served to reduce many transaction costs of irrigation projects (Bretsen and Hill 2006; Libecap 2011). In addition, the central administration reduced transaction costs in arranging for division of water amongst ditches.

IDs became a popular irrigation organization throughout the West, but I focus only on those in New Mexico due to its empirical advantages. From 1910-1960 only 14 districts were formed, making it a manageable number (California had 168 by 1929 with 18 forming in 1920 alone [Hutchins 1931]). More importantly, the majority in New Mexico did not start anew, taking control of (sometimes dissenting) communal irrigation ditches.

Specific details on all IDs are not readily available, but the larger Elephant Butte Irrigation District (EBID) and Middle Rio Grande Conservancy District (MRGCD) are well documented on their websites (EBID 2013; MRGCD 2013). EBID was the first district in the New Mexico, forming in 1918 to manage the Elephant Butte portion of the large Rio Grande Project which the Bureau of Reclamation constructed to address interstate and international allocation issues on the river. Today it has 90,640 acres of water righted land across two counties under its purview, serving over 8000 constituents. In 1925 New Mexico formed its first conservancy district; the MRGCD stretches 150 miles along the Rio Grande, serving 11,000 irrigators and 70,000 acres of cropland. It employs 200 people to operate the 1,200 miles of irrigation ditches.

Difference in Irrigation Enterprises—Social Ecological Systems

Irrigation systems can be viewed as a SES in which natural resource systems interact with human systems. Here I adopt the version developed by Ostrom (2009) to frame the institutional comparison. The first tier categories are the resource units, resource system, user group, and governance system. These, along with the second tier variables are reproduced in Table 3. Between *acequias* and IDs, the root difference is the governance system. However, the governance system endogenously influences second tier elements in other categories (other than the resource units). Because the SES framework has been applied to the *acequias* already by Cox (2014), I primarily focus on IDs and how they differ.

IDs are substantially different from the older *acequias*, though both ultimately aim to deliver water to irrigators. However, one should keep in mind that *acequias* serve functions beyond delivering water, serving also as a cultural, spiritual, and ecological institution (Peña 1999; Rivera 1998; Rodríguez 2006). As irrigation systems, the root difference stem from the legislative distinctions in their legal standings, resulting in a number of variant features. The statutory powers are now quite diverse, with *acequias* being quite weak despite being the oldest irrigation institution (Crossland 1990). To structure the discussion, I use the SES framework, including in text parenthetical notes to reference the second-tier factors as identified in Table 3. For example, (U1) refers the "Number of users".

Acequias do not have the power of inclusion, they cannot tax, and they cannot issue debt. This is perhaps the most marked financial advantage the IDs have over *acequias* (GS7) (Hutchins 1931; Leshy 1982). In addition, in the 1914 *Snow v. Abalos* case of the New Mexico Supreme Court, it was found that the *acequia* owned only the ditch and that individual *parciantes* owned the water rights privately. IDs are allowed to hold rights, often exempt from the requirement of use, though individual rights do exist within IDs (GS4).[6] The democratic process also differs, as IDs vote similar to a corporation where power is more likely to be proportional to land holdings. *Acequia* members customarily vote only once per person (GS6). The decision process is more centralized with the number of member/board ratio much larger among the IDs.

Division of water varies as well (GS5). For users in IDs, they place an order for their water and then it is delivered as soon as hydrologically possible, often simultaneously with other farmers. For *acequia* farmers, delivery is almost always done on a rotational basis in which they receive the full flow for a given amount of time. Amongst members on the same river, either priority or some sharing agreement divided inter-*acequia* water use—with the sharing being more common among the *acequias*. With water rights pre-dating US sovereignty the Treaty of Guadalupe Hidalgo protects the rights and many areas in New Mexico have agreed to forego the Anglo priority system during adjudication processes (Richards 2008). This yields a decentralized administration and self-monitoring of water division, different than the internally managed and monitored division of water by IDs. Across streams, the IDs have considerably greater ability to effectively sanction any rule breakers (GS8).

One of the largest legal distinction is the ability (and necessity) of an ID to contract with the Bureau of Reclamation (GS1) as stipulated by federal law. The burden of debt, though, also

[6] In 1987 *acequias* received this right as adjudication of water rights proceeded throughout New Mexico.

necessitated an emphasis on the use of fees and assessments rather than labor which is often relied upon in communal ditches (GS5). *Acequias* cannot take on large debt loads, relying on savings and individual contributions instead, often using sweat equity rather than cash.

Due to the large expensive projects, IDs tend to be much larger than *acequia* systems (RS3). This drastically increases the number of users (U1), often being magnitudes larger. Arguably, the larger boundaries resulted in clearer system boundaries by including a number of diversion points on a single stream previously operating independently. With the ability to tax all users in a large area, they tended to undergo projects that altered the resource system beyond the capability of smaller local organizations (Wozniak 1997). Notably, canals were expanded; head gates upgraded to concrete structures; and dams constructed for both flood control and storage (RS4 and RS8), providing more predictability of the system (RS7).

Difference in Irrigation Enterprises—Census Data (1950)

In order to better quantify the differences between the organizations, I present data from the 1950 Agricultural Census. This was the last census in which statistics are provided based on the type of irrigation enterprise.[7] In New Mexico, the communal ditch category is primarily made up of *acequias*. Table 4 summarizes the designed differences based on the institutional structure. The scale of the operation is telling, as the communal ditches average 14 users while the IDs average 420. This is unsurprisingly related to the difference in coverage, with IDs serving 19,052 acres on average while communal ditches cover only 278.

Table 5 provides a number of summary statistics from the 1950 Census that can be seen as outcomes, though causality is not transparent. These are divided into three categories; finance, infrastructure and water delivery. For the purposes here, the IDs are combined with those classified as Bureau of Reclamation enterprises, as control of these often fluctuated between the local ID and the federal bureaucracy (Wozniak 1997). In terms of debt, farmers under IDs far outstripped the communal ditches, averaging 350 times the amount of debt. Only 4 percent of the communal ditches have farmers reporting debt compared to 60 percent of IDs.

With larger storage capacity the irrigated land within IDs had access to more stored reserves. Diversion structures were more likely to be constructed out of concrete. These improvements

[7] The data are only available at the State level. The Census provide no county statistics by enterprise beyond 1910, precluding such detail in the econometric analysis below.

were not without their own issues, as the districts often struggled to maintain the expanded infrastructure, raising fees often (Wozniak 1997).

A crucial question is whether or not the centralized IDs were able to turn these scale and financial advantages into better water delivery. This could be addressed at the extensive margin (expanding irrigated acreage) as well as the intensive margin (delivering more water per irrigated acre). On the extensive margin, they were effective in expanding irrigated land. The larger irrigated acreage for IDs came from sheer scale, but also effort. For instance, Mesilla Valley consisted of 11 ditches in 1890 that managed to irrigate 31,700 acres. Once the EBID formed, the Mesilla Valley jumped quickly to 45,995 irrigated acres by 1917 and nearly doubled to 88,714 by 1945.[8] The IDs perform well on the intensive margin as well. Based on the 1950 census data, while cost of water increased on a per acre basis, IDs delivered more than twice the water of communal ditches. To better understand the causality of IDs, I now turn to panel data.

DATA AND METHODS

Data

The main source of data comes from publicly available records of US Irrigation and Agricultural Census from 1890-1987, though the regression relies on 13 Censuses from 1910-1978.[9] Initial collection of census data came from manual entry from the original county reports (US Department of Agriculture 2012; US Census Bureau 2011). Additional census data was added from the Interuniversity Consortium for Political and Social Research (Haines 2005; Gutmann 2005). Historic county shapes come from the National Historical Geographic Information System (2013). A report from the Office of the State Engineer in New Mexico are utilized to identify various IDs and *acequias* (Saavedra 1987). A number of sources are referred to in order to place a date of formation on the IDs and *acequias* (Block 2014; Dos Rios Consultants 1996; Clark 1987; Bureau of Reclamation 2013). Additional data for controls come from Frye (2014) and US Army Corp of Engineers (2013).

[8] Figures tabulated from data reported by Wozniak (1997).

[9] Census years are 1910, 1920, 1925, 1930, 1940, 1945, 1950, 1954, 1959, 1964, 1969, 1974, and 1978

Method: County Level Difference-in-Differences

The main analysis tool is a hedonic valuation utilizing a Difference-in-Differences (DiD) framework at the county level to leverage the quasi-experiment. The specification is as follows:

$$Y_{ct} = \beta_1 \times PostDistrict_{ct} + \beta_2 \times District_c + Census_t + X_{ct} + \varphi_c + \epsilon_{ct} \qquad (1)$$

In the specification above, subscript c refers to the county and t refers to the year.

The primary outcome (Y_{ct}) considered is the logged price per acre of agricultural land. The methodology follows a number hedonic value studies, relying on a related market to back out the value put on a component that does not have a market itself. With the inclusion of numerous other variables that likely effect agriculture land value, the remaining portion is attributed to the presence of the ID. The method has been applied to agriculture land for water rights (Crouter 1987; Faux and Perry1999; Petrie and Taylor 2007), groundwater access (Hornbeck and Keskin 2011), and groundwater heterogeneity (Edwards 2014).

I consider other outcomes for Y_{ct} in order to identify some of the benefits and costs of IDs. I look at the crop value sold, value of all agriculture products, irrigation costs and debt levels. Debt and irrigation costs are available for a shorter time-series, not extending beyond 1940. The measure of debt pertains to the farmers themselves, not the irrigation organization.

β_1 is the coefficient of interest, capturing the impact of the interaction term, $PostDistrict_{ct}$, indicating the county has a district formed. Rather than a discrete indicator variable, I utilize a continuous treatment measure based on the percent of irrigated acres by the districts in the county compared to the total number of acres in farms. IDs rarely encompass an entire county, causing a simple indicator variable to drastically overstate the extent of treatment at the county level. The measure is based off 1987 data, a year with county level data on the extent of IDs. Accordingly, I utilize 1987 farm acreage as well, resulting in a measure that remains constant over time despite the likelihood that it varied in reality. Given the non-random placement of IDs, particularly related to irrigation, I only advance the estimated impact as the treatment on the treated. The effects may be smaller elsewhere.

$District_c$ is a dummy as to whether the county received or will have an ID. $Census_t$ represents a series of dummy variables for the various census years, capturing macro shocks: crop prices; inflation; available technology; general weather conditions. φ_c are county level controls that do not vary over the sample period. These include the average elevation and ruggedness, latitude and longitude measures, as well the presence of railroads within the county.

X_{ct} contains additional controls that vary overtime and are likely to influence agricultural land value and production. The fraction of irrigated farms, irrigated acres, total number of farms, and the number of creeks are all included, as these were significant predictors of ID formation. I also include the total population and farm acreage, primarily to control for land scarcity. A count of dams in the county is included to remove some of the infrastructure gains and focus on management. An indicator for the eventual presence and the presence of Interstate 25 addresses the concern that I-25 closely follows the Rio Grande and may impact agriculture value through increased market access (Frye 2014). Finally, I include measures of the main crops—wheat, hay, oats, corn, and beans—as a fraction of county acreage to address differential yields and prices. This inclusion is intended for the production outcomes, as the value of the land should not be beholden to the current crop mix.

Conducting historic, county level analysis in the Western United States presents issues due to altering borders of large counties. Today New Mexico boasts 33 counties, but as of 1900 the same geographic area was divided into only 19 counties. Much of the dynamic process ended by 1925, but many IDs formed prior to this time.[10] The main analysis is based on the 26 counties as drawn in 1910. As commonly done, the data from other years are reweighted to reflect these borders (e.g. Hansen et al. 2009). In instances of a county being divided in two, the process is clearly valid. When two counties become three, the validity rests upon the assumption that the agricultural data is uniformly distributed geographically. This assumption is somewhat tenuous given the size of the counties and clumping of agriculture around streams. As robustness checks, I explore other variations of sample selection.

Difference-in-Difference Assumptions

In order for the above equation to have a causal interpretation, it is necessary to satisfy the assumptions that the two sets of counties, those with and those without districts, would have shared an overall trend absent the intervention. Inherently unknowable, often this assumption is validated through showing equal trends prior to intervention. In unreported regressions, coefficients for year fixed effects interacted with $District$ are regressed on the various outcomes. An ID county is dropped from the sample once the ID is formed. Only 2 of the 26

[10] Los Alamos formed in 1949, but is quite small and has a miniscule agriculture sector. Cibola County formed from Valencia County in 1981.

coefficients are significant. With no distinguishable difference in pre-treatment trends, the different counties could be expected to continue to share a trend absent intervention.

Alternatively, levels—rather than trends—are often compared. Table 6 presents the mean values of variables in 1910, split by district and non-district counties. The counties included in districts do appear to have different levels, but few exhibit any statistical significance. Notably, the outcome variables are not statistically different in 1910.

Local Opposition

It is worth noting that the counties differ very little in historic *acequias* (64 to 54), legitimizing their use as the counterexample. *Acequia* users tend to be opposed to being part of IDs, yet have been included in many places. Drawing on the five northern counties and their experience with formed districts and defeated districts, Jose Rivera (1998) reveals the concerns small *acequia* farmers have. In fending off a district in Taos County, Rivera says users fear that "not only would acequia self-government be circumvented by a superimposed board from the conservancy district, but the economic risks could bankrupt the irrigators individually" (p. 157). Ultimately these concerns defeated the formation of the Rancho del Rio Grande Conservancy District and *acequias* maintained local control of water decisions in Taos County.

In many places *acequias* were unable to defend themselves and were subsumed by the larger governance structures. Of the six IDs operating in New Mexico in 1929, five had taken over irrigation systems already in place (Hutchins 1931). Using historical tabulations of *acequias* from Dos Rios Consultants (1996) and a State Engineer report of those still in existence in 1987 (Saavedra 1987), regressions on the percent of *acequias* no longer in existence find the formation of a district a good predictor. Results are reported in Table 7. While on average 31 percent have vanished, in counties with IDs, the rate is 63 percent, over twice the rate of loss.

RESULTS

Graphical Evidence

Prior to the statistical results, Figures 2 and 3 provide a visualization of the raw means overtime for land value and value of all agriculture products. Figure 2 indicates similar overall trends for the two sets of county. A gap appears expands through 1960 before the non-districts begin to catch up. For agriculture value, the gains by the ID counties appear relatively later, sometime after 1940. The delayed impact can be seen as the result of the lag between adoption and completion of physical infrastructure and implementation of new distribution rules.

Difference-in-Differences

In Table 8, I present the main results with the additional controls suppressed.[11] With 100 percent of a county forming an ID, estimates indicate a 5.47 log point increase the value of a farm acre, an economic and statistical significant impact. Because the typical ID County is not fully covered by the ID, but merely around 2 percent of farm land, the estimate needs reinterpreted. With this in mind, the average increase in price per acre is nearly 12 percent if we assume the gains are attributable only to the fraction of farm land in the ID.

The gains are in the value of crops sold, increasing nearly 35 percent on average. This large boon in production is somewhat tempered once all agriculture products are considered, though remains around 19 percent within IDs. The gains in production come at a cost, with ID counties having a 19 percent increase in irrigation costs per acre. And while not a cost per se, the ID counties do see an increase of debt of around 15 percent, substantiating some of the *acequia* irrigators concern of adopting an ID. Finally, it is noted that there is no significant increase in the debt-to-value ratio, and if anything, a decrease. These results are robust to the inclusion of county fixed-effects, as presented in the second panel of Table 8. The addition of fixed effects does tend to attenuate the valuation and crop production. The remaining results remain stable, though the impact on debt is smaller and no longer statistically significant at typical levels.

ROBUSTNESS

Various Years

When analyzing an institution or organization, it is important to understand how they perform in a variety of economic and climactic conditions (Ciriacy-Wantrup 1967). Accordingly, I run the main regression with the price of farm land using 1910 as the pre-treatment year and each subsequent census as the post-treatment period. The results are presented in Table 9. There is little gain in 1920, as could be expected with IDs forming only as early as 1918. Throughout the depression period (1925-1940 censuses), the IDs provided a

[11] Full tables are available from the author upon request.

significant positive value. This gain increased as conditions improved in the 1950s, accented by a 31 percent premium in 1954. Later periods do not exhibit the same advantages, with the magnitude and statistical precision of the estimates decreasing.

Sample Selection and Construction

In Table 10 I report main results from three alternatives samples. I reduce the sample to the 17 counties that existed in 1910 and were not subsequently divided, removing the need to reweight any data. I then try the same thing for 1920 counties but after adjusting 1910 data to the 1920 borders. Finally, I utilize the 1978 county borders, reweighting the prior periods based on the uniform geographic assumption to the 32 counties. The result remains the same though the 1978 results are smaller in magnitude, likely stemming the attenuation effect due to the tenuous uniform distribution assumption—mixing treated and control data.

Non-Agriculture Outcomes

A threat to identifying causality, even with fixed effects, is the possibility of an excluded variable that is correlated ID formation and altering property values or general production. To assess this possibility, I consider alternative non-agriculture outcome variables, presented in Table 11. Columns (1) and (2) consider manufacturing output. According to recent work by Richard Hornbeck and Pinar Keskin (2012), agriculture gains are not expected to spill over to other sectors. Data for manufacturing production at the county level is not reported in 1910, though collected and published in 1900. Therefore the regression uses reweighted 1900 data to capture a pre-treatment period for IDs forming in the 1910s. The result is a noisy, negative estimate of IDs impact. This makes it very unlikely that the ID counties were simply attracting better capital and labor in general for an unrelated reason and becoming more productive overall.

Columns (3) and (4) consider non-agriculture real estate values to assess whether the gains in agriculture property value are attributable to a county wide gain. These data are not available until 1930. Accordingly, the district dummy is removed and the regressions do not follow the DiD structure, and instead only look at the difference between county types. There is no positive premium in home values or rent amounts in ID counties. On net, the evidence supports the gains in agriculture land value stem from the formation of IDs.

DISCUSSION

General Results

The formation of an ID improved the value of agriculture land immensely. As discussed above, the gain could come through a number of channels, primarily the centralized management of distribution or the ability to overcome free-riding and construct shared infrastructure. The statistical results are not well positioned to fully distinguish between the two. Regardless, the results presented make some effort to remove gains from improved infrastructure. The additional controls do include fraction of land irrigated, capturing some expansion of supply, as well as the number of dams for irrigation use. To this extent, the measured gains are excluding some infrastructure. Indeed, regressions without the additional controls result in much larger gains, nearly twice as much in most cases.[12] The remaining gain suggests that centralized management alone provides advantages.

Most of the production gains are made by delivering more irrigation water to existing acreage; the aggregate increases of both crop and general agriculture products differs little from the per acre increases in production. Though unreported, there is very little increase in farm acreage in ID counties, while there are gains in irrigated acres. However, when controlling for irrigated acres their remains a premium in crop production, suggesting ID counties not only increase the irrigated acreage, but also made the given irrigated acreage more productive.

It is worth noting that the gain in crop production of ID counties is far larger than the general measure of agriculture products (and the value of land per acre). Though further detail is not pursued here, these results are consistent with adjustments along other margins. That is, non-ID counties are choosing production in areas less dependent on irrigation. Accordingly, the main results should be treated as the treatment-on-treated effects, with gains from IDs likely smaller in counties with less centralized water supplies.

Though the time-series is shorter, average irrigation cost per acre increased by $5.31 in district counties, nearly 20 percent of the overall average. The evidence is consistent with the *acequia* irrigators concerns of IDs driving prices up and some farmers out. Economically, if growth in production was the goal, the IDs not only solved transaction costs but also yielded net

[12] Additional results are available from the author upon request.

benefits. From the local communal irrigators' perspective, they may still lose out if they are priced out of farm land market, possibly losing the land and forced to become tenants.

The Depression Era

Overall, the 1920s and 1930s were a time of economic struggle for farms with high levels of farm foreclosures due to financial pressures (Alston 1983) and production shocks due to the dust bowl. Overall, production during this period declined in New Mexico, bottoming out in 1940, while irrigation costs and debt climbed. Frank Wozniak (1997) reports that 90 percent of the MRGCD lands were delinquent on payments and nearly a third of the irrigable land was confiscated by the state during the 1940s. Despite this, regressions looking only at 1910 as the pre-period and 1940 as the post-period yield evidence supporting the general findings above: Even in financial turmoil, the IDs softened the blow, maintaining land relatively more productive and more valuable, but possibly creating more exit and entry.

CONCLUSION

The evidence is supportive that the change of governance structure, from local communal irrigation organizations to larger centralized IDs, resulted in large production and value gains in New Mexico. The institutional advantages given to IDs allowed for the expansion of irrigated land within the treated counties. The financial advantages of bonds and taxes allowed the irrigators to overcome free-riding and expand the water supply through infrastructure improvements. The econometric analysis indicate additional advantages of centralized management and reduction of transaction costs in making water allocation an internal, firm-like process. The centralization process did not extend too far; the IDs formed at the appropriate scale (Bretsen and Hill 2006), often reaching across county borders to manage hydrological basins, but not further, as advocated by General Powell (Stegner 1954).

The economic impact should be considered in light of ecological and cultural impact. For instance, while the land became more valuable and more productive, it is unclear the amount of displacement that occurred. The concerns of being priced out of farming by the original irrigators may represent a real cultural cost. The evidence indicates an increase in farm prices as well as an (unreported) uptick in tenancy rates, though this is merely consistent with displacement, not conclusive.

Fundamentally, the *acequias* also differ in that it is a cultural and ecological institution (Peña 1999; Rivera 1998; Rodríguez 2006), providing users with values beyond economic production (Brown and Rivera 2000). As Crossland (1990) puts it, *acequia* "people interacted with arid lands instead of dominating them technologically" (p. 278). The summary of Taos County in the 1890 Census of Irrigation (New Mexico) echoes this notion, saying the irrigation "is of the most primitive character," but also, that they are not often short of water because they "have learned to adapt their acreage to the probable supply from the streams" (p. 201). This is to note that there is possible value beyond the direct economic output which is the metric considered here and increased production may be at odds with the sustainability of the environment. The large use of water for irrigation in the West, attributable largely to IDs and the Bureau of Reclamation (Libecap 2011) are not necessarily socially desirable, though they are an efficient organization in doing it.

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Figure 1: 1910 New Mexico Counties and Irrigation Districts

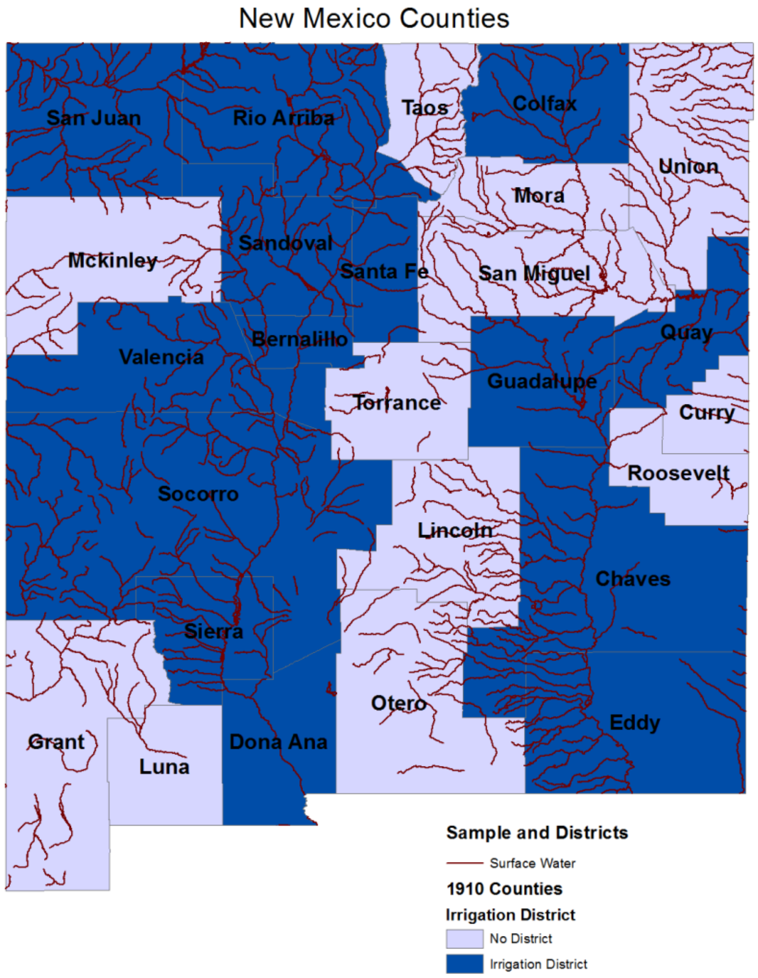
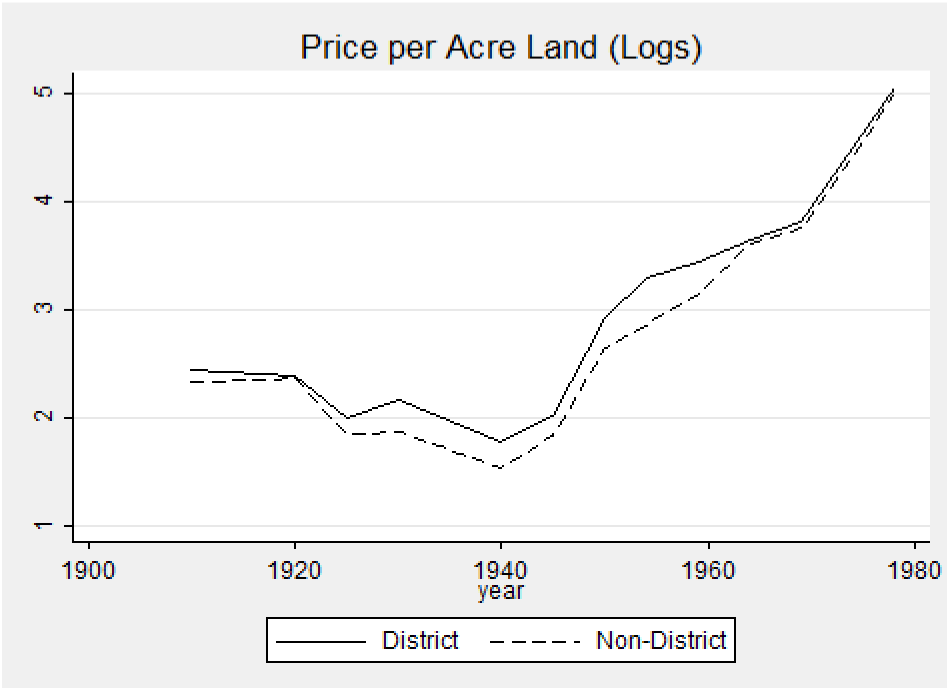
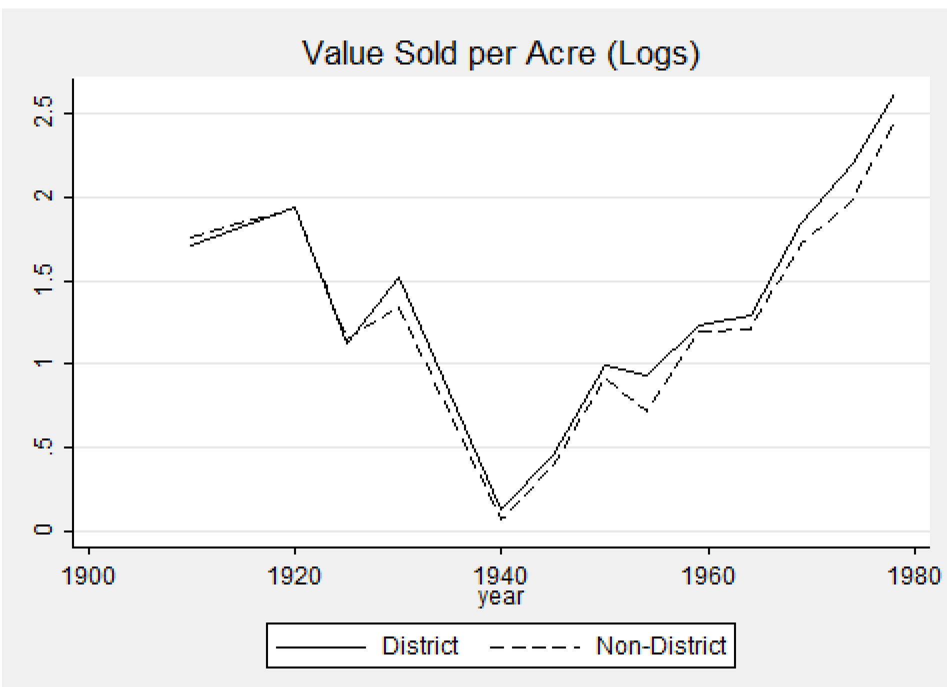


Figure 2: Agriculture Land Value Overtime



Note: Raw means of New Mexico Counties by treatment group.

Figure 3: Agriculture Production Overtime



Note: Raw means of New Mexico Counties by treatment group.

Table 1: Social-Ecological System Framework

Social, economic, and political settings (S)

S1 Economic development, S2 Demographic trends, S3 Political stability,
S4 Government resource policies, S5 Market incentives, S6 Media organization

Resource Systems (RS)		Governance Systems (GS)	
RS1	Sector	GS1	Government organizations
RS2	Clarity of system boundaries	GS2	Nongovernment organizations
RS3	Size of resource system*	GS3	Network structure
RS4	Human-Constructed Facilities	GS4	Property-rights systems
RS5	Productivity of the system*	GS5	Operational rules
RS6	Equilibrium properties	GS6	Collective-choice rules*
RS7	Predictability of system dynamics*	GS7	Constitutional rules
RS8	Storage characteristics	GS8	Monitoring and sanctioning processes
RS9	Location		

Resource Units (RU)		Users (U)	
RU1	Resource unit mobility*	U1	Number of users*
RU2	Growth or replacement rate	U2	Socioeconomic attributes of users
RU3	Interaction among resource units	U3	History of use
RU4	Economic value	U4	Location
RU5	Number of units	U5	Leadership/entrepreneurship*
RU6	Distinctive markings	U6	Norms/social capital*
RU7	Spatial and temporal distribution	U7	Knowledge of SES/mental models
		U8	Importance of resource*
		U9	Technology used

Interactions (I) → outcomes (O)

I1	Harvesting levels of diverse users	O1	Social performance measures (e.g. efficiency, equity, accountability, sustainability)
I2	Information sharing among users		
I3	Deliberation processes		
I4	Conflicts among users	O2	Ecological performance measures (e.g. overharvested, resilience bio-diversity, sustainability)
I5	Investment activities		
I6	Lobbying activities		
I7	Self-organizing activities	O3	Externalities to other SESs
I8	Networking activities		

Related ecosystems (ECO)

ECO1 Climate patterns, ECO2 Pollution patterns, ECO3 Flows into and out of focal SES

*Subset of variables found to be associated with self-organization

Note: Reproduced from Ostrom (2009)

Table 2: 1910 Irrigation District Predictors

	(1)	(2)
VARIABLES	OLS	OLS
Price per acre (log)	0.118	0.332
	(0.204)	(0.190)
% irrigated farms	0.0245***	0.0225***
	(0.00551)	(0.00458)
% irrigated acres	-0.0240	-0.0370**
	(0.0151)	(0.0135)
# of farms	0.000480***	
	(0.000148)	
# of creeks	-0.0434*	
	(0.0219)	
Farms/Creek		0.000565***
		(0.000125)
% farm acreage	0.00651	0.0124*
	(0.00637)	(0.00609)
# historic acequias	0.000904	-2.14e-05
	(0.00224)	(0.00118)
Population	-1.36e-05	-1.77e-05
	(1.97e-05)	(1.66e-05)
Longitude	-5.16e-08	-2.69e-08
	(1.87e-07)	(1.74e-07)
Latitude	5.70e-08	1.89e-07
	(1.66e-07)	(1.64e-07)
Constant	(0.587)	(0.575)
	-1.055*	-1.305**
Observations	25	23
R-squared	0.690	0.768

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Note: Regressions of eventual treatment based on 1910 agriculture census data. Creek data from Saavedra (1987). Acequia data from Dos Rios Inc. (1996).

Table 3: New Mexico Irrigation Districts and Counties

District	County(ies)				Year
Middle Rio Grande Conservancy District	Bernalillo	Sandoval	Socorro	Valencia	1925
Vermejo Conservancy District	Colfax				1952
Arch Hurley Conservancy District	Quay				1938
Hammond Conservancy District	San Juan				1956
La Plata Conservancy District	San Juan				N.D.
Pecos Valley Artesian Conservancy District	Eddy	Chaves			1932
Antelope Valley ID	Colfax				1912
Fort Sumner ID	De Baca	(Guadalupe)*			1919
Elephant Butte ID (EBID)	Dona Ana	Sierra			1918
Carlsbad ID	Eddy				1932
Santa Cruz ID (SCID)	Rio Arriba	Santa Fe			1925
Bloomfield ID	San Juan				1912
Bluewater-Toltec ID	Cibola	(Valencia)*			1927
Pojaque Valley ID	Santa Fe				N.D.

*County in parentheses indicate inclusion based on 1910 borders, but not current borders
Note: Data on counties come from Saavedra (1987). Date of formation come from various: (Clark 1987; US Bureau of Reclamation 2013; Block 2014; EBID 2013; MRGCD 2013)

Table 4: Institutional Designed Distinctions		
	Communal ditches	Irrigation districts
Owners	Private	Public
Management (GS1)	Users	Elected Board
Water rights (GS4)	Individual	Group/individual
Voting rights (GS6)	One per person	Proportional to land
Bureau of Reclamation projects (GS1)	No	Yes
Formation (GS7)	Voluntarily	Voluntarily or involuntarily
Purpose	Irrigation	Irrigation/Flood Control/International Obligations
Finance (GS5)	Labor and Fees	Bonds and Assessments
Monitoring and enforcement (G28)	Within canals: mayordomo, denial of water	Across canals: ID employees, denial of water
Enterprises*	565	10
Acres irrigated*	156,891	190,518
Average users* (U1)	14.20	420.40
Average acres* (RS3)	278.00	19,052.00
Average irrigation acres/farm*	19.56	45.32

Note: Data from the 1950 US Agricultural Census. Data for Bureau of Reclamation enterprises are combined with irrigation districts

Table 5: Institutional Outcome Distinctions		
Finances (I5)	Communal ditches	Irrigation districts
Capital investment	$ 5,589,490.00	$ 34,801,248.00
Total indebtedness	$ 214,849.00	$ 18,131,576.00
Indebted enterprises	25	6
Average debt reported	$ 8,593.96	$ 3,021,929.33
Infrastructure (RS4)		
Storage (AF)	128,430	3,006,800
Percent acres with storage	0.23	0.95
Percent concrete diversions	10.8	72.7
Water (RS5)		
Cost of water	$ 386,273.00	$ 1,138,107.00
Cost/acre	$ 2.46	$ 5.97
Cost/acre-foot	$ 1.15	$ 1.05
Water obtained (AF)	461,512.00	1,599,925.00
Water delivered (AF)	334,625.00	1,082,096.00
Water/acre	2.94	8.40
Water delivered/acre (O1)	2.13	5.68
Conveyance loss/water	0.25	0.30

Note: Data from the 1950 US Agricultural Census. Data for Bureau of Reclamation enterprises are combined with irrigation districts

Table 6: Sample Means 1910

	All mean	Non-District mean	District mean	Difference
Independent variable of interest				
Fraction acres to be in irrigation district	0.01	0.00	0.02	-0.02*
Outcomes (logs)				
Log of price per acre	2.39	2.33	2.45	-0.12
Total crop value	12.51	12.28	12.71	-0.43
Crop value per acre	-0.11	-0.22	-0.01	-0.21
Value of agricultural good sold	14.36	14.27	14.44	-0.17
Value of agricultural good sold per acre	1.74	1.76	1.72	0.05
Irrigation cost per acre[a]	14.48	18.23	11.89	6.34
Total debt	13.52	13.30	13.71	-0.41
Debt to value ratio (not Logged)	23.18	22.59	23.69	-1.10
Controls				
Number of farms	13,72.15	1,387.92	1,358.64	29.27
Number of farm acres	433,462.30	400,290.60	461,895.30	-61,604.70
Fraction irrigated farms[a]	0.45	0.29	0.59	-0.30**
Fraction irrigated acres[a]	0.09	0.06	0.11	-0.05
Number of creeks	5.62	6.08	5.21	0.87
Number of dams	0.27	0.25	0.29	-0.04
Population	12,588.50	11,596.58	13,438.71	-1,842.13
Interstate present	0.31	0.08	0.50	-0.42**
Railroad present	0.81	0.92	0.71	0.20
Mean elevation	87.31	79.68	93.84	-14.16
Mean ruggedness	2,126.19	1,998.76	2,235.43	-236.67
Latitude	-66,041.35	-132,244.00	-9,296.18	-122,947.90
Longitude	-819,821.20	-644,927.80	-96,9729.80	324,802.00
Fraction acres for hay	0.0172	0.0206	0.0142	0.0064
Fraction acres for oats	0.0006	0.0006	0.0005	0.0001
Fraction acres for wheat	0.0006	0.0006	0.0006	0.0000
Fraction acres for corn	0.0016	0.0023	0.0011	0.0012
Fraction acres for beans	0.0004	0.0005	0.0003	0.0002
Other variables of interest				
Irrigation enterprises[a]	125.18	104.67	139.38	-34.72
Land per enterprise[a]	382.16	287.12	447.95	-160.84
# of main ditches[a]	95.05	97.67	93.23	4.44
Acres capable of irrigating[a]	29,189.82	16,121.89	38,236.85	-22,114.96**
Percent of irrigated capacity[a]	0.72	0.77	0.68	0.09
Reservoirs[a]	23.09	22.00	23.85	-1.85
Storage capacity	1,234.61	907.07	1,515.36	-608.28
Total acequias (historic count)	58.76	64.27	54.43	9.84
Observations	26	12	14	

Statistically different means: *** p<0.01, ** p<0.05, * p<0.1

Note: most data from 1910 irrigation and agriculture census for New Mexico. Storage capacity and dams are derived from the US Army Corp of Engineers (2013), and total acequia count from Dos Rios Inc. (1996)

[a] aggregate irrigation data for Curry, Quay, Roosevelt, and Torrance Counties are divided evenly.

Table 7: Lost Acequias by County (1987)

	(1) Fraction Lost
District	0.323**
	(0.144)
Constant	0.307***
	(0.105)
Observations	28
R-squared	0.163

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Note: Percent acequias lost calculated by comparing historical totals (Dos Rios Inc. 1996) to 1987 counts (Saavedra 1987)

Table 8: District Impact on Agriculture 1910-1978

VARIABLES	(1) Land value per acre	(2) Total value crops sold	(3) Value of crops per acre	(4) Value of agric. products	(5) Value of agriculture products per acre	(6) Irrigation cost per acre	(7) Total debt	(8) Debt-to-Value ratio
Post district (fraction of acres)	5.469***	14.93***	14.86***	8.526***	8.496***	8.538***	7.060***	-13.05
	(1.216)	(3.343)	(3.303)	(1.657)	(1.677)	(2.048)	(1.656)	(13.46)
District	-0.126	-0.116	-0.266	-0.0643	-0.218	0.00939	0.0888	-0.288
	(0.0848)	(0.415)	(0.421)	(0.164)	(0.147)	(0.284)	(0.185)	(1.649)
County fixed effects	N	N	N	N	N	N	N	N
Census fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Observations	338	329	329	338	338	95	104	104
R-squared	0.890	0.706	0.719	0.846	0.800	0.592	0.778	0.393
Post district (fraction of acres)	3.152**	10.96***	13.98***	8.638***	11.57***	8.667***	1.591	0.441
	(1.190)	(2.844)	(4.968)	(1.611)	(2.936)	(2.019)	(1.346)	(18.28)
County fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Census fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Observations	338	329	329	338	338	95	104	104
R-squared	0.896	0.619	0.573	0.856	0.797	0.586	0.739	0.387
Number of id	26	26	26	26	26	25	26	26

Robust standard errors clustered at the county level in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Note: Other than debt-to-value ratio, all dependent variables are logged. Sample consists of 1910 counties with data reweighted to reflect these borders. Additional controls include #farms, #farm acres, %farms irrigated, %acres irrigated, #creeks, #dams, population, interstate indicator, railroad indicator, elevation, ruggedness, latitude, longitude, %acreage for hay, wheat, corn, beans, and oats. See text for data sources.

Table 9: District Impact on Agricultural Value by Year

VARIABLES	(1) Land value per acre	(2) Land value per acre	(3) Land value per acre	(4) Land value per acre	(5) Land value per acre	(6) Land value per acre	(7) Land value per acre	(8) Land value per acre	(9) Land value per acre	(10) Land value per acre	(11) Land value per acre	(12) Land value per acre
Post district (fraction of acres)	3.437	4.699***	6.996***	6.255***	4.708***	5.228**	13.40***	7.199***	1.856	4.482**	1.578	1.935
	(2.701)	(1.277)	(2.508)	(1.651)	(1.594)	(1.973)	(3.286)	(1.634)	(2.281)	(1.615)	(1.717)	(1.997)
District	-0.0724	0.137	0.114	-0.0133	0.00933	0.0354	-0.0802	-0.150	-0.185	0.0554	-0.0107	-0.0541
	(0.158)	(0.169)	(0.194)	(0.147)	(0.0928)	(0.121)	(0.138)	(0.131)	(0.197)	(0.199)	(0.219)	(0.210)
Year	1920	1925	1930	1940	1945	1950	1954	1959	1964	1969	1974	1978
Observations	52	52	52	52	52	52	52	52	52	52	52	52
R-squared	0.787	0.805	0.822	0.849	0.811	0.790	0.847	0.831	0.852	0.906	0.922	0.954

Robust standard errors clustered at the county level in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Note: The dependent variable is logged. Sample consists of 1910 counties with data reweighted to reflect these borders. Additional controls include #farms, #farm acres, %farms irrigated, %acres irrigated, #creeks, #dams, population, interstate indicator, railroad indicator, elevation, ruggedness, latitude, longitude, %acreage for hay, wheat, corn, beans, and oats. See text for data sources.

Table 10: District Impact on Agricultural 1910-1978

	(1)	(2)	(3)
VARIABLES	Land value per acre	Land value per acre	Land value per acre
Post district (fraction of acres)	6.614***	4.270***	1.886**
	(1.425)	(1.037)	(0.693)
District	-0.0664	0.0265	-0.00973
	(0.122)	(0.0909)	(0.0745)
Sample	1910 Consistent	1920 Consistent	1978 Borders
County fixed effects	N	N	N
Census fixed effects	Y	Y	Y
Observations	202	293	410
R-squared	0.887	0.896	0.881

Robust standard errors clustered at the county level in parentheses: *** p<0.01, ** p<0.05, * p<0.1
Note: The dependent variable is logged. Additional controls include #farms, #farm acres, %farms irrigated, %acres irrigated, #creeks, #dams, population, interstate indicator, railroad indicator, elevation, ruggedness, latitude, longitude, %acreage for hay, wheat, corn, beans, and oats. See text for data sources.

Table 11: Non Agriculture Outcomes

	(1)	(2)	(3)	(4)
VARIABLES	Manufacturing output	Manufacturing output	Median home value	Median rent
Post district (fraction of acres)	-5.400	-4.856	-1.526	-1.157
	(4.661)	(5.769)	(1.862)	(0.971)
District	-0.227			
	(0.337)			
Observations	89	89	130	129
R-squared	0.565	0.486	0.924	0.927
Number of id		26		

Robust standard errors clustered at the county level in parentheses: *** p<0.01, ** p<0.05, * p<0.1
Note: Dependent variables are all logged. Sample consists of 1910 counties with data reweighted to reflect these borders. Additional controls include #farms, #farm acres, %farms irrigated, %acres irrigated, #creeks, #dams, population, interstate indicator, railroad indicator, elevation, ruggedness, latitude, longitude, %acreage for hay, wheat, corn, beans, and oats. See text for data sources.