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From decentralized to centralized irrigation management☆

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ABSTRACT

Centralized organizations can internalize transaction costs and externalities, addressing possible inefficiencies of decentralized management. In practice, however, centralized organizations can have its own inefficiencies and decentralized management can do relatively well. Empirically testing relative efficiency is difficult because distinct organizations emerge endogenously in various contexts. This paper, in contrast, draws upon the unique history of New Mexico, leveraging a natural experiment to assess how the partial transition in the early 20th century from the original small decentralized communal Spanish irrigation systems (*acequias*) to centralized quasi-public irrigation districts altered agricultural development and production. Surface water irrigators in arid regions confront public good issues for building and maintaining shared infrastructure as well as common-pool resource issues to appropriate the surface water. My results confirm that irrigation districts can significantly improve outcomes when investing in costly infrastructure to expand irrigated acreage, increasing farmland values up to 33%. However, I find no broader evidence that the centralized control of water distribution provides any gains to acreage previously under irrigation by the decentralized *acequias*.

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1. Introduction

In the presence of imperfect property rights and transaction costs, institutions and organizations are central to explaining variation in economic outcomes (North, 1990). Firms, for instance, form in order to allocate resources through centralized administrative decisions rather than market transactions, avoiding externalities and market transaction costs (Coase, 1937). And while some activities are better conducted within a firm, others are better suited to maintaining independent agents that invest in institutions and relationships to lower the transaction costs (Williamson, 1979). The scale of two related but distinct activities may not align well, necessitating some collective action or the development of a separate organization to coordinate the larger activity (Hansen and Libecap, 2003). However, in practice, centralized management has its own costs and it is difficult to empirically assess how advantageous centralized management truly is with most existing evidence stemming from experiments (e.g. Casari and Plott, 2003; Mantilla, 2015; Rodriguez-Sickert et al., 2008). This paper considers New Mexico's historic experience with irrigation water, for which development and use often involve externalities, to

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better understand some of the implications of centralized management relative to decentralized management by leveraging a quasi-natural experiment in which organizational structure altered in some areas but not in others.

Water is of great value for farmers cultivating land in the arid regions. But due to the elusive flow of water and disparities between the optimal sizes for farms and irrigation enterprises (Bretsen and Hill, 2006), the endeavor requires coordination among irrigators to avoid the pitfalls of misaligned incentives that can lead to a "tragedy of the commons" (Hardin, 1968). In particular, the need for shared infrastructure, whether physical or institutional, creates a public good problem prone to free-riding while water's fugitive nature makes it costly to define property rights to provide exclusion, leading to issues of over-appropriation. Plenty of evidence exists that communities, most often small and homogenous, can cooperate and develop a mix of trust and rules that staves off the tragedy of commons (Ostrom, 1990). Even large communities engender cooperation when share social norms are pervasive (Stewart, 2009) But even where irrigators are similar along all other dimensions, biophysical differences, including spatial distribution on a stream or canal, creates heterogeneity and affects the investment in a common pool resource (Schnier, 2009). Upstream irrigators, for example, can more readily appropriate additional water and shirk canal investment and maintenance. This relationship can also impede voluntary cooperation to achieve efficient and equitable allocation of the water as has been found in Kenya and India (McCord et al., 2017; Ray and Williams, 2002). The very fact that the initial investment (in infrastructure) leads to a need to divide the resulting flows can create additional holdup problems in addition to the standalone public goods issue (Cardona and Rubí-Barceló, 2014).

Centralized control can avoid numerous bargains and even more numerous opportunities to shirk any resulting agreements and can sustain the provision of a common pool resource over time (Stoddard et al., 2014), but centralized decision-making is not without its own problems (Coase, 1960; Hayek, 1945). Many government-ran systems in developing countries perform poorly (Adams, 1990; Ostrom and Gardner, 1993; Suhardiman and Giordano, 2014). For example, larger government systems often impose simple and inflexible rules, resulting in inefficient and inequitable benefits accruing to the irrigators (Ferguson, 1992). In other instances the governments presence may erode the irrigators' willingness to collectively engage in other needed maintenance efforts (Lam, 1996). More generally, if centralized decisions are viewed as external rules, in contrast to local development of internal rules, underlying cooperative behavior can be impacted (Deci et al., 1999; Rode et al., 2014). Meanwhile, decentralized decisions are ways to deal with increasingly complex activities (Morikawa, 2015) and experimental results suggest decentralized decisions typically converge on efficient equilibria (Marengo and Dosi, 2005; Oechssler, 1997), perhaps partially because centralized networks appear to enshrine self-regarding activities while decentralized networks take up "good" suggestions (Mantilla, 2015). Furthermore, decentralized management can reduce the costs of reaching gross efficiency, meaning it also can increase net efficiency when transaction costs are explicitly considered (Casari and Plott, 2003). Still, current efforts to move from centralized organization to decentralized natural resource management offers only mixed success (Andersson et al., 2006; Larson and Soto, 2008; Meinzen-Dick et al., 2002; Nagrah et al., 2016) and it remains important to study past examples of drastic shifts in resource governance structure to better understand how the resource and the local users may be impacted by the nexus and mode of decision making.

Because of its aridity, development of the American West, delineated by the 100th meridian, dealt with irrigation challenges. Throughout the 19th and 20th century a number of farmers and policymakers attempted to overcome these obstacles and develop irrigation through various laws and organization forms with mixed success.[1] Whitbeck (1919) echoes this sentiment stating Western irrigation was neither a success nor failure, highlighting the 55,000 some non-federal projects – communal ditches, incorporated and unincorporated mutual companies, and commercial companies – as successful but the US Bureau of Reclamation projects struggling at the time. However, with greater hindsight it appears that Irrigation Districts (henceforth "IDs"), often in tandem with the Bureau of Reclamation, created significant irrigation growth compared to other irrigation organizations in the latter portion of the 20th century (Bretsen and Hill, 2006).[2] Their attractiveness and success of these quasi-public government entities has been attributed to their institutional innovation to overcome free riding and accumulate external capital—reducing a number of transaction costs (Bretsen and Hill, 2006; Hutchins, 1931; Leshy, 1982; Libecap, 2011). While the 17 Western states expanded irrigated acreage by an average of 1% annually from 1910 to 1978, ID acreage, in particular, grew by 4% annually—adding some 10,000,000 irrigated acres.

In this article, I assess the impact IDs have on agricultural development and production in New Mexico. The choice of New Mexico lies in its unique history among the Western States. Long before Anglo-Americans sought to irrigate the West, Spanish settlers colonized this region. No less dependent on irrigation than later settlers, they established irrigation beginning around 1600, some 240 years prior to the Mormons irrigating the soils of Utah. The Spaniards success stemmed from their transplantation of their communal *acequia* systems developed in the arid regions of Spain and many remain today serving as counter-examples to the oft-prescribed tragedy of the commons (Cox, 2014; Smith, 2016). However, successful avoidance of the "tragedy" is not indicative of efficiency or optimality. In fact the US found the systems lackluster, stating

[1] A fundamental shift in water law during the 19th century was the rejection of the Riparian Doctrine and the adoption of the Prior Appropriation Doctrine in the 17 Western States. The former defines correlative water rights to landowners abutting a body of water and is used in the more humid east. The latter provides absolute rights independent of land location based on first-come-first-serve. Designed to and able to safeguard investment (Leonard and Libecap, 2016), the doctrine introduces some economic inefficiencies in the division of water (Burness and Quirk, 1979; Smith, 2014). With deeper Spanish roots, New Mexico itself was (and is) slow to adopt and implement this law. The focus of this paper, however, is on organizational form and not the use of prior appropriation.

[2] Though popular, they were not universally successful; from 1890–1928, the number of districts formed in the US grew from just 17 to 801, though by 1928 nearly 300 were inactive (Hutchins, 1931).

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