This article was published on-line on September 6, 2017
Final version June 13, 2018

Essays in
ECONOMIC & BUSINESS HISTORY

The Journal of the Economic & Business History Society

Editor
Jason E. Taylor
Central Michigan University

ISSN 0896-226X
LCC 79-91616
HC12.E2

PHILOSOPHER'S CONCRETE: DAM CONSTRUCTION, FARMLAND VALUES, AND AGRICULTURAL PRODUCTION IN THE WESTERN US, 1890–1920

Soudeh Mirghasemi
Hofstra University
Soudeh.Mirghasemi@hofstra.edu

Did construction of the Bureau of Reclamation dams in the early 20th century raise farm values and increase agricultural output? I construct a new county-level panel dataset from 1890 to 1920 with information on geography, climate, politics, agriculture, and major dams, and then evaluate the effect of the Bureau of Reclamation dams on the value of farms and on crop productivity. Using fixed effect panel estimation, I find that new federal dam construction increased the average value of farmland by approximately 6.4 percent. When I apply an instrument to control for potential endogeneity, the effect of Bureau dams on farmland value increases in size, although the estimate also becomes noisier and is no longer statistically significant. My results indicate that Bureau dams constructed in prior decades and the new dams constructed by other agencies did not have a statistically significant effect on the value of farms. In terms of crop output, the only crop affected by the dams was alfalfa.

> "The philosopher's stone is really the philosophical stone, for philosophy is truly likened to a magic jewel whose touch transmutes base substances into priceless gems like itself."
>
> Manly P. Hall - *The Secret Teachings of all Ages*

> "We had pushed aside foreign countries and native peoples. Now we would push aside the desert."
>
> Bruce Reichert - *The Bureau that changed the West*

Introduction

Dam construction played a major role in the development of water resources during the early 20th century in the American West. Over the first half of the 20th century, the number of major dams in the west and their maximum capacity increased nearly sixteen-fold and two hundred-fold, respectively. At the same time, the rate of population growth in the West was at least double the rate in the rest of the US.[1] This was associated with an over four-fold increase in national agricultural output from 1900 to 1950.

The Newland Reclamation Act of 1902 created the Bureau of Reclamation, which built the lion's share of dam capacity for irrigation in the West. The initial aim of the act was to improve agricultural production by providing irrigation to arid areas. However, the effect of dam construction on agricultural growth in the west remains controversial. I construct an extensive historical county-level dataset from 1890 to 1920 and examine the effect of the Bureau's dam construction on the value of farmland and crop production in the West. Using the the data, I estimate the average gain in agricultural outcomes from treatment for those places that were treated (i.e., treatment on treated) and provide direct evidence that dams had a positive effect on some agricultural outcomes.

Whether large public dams tend to have net benefits has been a controversial topic. Studies in the US have found positive effects of hydroelectric dams on the local population and employment growth (Edson Severnini 2014), on county income and earnings growth (Mostafa Aleseyed et al. 1998), and on agricultural productivity (Zeynep Hansen et al. 2009). Esther Duflo, and Rohini Pande (2007) find that dams have reduced poverty and raised productivity in India in the modern era. On the other hand, Otto Eckstein (1958) shows that the benefit of water resource development varies by the location of the site and as characteristics of the region change. Carl Kitchens (2014) investigates the effect of electrification of the Tennessee Valley Authority's (TVA) large scale hydroelectric dams on economics activities. Comparing the counties with or without hydroelectric dams, he finds that TVA had an insignificant effect on economic growth in the Southeastern United States. Charles W.

[1] Except for the 1930s.

Howe (1968) finds that public investments in waterway improvements do not lead to rapid local economic growth. Marc Reisner (1986), in the highly influential *Cadillac Desert*, states that due to political pressures and only a shallow understanding of land productivity, climate conditions, and the economic environment, it was mostly political connections that influenced the water projects authorized by Congress (Michael C. Robinson 1979). Therefore, the locations of the irrigation projects were determined in great haste and without comprehensive examination.[2] One finding consistent with these views is the fact that the Bureau's share of capital invested in the irrigation projects was around 19 percent, while it's share of the total acres irrigated was only about seven percent in 1920.[3]

Factors influencing farm value have been studied extensively. The traditional approach assumes that farm value measures the discounted anticipated returns to agricultural production (Allen M. Featherstone, and Timothy G. Baker 1987; Oscar R. Burt 1986; Emery N. Castle, and Irving Hoch 1982). However, some studies show that the market value of farmland might exceed its agricultural production value as a result of urban proximity and potential for recreational use (Charles H. Barnard 2000). Other studies estimate farm value based on the potential development and conversion to urban use (Andrew Plantinga, and Douglas Miller 2001; Grigorios Livanis et al. 2006; Allison Borchers et al. 2014). Furthermore, studies have investigated the effect of infrastructure investments other than dam construction such as the effect of an expanded railroad network on agricultural land values (Dave Donaldson and Richard Hornbeck 2016; Robert Fogel 1965; Jeremy Atack, and Robert Margo 2011). Donaldson and Hornbeck (2016) estimate that, in the absence of railroad investments, farmland value in the U.S would have been 64 percent lower.

To advance the debate about the net benefits of major federal dams, I investigate the impact of the Bureau of Reclamation's dam projects on the local economy and agricultural activity from 1890 to 1920. To the best of my knowledge, this is the first quantitative study that attempts to assess the effect of the Bureau of Reclamation dams on agricultural activities. I

[2] In fact, during the first four years of federal investment in irrigation, 27 projects were authorized, but four of them were abandoned later (John A. Widtsoe 1928).

[3] US Census of Agriculture, 1920.

develop a new historical county-level panel dataset for the census years 1890, 1900, 1910, and 1920 with information on geography, climate, politics, agriculture, as well as with information on Bureau of Reclamation dams and other major dams. I use the data to measure the effect of Bureau dams on farmland value and crop production.

Using fixed effects panel estimation, I find that new federal dam construction increased the average value of farmland in the county by approximately 6.4 percent. The estimation results indicate that new dams constructed by agencies other than the Bureau did not have statistically significant effects on the outcomes. This is reasonable, as the Bureau projects entailed vast federal investments compared to the dam construction by other entities.[4] This can be explained by the much larger maximum capacity of the Federal dams compared to other agencies' dams. Furthermore, Bureau dams constructed in the previous decade (1890-1900) did not have any effect on the value of farms.

One potential source of endogeneity is that counties that lobbied for the Bureau dams might have anticipated that their agricultural sector would grow faster. I test whether there were differential pre-trends in economic activities in the Bureau counties before federal construction, and I do not find this to be the case. I find suggestive evidence that in the first 20 years of the governmental irrigation movement, federal dams were located in less densely populated areas and in areas where farm value per acre was decreasing. Nonetheless, as a way to further reduce endogeneity, I develop an instrumental variable approach. The instrument is defined as whether the county had the potential to have a Bureau dam interacted with the political strength of Republicans in the two presidential elections before the Reclamation Act was passed. When I apply the instrument to control for endogeneity, the effect of Bureau dams on farmland value increases in size, although larger standard errors mean that it is no longer statistically significant.

To examine whether the Bureau's dam construction affected agricultural activities, I estimate models with the production per acre and the average number of acres planted with important crops, the value of

[4] Although Bureau is the major federal dam builder, most of the other dam construction was led by The Bureau of Indian Affairs.

livestock, and dairy, and the share of improved acres as outcome variables. Looking at the impact of dam construction on the average crop production per bushel, alfalfa is the only crop with a positive and statistically significant coefficient; however, this crop had been actively produced before the dam construction. This verifies that the original dam's site had low soil quality in addition to being arid because in lands with low nitrogen levels, which result in low quality of most agricultural crops, it is necessary to first plant crops such as alfalfa. These findings are consistent with the narratives of the projects for this period. Christopher J. McCune (2001), in the Belle Fourche Project Bureau of Reclamation Report, states:

> Beginning in 1915, farmers increasingly turned to stock operations, mostly sheep, to try to turn a profit, as alfalfa became the primary crop of the project...One of the first reports given on the project lands stated that grain, hay, alfalfa, and perhaps small fruits will constitute the main crops, which was not much different than what had already been grown in the region for several years.

Furthermore, I do not find a statistically significant effect of dam construction on the value of livestock and the value of dairy products.

In this paper, I focus specifically on the Bureau investments, as they were a turning point in the roles played by the private sector and the federal government in the West. The Bureau was created after the government passed the Reclamation Act to allow the government to build larger projects due to lack of finances and engineering skills in the private sector. My results support the fact that dams had positive effects on the local economy, but only in limited ways. These effects might not have been sufficient but they were potentially important for the West.

Historical Background

Most of the development of the US had occurred in the East, and the Western US was comparatively underdeveloped until the end of the 19th century. Although the Western US provided abundant land for raising crops and livestock, farmers found the climate arid and sought new, large-scale irrigation methods to develop the land.

The Federal Desert Land Act, also known as the Carey Act, gave permission to private companies in the US to assemble irrigation systems in the Western states and to profit from the sales of water to the irrigators. Congress passed this Act on August 18, 1894, as the federal government decided that the task of irrigation was too large for individual settlers. The new Act delineated a new approach for the disposal of public desert land. The private sector attempted to evaluate these lands in the Western US to find an opportunity to establish an agricultural society. Except for in Idaho and Wyoming, the Carey Act was not as successful as intended. [5] Westerners argued for further action by the government to build larger projects due to lack of finances and engineering skill.

In 1902, the Congress passed the Reclamation Act, which made the federal government, in the form of the Bureau of Reclamation, responsible for irrigation in the US Western states[6] (E. Willard Miller and Ruby Miller 1992). The bill's goal was to convert arid federal land into a suitable place for living, by constructing dams, power plants, canals, lateral systems, pumping plants and other water facilities. Building of a dam required prerequisite construction, such as roads and railroad construction. The water projects were to be financed through a Reclamation Fund, which was funded by selling federal land and, later, by selling the water to the irrigators (Reisner 1986). To discover the feasibility of the water projects, the Bureau of Reclamation prepared geological surveys, were prepared by the Bureau of Reclamation, which included all related factors, such as the amount of water flow, elevation of the surface and the streams and their catchment areas for the dam construction (Frederick H. Newell 1903).

Initially, the Bureau's ambition was to boost agricultural activities and help the local economy by constructing water projects and delivering water to the arid areas. However, because of political pressure from

[5] In 1908, Idaho received an additional two million acres (8,000 km) and Wyoming received an additional one million acres (4,000 km) of land to develop under the Carey Act. Today, approximately six percent of the Carey Act lands irrigated in the United States are in Idaho.

[6] Western states served by Reclamation are Arizona, California, Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Utah, Washington and Wyoming. Texas was not included during the first few years.

Congressmen, Senators, and state legislators to acquire water projects, dams might have been constructed in the districts with little potential for agriculture. The water projects mostly had to be authorized by Congress, but the President could veto the bill. Marc Reisner (Reisner 1986), in the highly influential *Cadillac Desert*, states that:

> Initially, little consideration was given to the hard realities of the irrigated agriculture. Neither aid nor direction was given to settlers in carrying our the difficult and costly work of clearing and leveling the land, digging irrigation ditches, building roads and house, and transporting crops to remote markets....The government was immediately flooded with requests for project investment as the Local chambers of commerce, real estate interests and congressman were convinced their areas were ideal for reclamation development.

Twenty-four federal irrigation projects were authorized within four years of the passage of the Act, four of which were abandoned later. The financing of the Reclamation projects compelled the farmers to meet their repayment obligation in 10 years. This proved to be unrealistic, as 60 percent of the farmers delayed their payments. In some cases, the delays stretched beyond 20 years from the passage of the first Reclamation law, and the repayment period was extended to 40 or 50 years.

Data

The new county-level dataset is assembled from several sources, agriculture, geography, climate, politics, and major dams for the 1890 through 1920 census years for the Western US.[7] The data on agriculture comprise a county-level dataset from the US Census of Agriculture, which is available every ten years during the study period. All other datasets were transformed to a county-level unit level to have consistency in the panel dataset. The only exception involved the political data, which are a

[7] Due to the change of boundaries over the years, the 1900 shape file is chosen as a base year, and 1910 and 1920 weighted average values are calculated applying the Geographic Information System (GIS).

percentage of votes for Republicans in presidential elections, measured at the state level. I assembled the datasets mainly by using the Geographic Information System (GIS) software. One major issue in constructing the panel dataset for this time period was the considerable change in counties' boundaries, which required me to make the data comparable across the years of the study. This adjustment was made based on the year 1900 shapefile, applying GIS software.

Census of Agriculture Data

The US Census of Agriculture data are reported for the following: value of farms, number of acres in farming, improved acres, value of dairy product, value of livestock, production of important crops [8] and population.[9] Table 1 shows the summary statistics of the data. For counties with or without Bureau dams, Bureau counties, on average, were less densely populated and had fewer farms compared to non-Bureau counties. Furthermore, the Bureau counties had statistically significantly more production per acre and a higher average number of acres planted with alfalfa, while the production per acre and the average number of acres planted with the cotton were statistically significantly larger in non-Bureau counties.

Major Dams

Information on dams comes from the National Inventory of Dams[10], Water Control Infrastructure for all the major dams constructed in the US from 1800 to 2003. The data include information on the name, national ID, latitude, longitude, owner name, type of owner, year of completion, purposes and the primary purpose, capacity, height and some other characteristics for the major dams in the US.[11] There are 8,121 major dams included in the dataset.

[8] Sugar beet, Cotton, Wheat, Alfalfa

[9] All dollar values are in 1926 constant dollars.

[10] National Atlas of the United States, 200603, Major dams of the United States, Geographic NAD83, USGS (2006) [dams00x020_USGS_2006]: National Atlas of the United States, Reston, VA.

[11] A major dam is defied based on the standard criterion by the National Inventory of Dams: A major dam is 50 feet or more in height, has a normal storage

Table 1
Summary Statistics, 1900 - 1920

	Bureau counties		non-Bureau counties		
	Mean	Std. Dev.	Mean	Std. Dev.	Difference
Population	11,293.5	8,772.4	16,414.2	34,060.3	-5,120.7***
Population density	4.5	6.1	27.7	314.8	-23.2***
Farm(number)	1,021.1	782.9	1,394.9	1,267.9	-373.8***
Farm(acre)	399,798.8	301,466.8	416,488.8	307,142.4	-16,690.0
Acres improved	122,609.8	116,088.4	172,211.3	162,201.5	-49,601.4***
Value of farmland	15,233,854.8	12,352,326.5	15,868,580.4	15,191,183.1	-634,725.6
Value of farmland/acre	49.0	40.6	45.7	55.9	3.3
Value of diary	125,258.6	119,570.7	170,270.1	244,429.3	-45,011.5***
Value of livestock	3,050,205.22	1,819,528.67	2,262,063.35	1,623,395.70	788,141.87***
Sugar beet (bushel/ac)	1,071.0	4,663.6	1,450.9	12,691.1	-380.0
Sugar beet(acre)	5,667.8	40,211.0	2,439.8	19,838.4	3,228.0
Cotton(bushel/acre)	43.1	364.6	3,319.1	9,792.1	-3,276.0***
Cotton(acre)	86.0	710.7	11,724.5	32,699.1	-11,638.5***
Wheat(bushel/acre)	354,318.1	872,999.4	437,975.6	864,168.6	-83,657.5
Wheat(acre)	20,078.2	43,132.2	33,462.9	61,269.9	-13,384.7***
Alfalfa(bushel/acre)	33,140.3	45,309.6	10,700.1	22,141.0	22,440.2***
Alfalfa(acre)	11,452.1	12,582.3	4,640.3	8,659.7	6,811.8***
Elevation	3,232.5	1,648.7	2,272.3	1,811.9	960.2***
Precipitation	3.0	3.8	9.4	9.9	-6.3***
Days exceeds 100◦F	0.8	1.6	2.9	5.9	-2.2***
Days exceeds 90◦F	5.1	6.5	20.7	29.1	-15.6***
Days below 32◦F	6.4	12.8	6.5	11.4	-0.2
Days below 0◦F	0.5	1.6	0.3	1.2	0.2
N	78		2556		

*** p<0.01 ** p<0.05 * p<0.1

The major dam dataset includes the exact location, latitude and longitude, of each major dam. This helps to locate the counties that received a major dam by intersecting the dam point dataset with the US county shapefile. Further, the data consist of a name and a type of owner of major dams; local, private, state, and public utilities agencies. Looking at the maximum capacity of this construction, federal dams have significantly larger maximum storage compared to the dams constructed by private entities and other type of owners. This study focuses only on

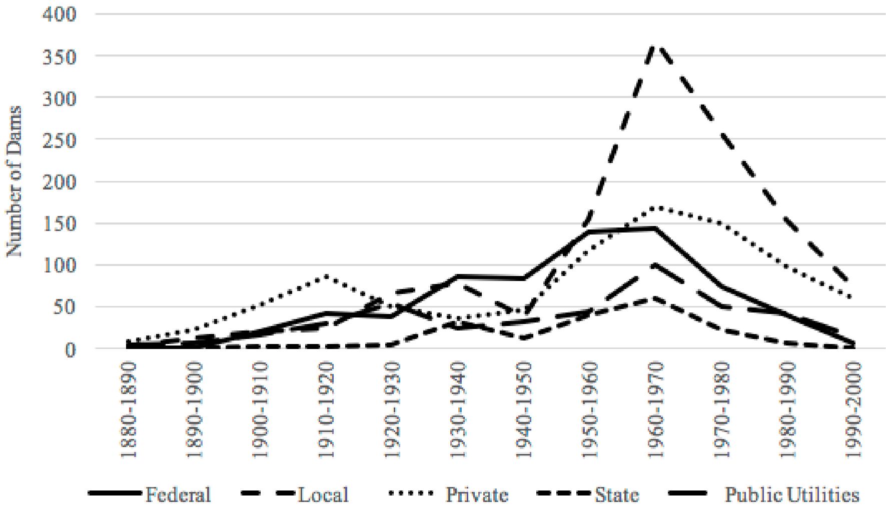
capacity of 5,000 acre-feet or more, or has a maximum storage capacity of 25,000 acre-feet or more.

the federally-constructed dams in the Western United States. Federal dams are divided into two categories: dams constructed by the Bureau of Reclamation (Bureau dams) and dams constructed by other federal agencies (non-Bureau dams). The dataset also provides the year that a dam's construction was completed. Therefore, the "Bureau dam" variable is an indicator of whether the Bureau constructed a dam in a county in decade *t*. If there was at least one new Bureau dam that was completed in a county in a decade *t*, then the value of the Bureau dam is equal to one in decade *t*. I made a few assumptions to construct this variable: dams deliver water only to the counties in which the dam is located; and water is delivered to the farmers when the construction is completed. These assumptions were necessary due to data limitation.

The total number of dams constructed in each decade by different owners is shown in Figure 1. There are five types of owners:

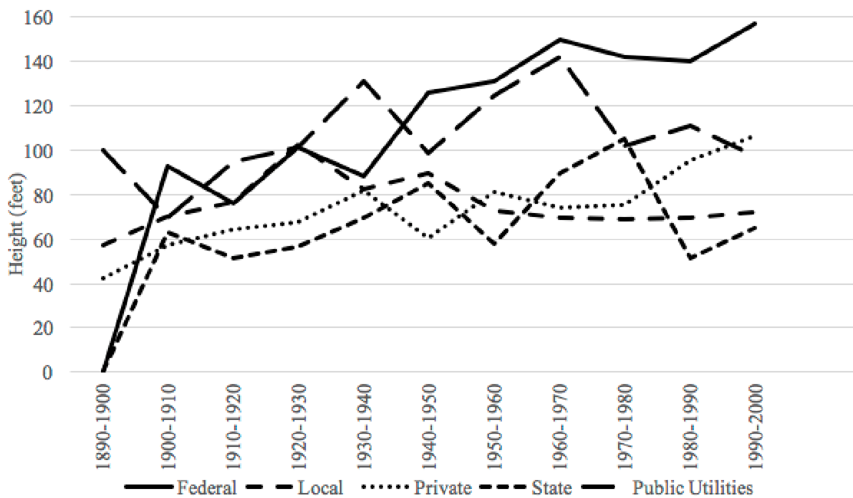
- Federal: The dam is owned by a federal agency.
- Local: The dam is owned by a county, city, regional, or other similar local government or government agency, such as city of ... and ... district.
- Private: The dam is owned by an individual or individuals, or by a private company.
- State: The dam is owned by a state or by a state agency.
- Public utilities: The dam is owned by a public utility, such as Southern California Edison Company, Pacific Gas and Electric Company, etc.

Figure 1 indicates that between 1900 and 1920, the number of dams constructed by the federal government increased, but that the number of private dams increased more. Figure 2 and Figure 3 show two characteristics of dams used to compare their size. Figure 2 compares the height of the dams constructed by various owners from 1880 to 2000. The tallest dams belong to the public utilities. Another characteristic of size is the maximum storage capacity, which is the total storage space in a reservoir below the maximum attainable water surface elevation, including any surcharge storage. Clearly, federal dams have significantly larger maximum storages compared to the dams constructed by private entities and other type of owners.



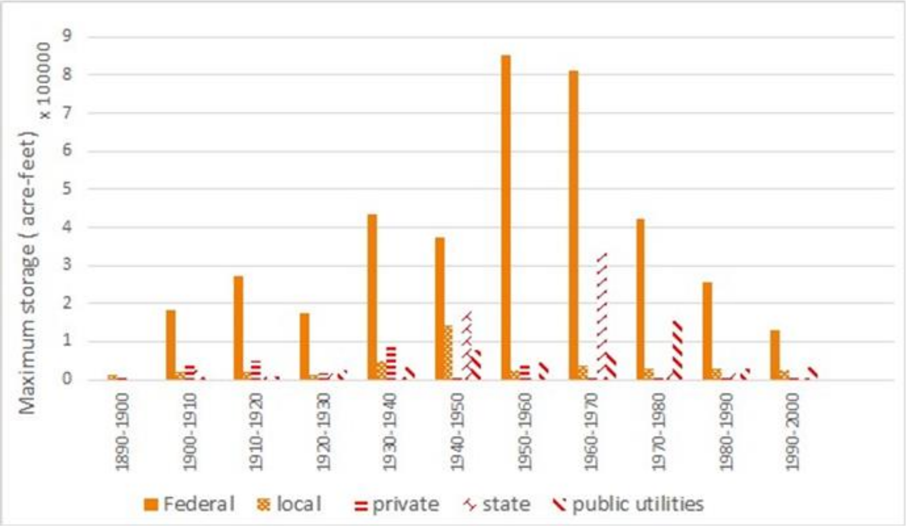
Note: Only Western states are included.

Figure 1
Number of Dams Constructed by Different Types of Owner



Note: Only Western states are included.

Figure 2
Mean of the Height of Dams Constructed by Different Types of Owner in Each Decade



Note: Only Western states are included.

Figure 3
Mean of the Maximum Storage of Dams Constructed by Different Types of Owner in Each Decade

The summary statistics of the federal dams are presented in Table 2. Between 1900 and 1920, there were 66 major federal dams throughout the US, 54 of them were constructed by the Bureau.[12] Idaho, California, Montana and Wyoming, were the states with the most Bureau dams.

Table 2
Federal Major Dams in the West

Federal dams	Total	Bureau	Others
1902 - 1910	31	30	1
1910 - 1920	35	24	11
Total	66	54	12

Note: Although Bureau is the major federal dam builder, most of the other dam construction was led by The Bureau of Indian Affairs.

[12] During this time period, all the dams owned by Bureau of Reclamation, were originally constructed by Bureau.

The primary purposes of dam construction include flood control, debris control, fish and wildlife protection, hydroelectric generation, irrigation, navigation, fire protection, recreation, water supply enhancement, and tailings control. Table 3 shows the frequency of the primary purpose of the dam construction. Clearly, most of the dams built by the Bureau were intended for irrigation and water supply.

Table 3
Primary Purpose

Primary purpose	Total	Bureau
Irrigation or Water Supply	60	51
Flood control or Navigation	2	1
Hydroelectric	1	1
Recreation	1	-
Others	2	1

Note: The table shows the primary purpose of the dams constructed by Bureau during 1902-1920. The others category includes debris control, fish and wildlife ponds, tailings and fire protection, stock, or small farm pond purposes.

Dams can be constructed for either single-purpose or multiple purposes, with different geographical and topographical preferences. For irrigation dams, the river gradient should be neither steep nor flat, but dams for hydroelectric power need a higher river gradient (Thomas Cech 2010). According to a study by Duflo et al. (2007), “Low (but nonzero) river gradient areas are most suitable for irrigation dams while very steep river gradient areas are suitable for hydroelectric dams.”

Presidential Elections

According to the Bureau of Reclamation records, President Theodore Roosevelt strongly supported the flourishing of the West, and about 24 out of 27 projects were approved immediately after passing the Reclamation Act in 1902. The authorization dates of these early projects were between 1903 and 1908, as shown in Table 4.

Table 4
Authorization Dates of Bureau of Reclamation's Projects

State	Projects	Dates
South Dakota	Belle Fourche	May 10, 1904
Idaho	Boise	Mar 27, 1905
New Mexico	Carlsbad	Nov 28, 1905
Oregon	Klamath	May 17, 1905
Montana	Milk River	Mar 14, 1903
Idaho	Minidoka	Mar 21, 1904
Nebraska	North Platte	Mar 14, 1903
Washington	Okanogan	Dec 2, 1905
California	Orland	Oct 5, 1907
New Mexico/Texas	Rio Grande	Dec 2, 1905
Arizona	Salt River	Mar 14, 1903
Wyoming	Shoshone	Feb 10, 1904
Montana	San River	Feb 26, 1906
Nevada	Truckee-Carson	Mar 14, 1903
Oregon	Umatilla	Dec 4, 1905
Washington	Yakima	Dec 12, 1905

Republican states were rewarded more when the President was Republican and Republicans dominated the Congress. The average state Republican vote share in the Presidential elections of 1896 and 1900 captures the Republicans' political strength for the two presidential elections before the Act was passed. The political data come from the Inter-University Consortium for Political and Social Research (ICPSR)[13] United States Historical Election Returns database. The data include the state-level percentage of votes for Republicans in presidential elections.

The summary statistics for Western states in Table 5 show a strong relationship between Republican votes in the presidential elections of 1900, 1904, 1908 and the location of dams. We choose these elections

[13] Inter-University Consortium for Political and Social Research (ICPSR). United States Historical Election Returns, 1824-1968, ICPSR Dataset Number 0001. Inter-University Consortium for Political and Social Research (ICPSR). Historical, Demographic, Economic, and Social Data: The United States, 1790-1970, ICPSR Dataset Number 0003, as corrected by Michael Haines, Department of Economics, Colgate University, Hamilton, NY.

since this time period was crucial, as the majority of the authorization dates of the early projects were during 1903-1908. The table shows the percentage of votes for Republicans in the presidential election and whether a dam was constructed. Columns (2) through (4) show the percentages of Republican votes for the president in 1900, 1904 and 1908, and column (5) shows the average of the three elections. The Dam column in as indicator of whether or not a dam was constructed in a state during the mentioned time period. As we can see, South Dakota, Washington, Wyoming, Oregon and California remained Republican during the first decade of the twentieth century, and the Bureau constructed dam projects there. Interestingly, states such as Idaho and Montana, which were Democrat and became Republican in 1904, even if for one presidential election, had dam construction starting after 1904. This shows the political power of the Republican Party in constructing major dams in Republican states. Therefore, it is reasonable to consider the percentage of votes for the Republican candidate as a political variable that had a significant influence on the location of dams.

Climate and Geographical Data

The climate and geographical data, obtained from the U.S Historical Climatology Network for each weather station, also comprise a point dataset. The number of stations is limited during this time period. The GIS software is applied to interpolate the climate data and calculate values at the county level. Then, the average of the climate variables is calculated per decade for each county.

Specifically, the data include averages of extreme events: hot days that exceed 100 degrees Fahrenheit; hot days that exceed 90 degrees Fahrenheit; cold days below 32 degrees Fahrenheit; cold days below 0 degrees Fahrenheit; and total rainfall per year. Looking at Table 1, on average, Bureau counties compared to non-Bureau counties were located in higher altitudes and in mountainous areas and also had less annual precipitation, which is statistically significant at the one-percent level.

Table 5
Association of the Percentage of Votes for Republican in Presidential Elections and Dam Construction

State	1900	1904	1908	Average	Dam
North Dakota	62.1	75.1	61	66.1	-
South Dakota	56.8	71.1	58.8	62.2	yes
Washington	53.4	70	57.8	60.4	yes
Wyoming	58.6	66.9	55.4	60.3	yes
Oregon	55.5	67.3	56.5	59.8	yes
California	54.5	61.9	55.5	57.3	yes
Kansas	52.6	64.9	52.5	56.7	-
Utah	50.6	61.5	56.2	56.1	-
Idaho	46.9	65.8	54.1	55.6	yes
Nebraska	50.5	61.4	47.6	53.2	-
Colorado	42	55.3	46.9	48.1	-
Montana	39.8	53.5	46.9	46.7	yes
Nevada	37.8	56.7	43.9	46.1	-
Texas	30.9	22	22.4	25.1	-
Arizona	-	-	-	-	-
New Mexico	-	-	-	-	yes
Oklahoma	-	-	43.5	-	-

Note: Arizona, New Mexico and Oklahoma were territories that did not have voting representation in the US Congress and, therefore, had no electoral votes.

Soil Data

Soil data are from the Web Soil Survey (WSS), which uses information from the National Cooperative Soil Survey. The soil survey was developed for polygons of areas with similar soil characteristics. The data are available for each state. The data are interpolated by the GIS software to calculate the values at the county level for the 1900 shapefile for each county. The data include the fraction of the land prone to floods, the soil erodibility factor (K-Factor), slope steepness (S factor), wind erosion, the fraction of the land occupied by wetland, salinity, permeability, moisture capacity, clay content, and sand content.[14]

Empirical Strategy

Initially, the Bureau's ambition was to boost agricultural activities and help the local economy by constructing water projects and delivering water to arid areas. These were the areas with poor soil and unsuitable climate condition where the Bureau expected to have a substantial effect on the agricultural activities. The treatment effect can be defined as whether or not the arid county received a dam. I estimate the average gain in agricultural outcomes treatment in those places that were treated (i.e., treatment on treated) (Joshua Angrist and Guido Imbens 1995), rather than estimating the effect of dam construction randomly (i.e., average treatment effect) (Paul Holland 1986). Estimating the average treatment effect is not applicable as the dams are more likely to be constructed in places with geographical and topographical prerequisites and higher potential need for water. To the best of my knowledge, no other study estimates effect of Bureau Reclamation dam construction on agricultural outcomes.

I estimate the effect of dam construction on farmland values and crop production using county-level data in the following regression:

$$Y_{it} = \beta_0 + \beta_1 Dam_{it} + \beta_2 X_{it} + \delta_i + w_{st} + \varepsilon_{it} \quad (1)$$

The main dependent variable is the log of the value of the farm per acre in county i in census year t. The Dam variable is an indicator of whether the Bureau constructed a dam in county i in decade t, and β_1 is the coefficient of interest. Therefore, Bureau counties are defined as the counties that received Bureau dams. Also, it is assumed that only Bureau counties received water after the dam was constructed. The assumption was made because of the limited information on the time and location of

[14] The fraction of the land prone to floods is reported as a frequency variable, as none, very rare, rare, occasional, frequent, and very frequent, and it is not included in the analysis.

water delivery during this period.[15] This assumption likely underestimates the effect of dam construction on the local economy. In most cases, water use associations were gradually formed, and canals and laterals were extended over time. however, these data are not chronologically mapped for most of the projects.[16]

X_{it} , is a vector of control variables. Rainfall and hot and cold extreme weather events are included to control for climate conditions and they are interacted with soil characteristics to control for the combined effect of soil and climate on outcomes.

When having a land value per acre as an output, the main assumption is that the present value of the farmland is the discounted value of farmland rents into an unlimited future time period. This is valid if the land market functions accurately; then, prices will reflect the present discounted value of land rents into the infinite future. It is also assumed that farmers cultivate the land that gives them the maximum present farmland value. Farmers adapt to changes and choose the appropriate crop for their land.

It is plausible that the value of farmland may have increased because of land speculation rather than improvement in agricultural activities. Therefore, I consider the production per acre and the average number of acres of important crops planted, the value of livestock per acre, dairy value per acre, and the share of improved acres to reveal whether there

[15] Looking at the projects, case by case, I was not able to find a consistent pattern of water delivery to the nearby areas. For example, in Duflo and Pande (2007), dams deliver water to the downstream regions. However, with Bureau dams, there are some cases in which some of the water was delivered to the north through pumping and some to the South through gravity. For instance: Minidoka Project has North and South Side Divisions: 1) North Side Canal - The Gravity Division: This division has been operated by the Minidoka Irrigation District 2) South Side Canal - The South Side Pumping Division: This division has been operated by the Burley Irrigation District.

[16] The "Belle Fourche Project," one of the earliest irrigation projects developed by the Reclamation project, is a good example for understanding the development of irrigation during early twentieth century. The Online Appendix, part A (www.ebhsoc.org/journal, Volume 36) includes the Belle Fourche Project short history, and figures which illustrate the location of the Belle Fourche dam, main roads, canals, laterals, creeks, phone lines, railroad, and areas served with water, and how the canals and laterals were extended over time.

was an effect on agricultural activities. I also include county fixed effects to capture the time-invariant unobserved characteristics related to each county. Year-state fixed effects are included to control for the shocks that occurred in the states in each year. ε_{it} is the unobserved error component. The identification of the effect of the dams comes from changes over time when a dam is added within the same county after controlling for the factors listed above.

The market equilibrium of dam construction is not examined in the paper. There is likely a price effect associated with dam construction over time. If crop production increases as a result of dam construction, then the crop prices might fall across the census periods. My estimates are adjusted for state by year fixed effects, which might slightly take this issue into account.

Figure 4 and Figure 5 show the variation of farm value growth rates at the county level for the first and second time period, respectively. The geographical figures also illustrate dams constructed by the Bureau in each period. Figure 4 illustrates the percent change in the farm value per acre from 1900 to 1910. The value of farms per acre in the Central and Western US increased significantly during this period. The counties that received Bureau dams experienced increases in the value of the farmland per acre. Figure 5 shows the percent change in the farm value per acre during 1910 to 1920. Due to the effects of World War I and high inflation, the value of the land per acre did not increase in most of the US during this period.

Furthemore, Table 6 shows the list of the main crops that were cultivated after the dam construction, during the study's time period.[17]

Alfalfa was cultivated mainly in the regions close to the dam sites before the irrigation projects. After completion of the projects, due to the difficulty in growing any kinds of crops other than hay in the soil, most of the cultivation that took place was to grow feed for sheep and cattle. McCune (2001), in the Belle Fourche Project Bureau of Reclamation report, states:

[17] Figures in The Online Appendix, part B (www.ebhsoc.org/journal, Volume 36) illustrate two of the major crops after the Belle Fourche Project completion.

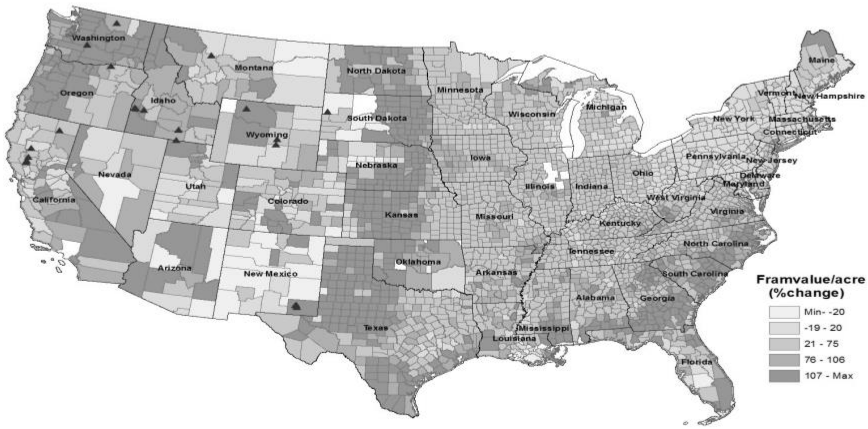


Figure 4

Percent Change in Farm Value per Acre (1900-1910)

Figure 5

Percent Change in Farm Value per Acre (1910-1920)

> "One of the first reports given on the project lands stated: Grains, hay, alfalfa, and perhaps small fruits will constitute the main crops. This was not much different than what had already been grown in the region for several years."

Alfalfa is a good source of nitrogen and minerals and holds moisture in the soil, which makes the soil a better medium for growing more valuable and water-intensive crops. Interestingly, after this time period, water-intensive crops such as sugar beets and cotton also became important crops. This was because of farmers' alfalfa cultivation and the slow demand for and excess supply of alfalfa.

Table 6

Major Crops After Dam Completion

State	Projects	Crops
SD	Belle Fourche	alfalfa, hay, grain, sugar beet
ID	Boise	cereal crops, forage, vegetable, seed crops, fruit
NM	Carlsbad	alfalfa, cotton, livestock, wheat, barley, oats, vegetable
OR	Klamath	forage, livestock, potato
MT	Milk River	alfalfa, hay, wheat, barley
ID	Minidoka	alfalfa, pasture lands, potato, sugar beets, livestock, dairy
NE	North Platte	alfalfa, beans, corn, potato, sugar beets, livestock
WA	Okanogan	apple, peach, pear, cherries, alfalfa, forage
CA	Orland	alfalfa, fruit, orange, nut, butter
NM/TX	Rio Grande	alfalfa, corn, wheat, cotton, fruit, vegetable
AZ	Salt River	alfalfa, cotton, dairy, cattle, corn, grain
WY	Shoshone	alfalfa, livestock, sugar beet
MT	Sun River	alfalfa, wheat, oats, barley, peas, pasture grass
NV	Truckee-Carson	alfalfa, hay, feed grains, wheat, potato, livestock
OR	Umatilla	alfalfa, hay, apple, pasture land, livestock
WA	Yakima	alfalfa, apple, pear, peach, potato, vegetable, forage

Endogeneity

To obtain an unbiased estimate when applying a fixed effects model, the unobserved error term must be uncorrelated with dam construction in each county. There are a few scenarios that could lead to the violation of this identification assumption. Construction of a dam required the building of roads and railroads as most of the dam sites were in remote areas.[18] This effect will be captured by the dam coefficient since the prerequisite constructions were part of the projects and, therefore, I consider these changes to be part of the treatment effect. It is possible that dams were located in counties with high potential for agricultural activity, therefore, not controlling for climate conditions leads to an overestimation of the coefficient of interest. Including more controls, such as climate variables, helps to reduce the endogeneity problem.

Educated and up-to-date farmers likely had access to newer and superior technology. At the same time, they could better lobby to bring dams to their areas. Since farmers' education and knowledge have a positive effect on the agricultural outcome and are positively associated with having a dam constructed nearby, the coefficient of interest would be biased upwards. In order to address this issue I can control for general county education. Since these were rural areas, I find it is unlikely that farmers' education differed much from the general measure of education.

Some farms had access to groundwater to irrigate their lands. It is likely that dams were constructed to irrigate the areas in which construction of wells and access to groundwater were not possible. Thus, not having access to ground water is positively correlated with dam construction, while it is negatively correlated with the productivity of the land. This leads to an underestimate of the coefficient of interest. There is no solid evidence of any new developments in groundwater pumping technology between 1900 and 1920 (Richard Hornbeck and Pinar Keskin 2012). Therefore, the groundwater variable is time-invariant and can be captured by the county fixed effect.

Furthermore, some might think that federal spending on other industries in a county might have attracted other industrial construction besides dams. However, the federal government was not spending much in the West at this time on anything other than dam projects. So it is unlikely that such factors would bias my estimates.

[18] Such as Coulee Railroad between Coulee City and Coulee Dam in Washington, and road construction along Buffalo Bill Reservoir near Cody, Wyoming.

To ensure that there were no other factors were contributing to endogeneity, I assess whether there were differential pre-trends in economic activities in Bureau counties versus non-Bureau counties before federal construction. The pre-trend test in a standard difference-in-difference procedure was applied for some of the important variables, such as population, population density, farm value, and farm value per acre, for the 1890-1900 period. Table 7 shows the result of these comparisons: there are no statistically significant differences between the mean changes in the population, farm value per acre, and total farm value variables in non-Bureau and Bureau counties. There is a statistically significant difference between the mean growth trends of population density in Bureau and non-Bureau counties, but the mean growth trend is higher in non-Bureau counties. This would bias my coefficients towards finding no positive effect of Bureau dams.

Table 7

Pre Trend Test - 1890-1900

	Bureau counties		non-Bureau counties			
	Mean	SE	Mean	SE	Difference	t-test
Growth trend (change)						
Population density	.5933242	.3931483	3.609915	1.168711	-3.016591**	2.446
Population	2036.63	687.0943	2448.817	187.8532	-412.1879	0.578
Farm value per acre	-5.147041	1.337172	-3.656948	.466467	-1.490094	1.052
Farm value	-288794.6	715602.7	522189.5	70920.24	-810984.1	1.127
Growth rate (% change)						
Population density	.6177756	.1767042	.6273785	.0774735	-.0096029	0.049
Population	.606753	.1771024	.6181378	.0770102	-.0113847	0.059
Farm value per acre	-.3225601	.0685111	-.186341	.0149981	-.1362191*	1.942
Farm value	.7791656	.2556491	1.444999	.1927996	-.6658336**	2.079

*** p<0.01 ** p<0.05 * p<0.1

When looking at the growth rates (average of the changes), the null hypothesis of identical trends cannot be rejected for population and population density. For farm value per acre and total farm value, there is a statistically significant difference between the means. However, the Bureau counties had a more negative farm value per acre growth rate compared to non-Bureau counties. Also, the total farm value growth rate in non-Bureau counties was higher in Bureau counties. Hence, I find no evidence that the Bureau constructed dams in the counties with more economic activities prior to dam construction.

IV strategy

As a way to further reduce endogeneity, I develop an instrumental variable approach. The study of the political economy of dam locations (Soudeh Mirghasemi 2013), shows that the locations of the dams were strongly associated with the states' average Republican vote share in presidential elections. The average of the percentage of votes for Republicans in the 1896 and 1900 presidential elections can be used as a measure of the relative political power of the Republicans, who held the Presidency and had a majority in both houses of Congress for 18 consecutive years (from 1896 till 1912). The instrument is constructed based on geographical and political factors. The geographical factor involves the potential places where the Bureau could construct a dam, while the political factor captures political strength. More specifically, the instrument is defined as follows:

$$Z_i = \begin{cases} 1\{\text{Dam1960}_i\} * \dfrac{(\%\text{Repub}_{1896s} + \%\text{Repub}_{1900s})}{2} & \text{if } t = 1910, 1920 \\ 0 & \text{if } \quad t = 1900 \end{cases}$$

The first part of the instrument is a geographical factor for places with potential to have a dam. Dam1960_i shows whether the Bureau constructed a dam in county i by 1960. The measure captures all of the locations where the Bureau might have expected to locate a dam, given the technology available through 1960.[19] The second part of instrument captures the political strength of the Republicans for the two presentational elections before the Act was passed. It is the average state Republican vote share in the presidential elections 1896 and 1900 presidential. Republican states were rewarded more when the President was Republican and

[19] The year 1960 is chosen since, after this decade, the number of federal dams constructed started decreasing. Changing the year still keeps the IV as a valid instrument and does not alter the results.

Congress was dominated by Republicans. The Z_i value is interacted with the years 1910 and 1920 as all the projects had been authorized in the first few years after the passage of the Reclamation Act.

The identification assumption is that the instrument is not correlated with the error term. This assumption makes sense, as the political component of the instrument is used for the period before the dam projects were authorized. The measure is based on voting information from periods of ten to 15 years before the impact of the dams. It is unlikely that there is serial correlation that stretches so many years back in time.

The following is the first-stage equation:

$$Dam_{it} = \beta_0 + \beta_1 X_{it} + \beta_2 Z_{it} + \delta_i + w_{st} + \varepsilon_{it} \qquad (2)$$

X is the vector of the economic and geographical characteristics from equation 1. Z is the instrumental variable. δ_i is the vector of county fixed effects to capture the time-invariant unobserved characteristics related to each county. w_{st} is the year-state interaction fixed effects to control for the shocks that happened within the states, and ε_{ist} is the unobserved error component.

Results

Table 8 displays the regression results for the log of the value of the farm per acre as an independent variable. The dam variable in the model is an indicator of whether the Bureau constructed a dam in county i during the decade before census year t.[20] The first column shows the baseline model controlling for county and time fixed effects. The dam coefficient is positive but not statistically significant. The coefficient indicates that for each newly constructed dam in a county, there is an increase in farmvalue by roughly six percent of the mean farmland value in the same county. Adding climate controls in the second column increases the size of the dam coefficient, but it remains statistically insignificant. Column 3 indicates the results of the estimation after adding

[20] I have reestimated the model if the dam variable is the number of new dams constructed in each county instead of a binary variable. The results are robust.

interactions between soil characteristics and climate variables to the model. The dam coefficient increases to 15 percent of the mean farmland value, and it becomes statistically significant at the 10-percent level. The change in the coefficient shows that both the dam location and the farmland values are influenced by the interaction between weather and soil, in ways that lead to negative omitted variable bias for coefficients in specifications (1) and (2). When the state year fixed effects are added to the model in the last column, the dam coefficient remains statistically significant and increases to 19 percent.

Table 8

Fixed Effect Results: Impact of a Newly Constructed Dam on the Natural Log of the Value of the Land per Acre 1900-1920

	(1)	(2)	(3)	(4)
Dam	0.059	0.081	0.155*	0.193*
	(0.104)	(0.107)	(0.092)	(0.105)
Time fixed effect	Yes	Yes	Yes	Yes
County fixed effect	Yes	Yes	Yes	Yes
Controls	No	Yes	Yes	Yes
Soil*climate	No	No	Yes	Yes
State*year fixed effect	No	No	No	Yes
*R*2	0.25	0.26	0.31	0.40
N	2610	2610	2610	2610

*** p<0.01 ** p<0.05 * p<0.1

Standard errors are in parentheses, clustered at county level

Controls: Extreme cold and hot events, and precipitation

The results of the IV estimation are shown in Table 9. The first column is the same as the fourth column of Table 8. The Kleibergen-Paap F statistic of 17.3 for the instrument in the first stage shows that the instrument is strong. Applying the IV in the second column makes the dam coefficient larger, but it is no longer statistically significant.

Table 10 shows the Fixed Effects and IV estimation results after adding the lag of the dam variable and non-Bureau dams separately to the model. The first and second columns display the same specification as the fourth column of Table 8, except that they control for the impact of the dam constructed in both the current period and previous period by including the Lag Bureau in the model. The fixed effect estimation results in column 1 show a statistically significant effect of Bureau dams on the farmland value; however, the lag of Bureau dams variable does not have a statistically positive effect on the lag of the value of the farm. The sign and magnitude of the dam coefficient are similar to those in the last column of Table 8. Applying the instrument in the second column increases the dam coefficient in size, but it is no longer statistically significant.

Table 9

Fixed Effect and Instrumental Variable Results, Impact of a Newly Constructed Dam on the Natural Log of the Value of the Land per Acre 1900-1920

	(FE)	(IV)
Dam	0.193*	0.818
	(0.105)	(0.632)
Controls	Yes	Yes
Time fixed effect	Yes	Yes
County fixed effect	Yes	Yes
State*year fixed effect	Yes	Yes
*R*2	0.40	0.39
N	2610	2609
Kleibergen-Paap F statistic:		17.319

*** p<0.01 ** p<0.05 * p<0.1

Standard errors are in parentheses, clustered at county level

Controls: Extreme cold and hot events, precipitation and soil-climate interactions

The third and fourth columns show the same specification as the fourth column of Table 8, except that they control for the impact of the dams constructed by other group, including other federal dams, state dams, and private dams. The third column shows the result of the Fixed Effect estimation, and the sign and magnitude of the Bureau dam coefficient are similar to those in the last column of Table 8. The new non-Bureau dams do not seem to have a significant impact on the value of the land. When I apply an instrument to control for endogeneity, the effect of Bureau dams on farmland value increases in magnitude, although larger standard errors mean that it is no longer statistically significant.

Table 10

Fixed Effect and Instrumental Variable Results, Impact of a Newly Constructed Dam on the Natural Log of the Value of the Land per Acre 1900-1920

	(lag Bureau) (FE)	(lag Bureau) (IV)	(non-Bureau) (EF)	(non-Bureau) (IV)
Dam	0.211**	0.554	0.189***	0.716
	(0.102)	(0.361)	(0.092)	(0.474)
Lag Dam	0.122	0.248		
	(0.145)	(0.211)		
Non-Bureau Dam			-0.097	-0.099
			(0.091)	(0.094)
Controls	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes
County fixed effect	Yes	Yes	Yes	Yes
State*year fixed effect	Yes	Yes	Yes	Yes
*R*2	0.40	0.39	0.40	0.39
N	2610	2609	2610	2609
Kleibergen-Paap F statistic:		19.730		19.545

*** p<0.01 ** p<0.05 * p<0.1

Standard errors are in parentheses, clustered at county level

Controls: Extreme cold and hot events, precipitation and soil-climate interactions

Lag Dam variable that equals one if Bureau constructed dam in county *i* in period *t*-1

Non-Bureau Dam variable that equals one if other agencies constructed dam in county *i* in period *t*

These results seem reasonable, as the Bureau projects were vast federal investments compared to the dam construction by other entities. The narrative shows that land speculation occurred in some cases and led to increases in the price of the land without it being developed. [21] However, the IV results here can not reject the hypothesis of zero effect.

[21] "Land speculation was practiced by several project settlers, who would buy, but not develop lands in anticipation of selling them for greater profit in the future. This led to even more instances of farmers going broke and selling out. Newell, in his report remarked that few newcomers can handle effectively even forty acres. If they obtain a larger area, they must struggle to pay taxes and water charges with the products of less than forty acres or with the scanty returns of lands ineffectively tilled." Belle Fourche Project, Historic Reclamation Projects.

This study estimates the effect of dam construction on the land values and agricultural output in the short run. However, looking at the Table 11 from the Census might provide some knowledge about the effectiveness of the bureau of reclamation projects. Table 10 shows the total acres irrigated and the capital invested, as well as Bureau's share for 1900, 1920, 1930, and 1940.[22] The Bureau had 18.6, 21.7, and 25.8 percent of capital investments, respectively, in 1920, 1930, and 1940. However, the acres irrigated by the Bureau of Reclamation were only 2.7, 6.5, 7.6, and 8.7 percent in 1910, 1920, 1930, and 1940, respectively.

Table 11
Area Irrigated, Capital Invested

Year	1910	1920	1930	1940
Total acre irrigated	14,433,285	19,191,716	19,547,544	21,003,739
Bureau share (%)	2.7	6.5	7.6	8.7
Total capital invested	-	697,657,328	1,062,049,201	1,052,049,201
Bureau share (%)	-	18.6	21.7	25.8

This explanation is not meant to convince the reader that the long-run analysis is not necessary. However, it provides some facts implying that the Bureau projects, even in the long run, might not have been that effective and beneficial.

To examine whether Bureau dam construction affected agricultural activities, I estimate models with the production per acre and the average number of acres of the important crops planted, the value of livestock and dairy, and the number of improved acres as outcome variables. The results of the estimation of the production per acre and the average number of acres of important crops planted are displayed in Tables 12 and 13. The fixed effect estimation of the dam coefficient in table 12 is positive and statistically significant only for the alfalfa crops. Constructing a Bureau dam in a county increases the alfalfa production per acre and the average number of acres of alfalfa, respectively, by roughly 6 and 1 percent.

[22] The census data for the capital invested is not available for the 1900 census year.

Using IV estimation in Table 13, the dam coefficient remains statistically significant only when the outcome variable is alfalfa production per acre. Alfalfa was a crop that was actively produced in Bureau counties before dam construction as seen in Table 1, and dam construction, led only to increases in the alfalfa production per acre in these counties. These findings are consistent with the narratives for some of the projects of this period. McCune (2001), in the Belle Fourche Project Bureau of Reclamation report, states:

> Beginning in 1915, farmers increasingly turned to stock operations, mostly sheep, to try to and turn a profit, as alfalfa became the primary crop of the project....One of the first reports given on the project lands stated that grain, hay, alfalfa, and perhaps small fruits will constitute the main crops, which was not much different than what had already been grown in the region for several years.

Table 12 indicates that Bureau dam construction did not have a statistically significant effect on other crops, such as cotton, sugar beets, and wheat. Estimation results applying the instrument in Table 13 show that Bureau dam construction did not have statistically significant effect on sugar beets and wheat. Even though the dam coefficient for cotton, the average number of acres planted, is statistically significant, not much cotton was planted in the Bureau counties. (Table 1)

Furthermore, the results of the Fixed Effect and IV estimations in Tables 14 and 15 for the value of livestock per acre, dairy value per acre, and the share of improved acres show that none of the estimations of the dam coefficients are statistically significant.

Table 12
Fixed Effect Results: Impact of a Newly Constructed Dam on Bushel per Acre and Acres Planted of Major crops 1900-1920

	Alfalfa		Cotton		Sugar beet		Wheat	
	bushel	acre	bushel	acre	bushel	acre	bushel	acre
Dam	0.057**	0.013**	-0.000	-0.001	-0.002	0.033	-0.229	-0.006
	(0.024)	(0.006)	(0.000)	(0.001)	(0.003)	(0.040)	(0.168)	(0.008)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State*year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
*R*2	0.24	0.33	0.20	0.34	0.16	0.16	0.47	0.49
N	2610	2610	2610	2610	2610	2610	2610	2610

*** p<0.01 ** p<0.05 * p<0.1

Standard errors are in parentheses, clustered at county level. Dependent variables are defined as "bushel per acre" and "total acre divided by farm land"

Controls: Extreme cold and hot events, precipitation and soil-climate interactions.

Table 13
Instrumental Variable Results, Impact of a Newly Constructed Dam on Bushel per Acre and Acres Planted of Major crops 1900-1920

	Alfalfa		Cotton		Sugar beet		Wheat	
	bushel	acre	bushel	acre	bushel	acre	bushel	acre
Dam	0.079**	0.000	0.000	-0.005*	0.051	0.111	-0.488	-0.003
	(0.038)	(0.021)	(0.001)	(0.003)	(0.063)	(0.087)	(0.369)	(0.021)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State*year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
*R*2	0.23	0.32	0.20	0.34	0.12	0.12	0.47	0.48
N	2609	2609	2609	2609	2609	2609	2609	2609

*** p<0.01 ** p<0.05 * p<0.1

Kleibergen-Paap F statistic: 19.548. Standard errors are in parentheses, clustered at county level

Dependent variables are defined as "bushel per acre" and "total acres divided by farmland"

Controls: Extreme cold and hot events, precipitation and soil-climate interactions

.

Table 14
Fixed Effect and Instrumental Variable Results, Impact of a Newly Constructed Dam on the Share of Acre Improved, Log of the Livestock per Acre, and Log of the Dairy value per Acre 1900-1920

	Acre improved	livestock	Dairy
Dam	0.021	0.079	0.134
	(0.020)	(0.092)	(0.153)
Controls	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes
County fixed effect	Yes	Yes	Yes
State*year fixed effect	Yes	Yes	Yes
N	2599	2599	2599
*R*2	0.37	0.56	0.27

*** p<0.01 ** p<0.05 * p<0.1

Standard errors are in parentheses, clustered at county level

Controls: Extreme cold and hot events, precipitation and soil-climate interactions

Table 15
Instrumental Variable Results, Impact of a Newly Constructed Dam on the Share of Acre Improved, Log of the Livestock per Acre, and Log of the Dairy value per Acre 1900-1920

	Acre improved	livestock	Dairy
Dam	-0.003	0.060	0.202
	(0.062)	(0.339)	(0.438)
Controls	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes
County fixed effect	Yes	Yes	Yes
State*year fixed effect	Yes	Yes	Yes
N	2597	2597	2597
*R*2	0.37	0.56	0.27

*** p<0.01 ** p<0.05 * p<0.1

Standard errors are in parentheses, clustered at county level

Controls: Extreme cold and hot events, precipitation and soil-climate interactions

Conclusion

Did the construction of the Bureau dams in the early 20th century cause the desert to flower and increase returns that could be earned from the land? In this paper, I develop a new county-level panel dataset from 1890 to 1920, including information on geography, climate, politics, and agriculture, and on the Bureau of Reclamation dams and other major dams. I use the data to evaluate the effect of the Bureau dams on the value of farms and crop productivity.

The results indicate that for each newly constructed dam in a county, there is an increase in the value of the farm by 19.3 percent of the mean farmland value in the same county (approximately 6.4 percent). When I apply an instrument to control for potential endogeneity, the effect of Bureau dams on farmland value increases in size; however, the estimates also become noisier and are no longer statistically significant. The estimation results indicate that the new dams constructed by agencies other than the Bureau and the already constructed dams by the Bureau did not have a statistically significant effect on the farmvalue. Furthermore, I estimate that the only crop affected by dams was alfalfa, which had been actively produced before.

In this study I focus specifically on the Bureau investments, as they represent a turning point in water investments that shifted the source of dam funding from the private sector to the federal government in the West. The Bureau was created after the passage of the Reclamation Act to take further action to enable the federal government to build larger projects due to the of lack of financing and engineering skills in the private sector. My results support the fact that dams had a positive, but limited, effect on the local economy.

The study shows that the Bureau dams increased the county farm values by at least six percent. A quick back-of-the-envelope calculation shows that the total Bureau spending for this time period, was approximately $130 million, while the immediate effect of Bureau dams increased farm values by only $13.9 million. Although this effect could have been two or three times larger based on some of the estimates in the paper, the direct impacts of bureau dams on farm values were significantly smaller than the Bureau's dam spending. Political pressures and inappropriate dam sites could be some of the reasons that the short-run direct effect of Bureau dams was not as expected. This explanation is not meant to convince the reader that the long-run analysis is not necessary.

Acknowledgements

I would like to thank Price Fishback for his guidance, as well as Ashley Langer, Derek Lemoine, and Jessamyn Schaller, Andrew Gahan, Dong-Woo Kang, Roberto Mazzoleni, Carl Kitchens, Taylor Jaworski, and many others for their helpful comments, suggestions, and support that have improved the article. I also wish to thank the Economic History Association, the University of Arizona's Department of Economics, and Hofstra University's Department of Economics for their grants and support. I received so many helpful comments from two anonymous referees and the editor Jason Taylor. All remaining errors are my own.

WORKS CITED

Aleseyed, Mostafa, Terance Rephann, and Andrew Isserman. 1998. "The Local Effects Of Large Dam Reservoirs: US Expenditure, 1975-1995." *Review of Urban and Regional Development Studies* 10(2): 91-108.

Borchers, Allison, Jennifer Ifft, and Todd Kuethe. 2014. "Linking the Price of Agricultural Land to Use Values and Amenities." *American Journal of Agricultural Economics* 96(5): 1307-1320.

Atack, Jeremy, and Robert A. Margo. 2011. "The Impact of Access to Rail Transportation on Agricultural Improvement: The American Midwest as a Test Case, 1850-1860." *Journal of Transport and Land Use* 4(2): 5-18.

Autobee, Robert. 1994. "Rio Grande Project". Bureau of Reclamation.

Burt, Oscar R. 1986. "Econometric Modeling of the Capitalization Formula for Farmland Prices." *American Journal of Agricultural. Economics* 68 (1): 10-26.

Barnard, Charles H. 2000. "Agriculture and the Rural Economy: Urbanization Affects a Large Share of Farmland." *Rural Conditions and Trends* 10 (2): 57-63.

Castle, Emery N. and Irving Hoch. 1982. "Farm Real Estate Price Components, 1920-78." *American Journal of Agricultural Economics* 64(1): 8-18.

Cech, Thomas V. 2010. *Principles of Water Resources: History, Development, Management, and Policy*. Hoboken, NJ: John Wiley & Sons.

Donaldson, Dave and Richard Hornbeck. 2016. “Railroads and American Economic Growth: A ’Market Access’ Approach.”. *The Quarterly Journal of Economics* 131(2), 799-858.

Duflo, Esther, and Rohini Pande. 2007. “Dams.” *The Quarterly Journal of Economics* 122 (2): 601-646.

Eckstein, Otto. 1958. *Water Resource Development-the Economics of Project Evaluation.* Cambridge, Mass. Harvard University Press.

Featherstone, Allen M., and Timothy G. Baker. 1987. “An Examination of Farm Sector Real Asset Dynamics: 1910-85.” *American Journal of Agricultural Economics* 69 (3): 532-546.

Fogel, Robert William. 1965. “Railroads and American Economic Growth: Essays in Econometric History.” *Business History Review* (pre-1986) 39, no. 000001 (1965): 130.

Hansen, Zeynep K., Gary D. Libecap, and Scott E. Lowe. 2009. “Climate variability and water infrastructure: historical experience in the Western United States.” No. w15558. National Bureau of Economic Research.

Holland, Paul W. 1986. "Statistics and causal inference." *Journal of the American Statistical Association* 81(396): 945-960.

Hornbeck, Richard, and Pinar Keskin. 2012. “Does agriculture generate local economic spillovers? short-run and long-run evidence from the ogallala aquifer.” No. w18416. National Bureau of Economic Research.

Howe, Charles W. 1968. “Water and regional growth in the United States 1950-1960.” *Southern Economic Journal* 34: 477.

Angrist, Joshua, and Guido Imbens. 1995. “Identification and estimation of local average treatment effects.” NBER Technical Working Paper No. 118.

Inter-University Consortium for Political and Social Research (ICPSR). United States Historical Election Returns, 1824-1968, ICPSR Dataset Number 0001.

Inter-University Consortium for Political and Social Research (ICPSR). Historical, Demographic, Economic, and Social Data: The United States, 1790-1970, ICPSR Dataset Number 0003, as corrected by Michael Haines, Department of Economics, Colgate University, Hamilton, NY.

Kitchens, Carl. 2014. "The Role of Publicly Provided Electricity in Economic Development: The Experience of the Tennessee Valley Authority, 1929–1955." *The Journal of Economic History* 74(02): 389–419.

Livanis, Grigorios, Charles B. Moss, Vincent E. Breneman, and Richard F. Nehring. 2006. "Urban Sprawl and Farmland Prices." *American Journal of Agricultural Economics* 88 (4): 915-929.

McCune, Christopher J. 2001. "Belle Fourche Project." Historic Reclamation Projects. Denver: Bureau of Reclamation.

Miller, E. Willard, and Ruby M. Miller. 1992. "Water quality and availability: a reference handbook." ABC-CLIO, page 100.

Mirghasemi, Soudeh. 2013. "Politics and Dam Construction: Historical Evidence from the Western US." Working paper. Univeristy of Arizona.

National Atlas of the United States, 200603, Major dams of the United States, Geographic NAD83, USGS (2006) [dams00x020_USGS_2006]: National Atlas of the United States, Reston, VA.

Newell, Frederick H. 1903. "First annual report of the Reclamation service from June 17 to December 1, 1902." Government Printing Office, Washington & London.

Plantinga, Andrew J. and Douglas J. Miller. 2001. "Agricultural Land Values and the Value of Rights to Future Land Development." *Land Economics* 77(1): 56-67.

Reisner, Marc. 1986. *Cadillac Desert: The American West and Its Disappearing Water*. New York: Viking.

Robinson, Michael C. 1979. *Water for the West, the Bureau of Reclamation 1902-1977*. Chicago: Public Works Historical Society.

Severnini, Edson. 2014. "The Power of Hydroelectric Dams: Agglomeration Spillovers." IZA Discussion Paper No. 8082.

Widtsoe, John A. 1928. *Success on Irrigation Projects*. New York: John Wiley and Sons, Inc.