Effects of Water Rights Quantification on Tribal Economies: Evidence from Western U.S. Reservations

by

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ABSTRACT

This paper looks at economic factors and water rights quantification on 95 Native American reservations economies in the western United States (U.S.). The study looks at the issues in two parts: (1) the characteristics of reservations quantifying their water rights compared to those who do not and (2) the effects of water rights quantification on reservation economic characteristics. Data was compiled from the U.S. Census Bureau, USDA, water specialists, court decrees, news articles, and scholarly papers. Results found that tribes who operate casinos and have higher revenues from agricultural goods are more likely to have quantified their water rights. Tribes with quantified water rights also had increased income levels. This study can help tribes design policies to create sustainable water management policies and economies on tribal reservations.

CHAPTER ONE

INTRODUCTION

Native American nations have entitlements to water resources and some tribes engage in off reservation water leasing in the western United States (U.S.). More than 50 tribes have secured over 10 million acre-feet per year (afy) of water through tribal water settlements or court decrees in the western U.S. (See Appendix Table C.3.). Native American water rights were formally recognized by the U.S. courts in 1908, when an irrigation project was being developed by the Fort Belknap Indian Reservation in Montana. During dry periods, the tribal project could not access water, so the U.S. government sued upstream water users on behalf of the tribe in *Winters v. United States* (Landry and Quin 2007; Mecham 2011). The Supreme Court recognized that tribes have the right to use and manage water on their reservations. While tribes have water rights, the quantification of those rights must be addressed through litigation and/or multi-party negotiations and Congressionally-approved water rights settlements.

Over the last 50 years, settlements have been the course selected by most tribes. A settlement is a negotiation between a tribe, the federal government, states, water districts, and water users in the area where the tribe is pursing quantification of their water rights. Settlements aim to resolve conflict between water right holders by allowing parties to specify terms of water allocation, provide water certainty, and avoid costly and lengthy litigation. Most settlements also explicitly allow tribes to lease their water rights off the reservation (Stern 2015).

After centuries of struggle, there is a great need for sustainable economic development and effective policies to decrease poverty and unemployment rates on

Native American reservations. The Navajo Nation, the largest reservation in the U.S., has an unemployment rate of 44 percent and a median family income of approximately $12,000 (Moore, Benally, Tuttle 2008). Some tribal members living on the Navajo reservation must wait for weekly water truck deliveries or drive to buy water and transport it home. It is important to note that tribal nations across the U.S. are diverse. Some reservations are large and some are small. Some rely on agriculture for jobs and incomes, while other rely on manufacturing and casinos. Some reservations have potable tap water, developed infrastructure, and low poverty rates and some do not.

While tribes are across the U.S. are diverse, overall a large disparity still exists on average between the national economy and tribal reservation economies. The 95 reservations in this study have much lower mean household income and education attainment rate than the U.S. (See Table 1). Tribal households have double the unemployment rate and make only three-fifth of the mean household income of the national U.S. population. Almost 25 percent of families on reservations live below the poverty level while only 11 percent of families off the reservation live below the poverty level. Therefore, reservations development is studied in this paper.

Table 1. Economic Indicators in the U.S. compared to 95 Reservations in this Study (2011 to 2015 Estimates)

Economic Indicators	**United States**	**95 Reservations**
Unemployment rate	8.3%	17.77%
Mean Household Income	$75,558	$49,921
Percentage of Families Below the Poverty Level	11.3%	24.88%
Percentage of People Who Attained a High School Education or Higher	87.1%	79.35%

Source: American Factfinder, Advanced Search, U.S. Census Bureau. 2017. Web. May 2017.

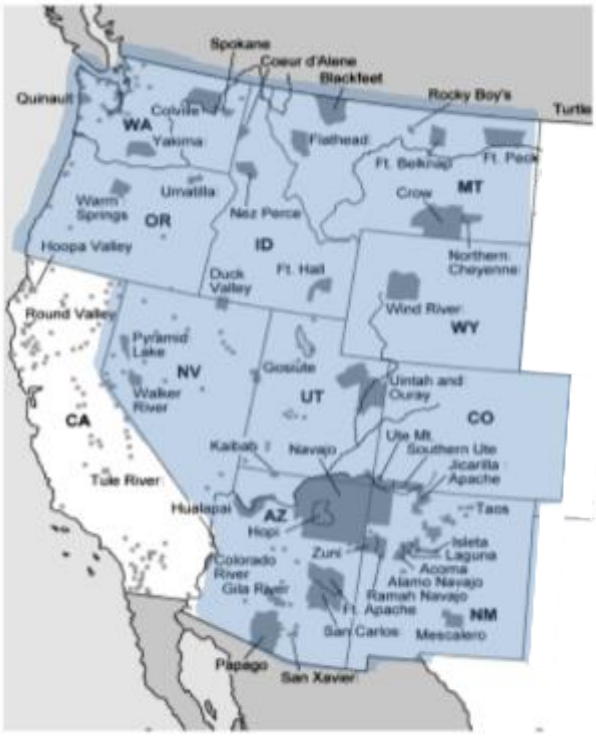
One method to promote economic development on reservations is by quantifying water rights and developing infrastructure to deliver water to homes, businesses, and farms on the reservation. Most Native American water settlements allow off-reservation tribal water leasing. Water leasing agreements must be approved by the Secretary of the Interior and states impose various conditions on tribal leases to protect state interests (Clay and Quinn 2007). Revenues earned from water quantification and leasing can offer major financial benefits for tribes (Bovee et al. 2016; Killoren 2012; Colby 2006; Clay and Quinn 2007; Cosens 2006).

Previous research has been vague on the economic effects of water quantification on reservations. And while litigation, settlements, and leasing may bring in large amounts of money, impacts of financial transactions are not well understood. There is a lack of data and quantitative analysis on water quantification to allow tribes to make effective policies.

This paper examines (1) the characteristics of reservations quantifying their water rights compared to those who do not and (2) the effects of water rights quantification on economic characteristics. This paper is based on data about reservations located in the western U.S., to better understand the effect of water rights quantification. Data was collected from the U.S. Census Bureau, U.S. Department of Agriculture (USDA), water specialists, court decrees, news articles, and scholarly papers. Data was gathered about 95 tribal reservations (Table C.3., column 1, for a list of the reservations in this study) located in ten states from 2010 and 2015 in the western U.S. (see Figure 1 below). This data set provides an opportunity to look more comprehensively at economic patterns related to tribal water rights in the western U.S.

Figure 1. Ten States Observed in the Western U.S. With Tribal Reservations
(Note: Only larger reservations names are included in the graph but this study looks at 95 reservations in the states highlighted in blue)

1	Arizona (AZ)
2	Colorado (CO)
3	Idaho (ID)
4	Montana (MT)
5	Nevada (NV)
6	New Mexico (NM)
7	Oregon (OR)
8	Utah (UT)
9	Washington (WA)
10	Wyoming (WY)



Source: U.S. Federal and State Indian Reservations. Digital image. Infoplease. N.p., n.d. Web. 2 May 2017. <https://www.infoplease.com/us/race-population/us-federal-and-state-indian-reservations>.

Econometric models were developed to examine the characteristics of reservations quantifying their water compared to those who have not. *Water Rights* (whether a tribe has quantified water rights or not) and *Casino* (whether a tribe operates at least one casino or not) were used as dependent variables in the models. Both dependent variables are dichotomous so probit functions were utilized to model the binary outcomes. The effects of water rights quantification on reservation income and unemployment were modeled through Ordinary Least Squares (OLS). Separate models looked at data from all the reservations and data from just the 32 reservation in 2010 and 34 reservations in 2015 who responded to USDA's Agricultural Survey.

The results of the paper indicate that tribes which operate a casino and have higher revenues from agricultural goods are more likely to have quantified their water rights, and that tribes who have quantified their water rights are more likely to operate a casino and have higher revenues from agricultural goods (see Tables 9 and 10). The direction of causality is not well understood. While water rights quantification is highly correlated to a tribe operating a casino, statistical analysis does not indicate that water quantification directly affects income or unemployment levels on the reservation (see Tables 11 and 12).

This paper aims to contribute to better understanding the effects of water quantification on tribal economies so tribal officials create successful water policies or improve current water policies on the reservation. Results can help tribes design policies to create sustainable economies on tribal reservations. As the original inhabitants of the Americas, they are entitled to govern their resources, to lease water, develop water infrastructure, practice their traditions, and address the increased pressure of climate change on their resources. Reservations are a home base for Native Americans and reservation economies require water to flourish.

The rest of the paper is as follows. Chapter Two discusses existing research on the topic. Chapter Three identifies the data sources, definitions, and how different variables were created. Chapter Four provides the model and Chapter Five presents the regression results. Chapter Six is the concluding section. The main chapters of the thesis are succinct, and are organized to be used in creating a draft journal article. Additional details are provided in the Appendices.

There are six appendices. Appendix A lists the seminars and conferences I have attended to gain a better understanding of the topic and presentations I have given. Appendix B provides additional details on this tribal infrastructure and economic enterprises. Appendix C gives concise list reservations observed and data collected. Appendix D consists of the four models examined in this study and their corresponding results. Appendix E illustrates models attempted i.e. First-Difference Models. The models attempted provided insignificant results. These results could be due to limited data available on reservations at this time. In the future, it would be interesting to see what results these models could provide with more observations.

CHAPTER TWO

LITERATURE REVIEW

I. TRIBAL HISTORY AND ECONOMIES

Native Americans were the original inhabitants of the Americas. Since the late sixteenth century, European colonialism caused Native American tribes in the U.S. to either disintegrate, assimilate, or relocate to land representing only a fraction of the territory they used to control, known as reservations. While reservation land is quite limited compared to their pre-European land base, reservations allotted to tribes give a base from which to govern themselves.

Even after reservations were established, Native Americans continued to sacrifice large tracts of land for U.S. settlement. By 1930, approximately ninety million acres of tribal land holdings were lost through the Dawes Act of 1887 (also known as the General Allotment Act). The Dawes Act, Bureau of Indian Affairs' relocation programs, and other policies were intended to push Native Americans to leave reservations and assimilate into mainstream American society. Congress passed the Indian Reorganization Act in 1934 to end the negative impacts of allotment on Native Americans and restore surplus tribal land. The federal government was recognized as having a legal obligation to protect tribes in 1942 through *Seminole Nation v. U.S.* (Tsosie 2006; Crane-Murdoch 2016). The trust doctrine offers an important legal tool to protect tribal rights to natural resources. More recently, the Indian Civil Rights Act of 1968 and the Indian Education Assistance and Self-Determination Act of 1975 was passed to help tribes gain control over their own development goals and programs.

Over the several eras (Allotment Era, Reorganization Era, and Determination Era) of U.S. policies regarding tribal nations, countless issues have arisen due to tension regarding tribal management of their land and water resources (See Extended Literature Review for more details). In recent years, Native Americans increasingly control resource development on their land. Mining resources and energy development use large amounts of water. Therefore, it is important for tribes to exercise decision making power in identifying how water fits into their tribal goals, and how to best manage it (Grogan 2011). There is a lack of formal tribal nations representation in federal government, an imbalance of political power, and the federal government is often conflicted by its own interests versus tribal interests (Tsosie 2006). Tribes are dependent on the federal government, and economic development on reservations depends on the two maintaining a healthy relationship.

Today, there are 312 federally recognized tribes across the U.S. with reservations primarily located in isolated areas with high poverty rates, low employment rates, little access to technology, and lack of infrastructure (Bissell 2004). Many Native Americans move away from their reservation to gain employment. One method to promote economic development on reservations is by quantifying water rights and developing infrastructure to deliver water to homes, businesses, and farms on the reservation.

Water is needed for many different uses in numerous sectors on reservations. Casinos, government offices, businesses, schools, households, and farms require water for daily activities. Electricity generation and irrigated agriculture require some of the largest uses of water on reservations in the western U.S. Some water related economic

problems on reservations include lack of water supply, lack of water where needed, and water quality limitations.

Water resources that tribes used for centuries have been diverted by dams and upstream users, dried up by climate change, polluted, flooded, or overused. Some tribes who have had their water rights quantified lack the ability to use the water because it is too polluted or they lack infrastructure. For example, some areas of the Navajo Nation, continue to haul water for cooking, drinking, school, and other daily activities even though some of its water entitlements in New Mexico have been quantified.

Many tribes with quantified water rights still lack modern infrastructure to transport water to where it is needed most. For instance, farmers may not be able to expand their farms on the reservation because there are no pipelines to bring additional water to their land. It may not be feasible for a tribe to build water transportation and infrastructure because of the high costs. In some cases, water users off the reservation may seek to lease a tribe's excess water during a drought but cannot because the tribe is not allowed to transfer water. This prevents water from being used where it generates higher economic value and creates frustration for all parties involved.

However, there are some successful tribal water leasing programs. For example, Northern Cheyenne Tribe in Montana is not able to use its water on the reservation without a pipeline so it has started a leasing effort. The Tribe has developed a dry-year water leasing program that allows irrigators along the Tongue River to bid as much as 10,000 afy. The program has been successful with 15 to 25 farmers participating in the program each year (Landry 2007).

Many reservations in the western U.S. face some degree of water pollution from mining (Furlow 2014; Barton 2014). It is expensive to develop safe drinking supplies, so reservation households with water quality limitations must boil water or buy bottled water off the reservation to meet their needs. For example, Navajo Nation locations have water of low quality and contamination from uranium mining, coal mining, and coal-fired power plants. Affected households have access to water by a weekly water delivery or they drive off reservation to haul water back to their homes. The Navajo Nation Council has been approved $180 million, the largest settlement granted in the U.S. to a tribe, to develop clean water accessibility. While this may seem like a significant amount of money, contrast it to the $100 million given to the town of Flint, Michigan which already has infrastructure in place and will be only performing infrastructure improvements (EPA 2017; Nacrosphere 2016). The approved funds for Navajo Nation were a fraction of the $554 million lawsuit against the government for mishandling tribal resources for over a hundred years. Those funds will be used to develop the tribal economy, community, and education system (Arizona Public Radio 2016). Note that this settlement related to management of funds is different from a water rights settlement.

Economic development needs reliable clean water. In only the last ten years, tribes in the western U.S. have spent millions of dollars and hours to get access to clean water and have developed infrastructure to transport it (Brammer 2015; Arizona Public Radio). If water problems were addressed, money and time being spent on water problems could be spent on developing the tribal economy. Tribes could develop renewable energy plants and create jobs in the industry. If tribes could have clean water delivered to their homes and offices, the time spent in hauling water could be used for

more productive purposes. Everyone could feel safe about the water they are consuming and children could spend more time focusing on learning their tribal language, mathematics, or music.

This section discusses tribal history and economies to illustrate how water rights quantification processes came about and why some reservations choose to quantify their water rights. Many reservations have a large gap compared to the mainstream U.S. economy. They face low-income levels, high unemployment rates, and high poverty rates. Water quantification can provide intrinsic value for some tribes through providing support for sovereign management of tribal water resources. In some cases, water rights quantification aids reservation economic development, supports continuity in cultural traditions, and provides resources to address effects of climate change on water resources.

Given a need for sustainable economic development and effective policies to decrease poverty on Native American reservations, this paper examines the effects of water quantification on tribal economies and uses income levels and unemployment rates as economic indicators. This paper also considers reservation location, since many tribal members leave their reservation to find jobs. The location of a reservation could indicate availability of jobs close by. Casino and agriculture are also considered important variables since these industries require water and a tribe may seek water quantification to pursue revenue from these business enterprises.

II. WATER APPROPRIATION HISTORY IN THE WESTERN U.S.

U.S. states have different water appropriation doctrines. The water governance systems apply to one of the two rights: (1) riparian water rights or (2) prior appropriate water rights (Water Law Overview 2017; Water Law 2017). The riparian governance

system appropriates water rights to those whose land is adjacent to a body of water such as a stream, lake or pond. A riparian owner may hunt, fish, irrigate, boat, and make use of their water in any reasonable way so long as it does not unduly interfere with neighboring owners' rights. Riparian rights also allow for private or public use of water. The states east of Texas use pure riparian or regulated riparian governance systems. These states were most influenced by English law and have the most available water (Water Law Overview 2017; Water Law 2017).

In the western U.S., the doctrine of prior appropriation of surface water was adopted where the first person to claim the water from a lake/stream/etc. has rights over its use. This system is based on the practices of miners during the mid-1800s Gold Rush settlement of the west. Prior to 1914, appropriative water rights were claimed by persons who first diverted and used water for any beneficial use. Since 1914, water rights must be acquired by an application to the respective state water resource departments (Water Law Overview 2017; Water Law 2017).

This paper will focus on the prior appropriation water rights system because the tribal nations studied are in the western U.S. Native American tribes' water rights were not appropriated at time their reservations were established. Their water rights were first recognized in 1908, when an irrigation project was being developed by the Fort Belknap Indian Reservation in Montana. During dry periods, the tribe could not access water so the U.S. government sued upstream water users on behalf of the tribe in *Winters v. U.S.* The Supreme Court ruled in favor of the tribe and federally protected reserved water rights. Tribes were granted tribal water rights based on their reservation's establishment date as the priority date. Their water rights cannot be forfeited for nonuse and cannot be

permanently transferred to another party. Therefore, under the doctrine of prior appropriation, tribes are entitled to senior water rights because they were the first to put water to beneficial use. Ground water may also be included in water rights for Native Americans through the *Winter v. U.S.* However, the case did not specify how to allot reserved water to tribes (Clay and Quinn 2007; Bark 2006).

The 1964 U.S. Supreme Court Case *Arizona v. California* developed the method to allot water based on practicably irrigable acreage (PIA). This method was endorsed by the court to determine the amount of water to allocate to tribal lands that can be feasibly and economically irrigated. *Arizona v. California* allocated about one million apy to five reservations i.e. Cocopah Tribe, Colorado River Indian Tribes, Fort Mojave Indian Tribe, Quechan Tribe of Fort Yuma, and Chemehuevi Indian Tribe. In the 1970s, other tribes began to file lawsuits and claim their water rights. However, under the PIA method, northern tribes and tribes located in mountainous areas may be allocated only small amounts of water due to unprofitable farming conditions. In 2001, the Arizona Supreme Court ruled that PIA is not an accurate standard to quantify water rights for tribal lands because it only looks at agricultural purposes for water. An Indian nation is not simply an agricultural plot of land but a homeland. To properly quantify water rights for a homeland, the specific "needs, wants, plans, cultural background, and geographic setting of the reservation" must be considered (Cosens 2006). In some cases, tribes and states settle disputes and decide on the appropriate quantification method (PIA, domestic use, mineral extraction, and fishing) but there is still a large reliance on PIA (Clay and Quinn 2007; Bark 2006; Cosens 2006).

This section discussed the need for a focus on western U.S. tribal reservations and agricultural tribal economies. This paper focuses on the prior appropriation water rights system because the tribal nations studied are in the western U.S. and tribal water rights were not appropriated at time their reservations were established. This section also provides background to the reader on negotiation and litigation processes used by tribes to quantify the water they are entitled to.

III. WATER SETTLEMENTS AND MARKETING BACKGROUND

Tribes have the right to use and manage water on their reservations through the 1908 *Winters v. U.S.* Supreme Court Case. However, they must quantify their water rights through costly and lengthy litigation or Congressionally-approved water settlements. Today, more than fifty tribes in the western U.S. have quantified their water rights and in the future, more are expected to negotiate water settlements. The Ak-Chin Indian Community of the Maricopa Indian Reservation, Confederated Tribes of the Colville Reservation, and the Spokane Tribe of the Spokane Reservation were some of the first tribes to quantify their water rights (See Table A.C.1).

In several settlement agreements, the federal government and other parties have provided funds for economic growth, community development, wildlife restoration, water acquisition, and water projects. Most settlements are not fully funded by the federal government and involve in-kind contributions from various parties, such as the tribe, states, cities, and other water users. In some cases, water may be transferred or exchanged with non-Indian water users to provide adequate water to satisfy a settlement's water budget. Every circumstance is unique. In the San Luis Rey settlement, the state, local, and tribal parties shared the cost to provide water, while in the Animas-La Plata Project

case the water users and the tribe shared the cost. The only two settlements fully funded by the federal government were the Ak-Chin Indian Water Rights Settlement and the Northern Ute Indian Settlement (Colby 2006).

Monetary payments are made to tribes when (1) compensating for damages, (2) the full amount of water cannot be allocated to the tribe in its location, or (3) tribes would prefer less water allocation in exchange for money to aid in the water infrastructure and economic development on the reservation. In the latter case, the tribe's monetary compensation should take the future value of water into account. Since tribes have fought hard for their water allocation, they are concerned with being compensated (Colby 2006).

After a tribe has quantified their water rights they can begin negotiating water leasing agreements. Water leasing by tribes does not transfer the title to water or land to non-tribal parties. Off-reservation water leasing has received some criticism such as: (1) water cannot be leased without land, (2) disrupt current water apportionments, (3) lower in-stream flows, (4) aid urban expansion, and (5) hinder tribal water rights. However, water leases are market driven and tribes can be paid to voluntarily not use their water (Nyberg 2014; Colby 2006).

All leases of water from tribes to other parties must be approved by the Secretary of Interior. Many settlements allow tribes to lease water to non-Indian parties, but each one has its own unique regulations. In Arizona, tribes lease water through the Central Arizona Project (CAP). Tribes are not allowed to permanently sell their water rights but can lease them for up to 100 years. Also, many tribes are not allowed to lease water to parties in another state. The Jicarilla Apache settlement and several other Arizona settlements ban interstate marketing, a provision that western states insisted upon. In a

few settlements, off-reservation leases are built in the agreement; For example, the Pima-Maricopa and Fort McDowell tribes agreed on 99-year leases to cities around the Phoenix area (Bovee 2016; Colby 2006; Nyberg 2014).

Currently, tribal water leasing is estimated to transfer 260,000 afy and receive $19 million annually. In the future, it is likely that tribal water marketing activity will increase when opportunities are present. As droughts become more persistent, short-term and intermittent water leases may be attractive for both Indian and non-Indian parties. This would allow tribes to maintain their rights to water and protect junior non-Indian users during a dry-period (Bovee 2016; Colby 2006).

For several decades, there has been an interest in tribal water quantification and tribal water leasing (Shupe 1990; Colby, Thorson and Britton 2005). And while water quantification and water leasing bring money into tribal economies, there is a lack of quantitative literature on the effects of the water quantification and water marketing on tribal economies.

In the past, it was easier for non-tribal farmers, businesses, and cities to divert unclaimed water from rivers or to pump groundwater that historically belongs to tribes because nearby tribes had not quantified their water rights. Today, many areas have fully appropriated surface water supplies and have placed limits on groundwater pumping. There is stress in western U.S. due to increasing populations and economic growth. Regional economies demand more non-agricultural water for industrial, urban, and environmental needs. Tribes which seek to use their water rights also raise demand for water. Today buying or leasing water has become an economical way to fulfill additional water needs. It can be more profitable for farmers, in some cases, to sell or lease their

water rights than to raise irrigated crops. These shifts have caused the level of water leasing activity to increase (Colby 2006).

Some leasing activity occurs in western U.S. in the Colorado River Basin, because the Colorado River Basin has a series of compacts and court decisions which have over allocated water. The Colorado River serves portions of seven western U.S. states, parts of Mexico, and Native American reservations. Economic issues involving competition for Colorado River water is putting stress on watersheds. Several areas are faced with critical water shortages and would like to discuss interstate allocations. They might also consider arrangements involving tribal water to meet demands. Tribes which have senior water rights of the Colorado River may be in a particularly advantageous position. Tribes could also lease water to aid water quality, reliability, and natural habitats (Colby, Bark-Hodgins and Chambers 2007; Nyberg 2014).

Today, more tribes are taking part in leasing their water rights. Several tribal water settlements in Arizona have made long-term leases to provide water to cities through CAP which brings Colorado River water hundreds of miles across the desert for use. There are several types of potential water marketing arrangements that can be used to transfer water from one party to another such as leases, dry year options, transfers of conserved water, water banking, and water investment portfolios. At least two parties take part in a water transfer, the water right holder such as a tribe and a new water user such as a city, developer or government agency. In a lease, a water right owner temporarily allows the usage of a specific amount of water over a set period to a water user. Under a dry year option, the water right holder maintains ownership of the water rights during the agreement (Culp et. al. 2015; Colby 2006).

While the quantification of water rights and water leasing offer tribes access to revenue, it is only one out of many options for generating economic activity on the reservation. Tourism, gaming, fishing, agricultural and mining are all methods by which tribes may generate income from (Fletcher 2004; Navajo Nation 2006; and Ezra Rosser 2005). For example, the Pyramid Lake Tribe generates significant income from its lake (Ritchy 2015). Tribes investigate a multitude of ways to develop their economy and decrease rates of poverty on the reservation. However, development is often hindered by off-reservation competitors, lack of funding from banks, tribal government fighting to prove tax-exemption for government projects, and lack of economic structure. Sometimes tribes hinder other tribes. In the past 10 years, several tribes are paying large amounts of money to stop other tribes from building competing casinos. "Since 2009, the Gila River Indian Community (GRIC) in Arizona has spent nearly $11 million on lobbying Congress to pass legislation that would prevent the Tohono O'odham Nation from opening a competing casino. A sister tribe, the Salt River Pima Maricopa Indian Community, also with casinos in the Phoenix area, has dropped a couple million dollars more on the fight (Sloan 2015)."

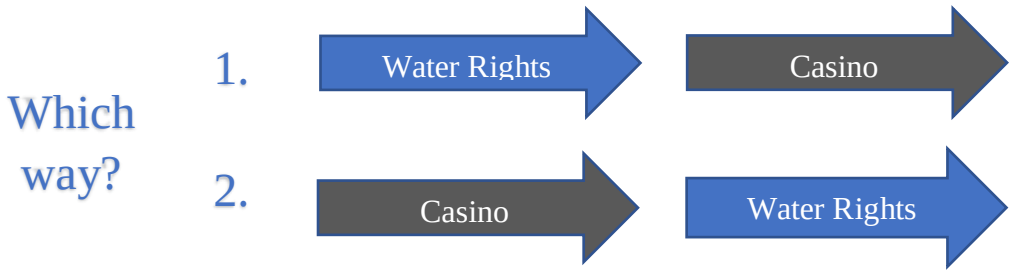
This section discussed water settlements and water leasing as potential methods to generate income for tribes. Water quantification may help tribes establish businesses to offer services to tribal members, and may assist with tribes in offering products and services to non-Indians; such as tourism and agricultural, and mineral products. Water settlements are a common method for tribes to quantify their water rights. Settlements can include providing money to tribes for infrastructure and business development. Settlement also can include explicit provisions for tribal water leasing off the reservation.

Water leasing provides an additional revenue source for tribes. See Table A.C.3 (in appendices) for the list of reservations participating in water leasing. The first tribe, the Fort McDowell Yavapai Nation Reservation, entered a 99-year lease with the City of Phoenix. It leases 4,300 apy of water to the city for $5.5 million. As another example, the Jicarilla Apache Nation entered a 1-year lease with the Sipapu Recreational Development to provide the business with a water supply for its ski area for $82 per acre-foot of water.

IV. THEORY OF CHANGE: CASINOS, WATER AND ECONOMIC DEVELOPMENT

As the previous sections illustrate, tribes have many avenues for economic development on reservations, including mining, gaming, and agriculture. The reservations studied as a part of this research exhibited several different patterns of economic development, with some quantifying their water rights and later beginning casino operations and others developing casinos first and later achieving water rights quantifications. These patterns are described in more detail in Chapter 3.

Figure 2. Which Way? Directionality between Water Rights and Casino



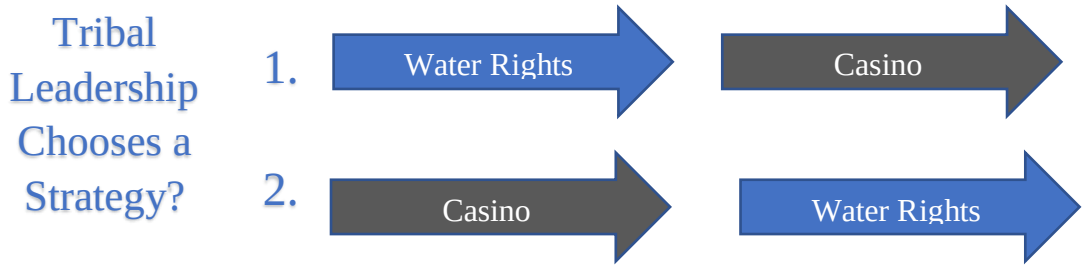
While there may be a relationship between water rights quantification and casino operation on reservations, the direction of causality is not well understood. There are several possible theories of change for the role of water rights quantification, casinos and reservation economic development. A tribe could begin by choosing to have a casino

resort and then choose to quantify its water rights, possibly because casino and resort water uses allow a tribe to justify a larger claim to water. Or, revenues from operating a casino may provide a tribe the funds needed to pursue water rights quantification. Or, a tribe may want to increase gaming development on the reservation decides to quantify its water rights so it has a secure water supply. On the other hand, a tribe could first have quantified its water rights and then choose to build a casino. Water quantification may secure a water supply so tribes can build larger casinos, a golf resort, or hotel that requires increased water consumption.

Tribal leadership on the reservation, along with legal and cultural factors, ultimately affects whether a tribe chooses to (1) quantify its water rights first and then develop gaming, (2) build a casino first and then pursue water right quantification, (3) quantify its water rights and develop gaming on the reservation concurrently, or (4) not participate in either gaming or water quantification.

Based on the literature, tribal leadership likely plays a strong role in a tribe's decision to quantify its water rights and/or develop gaming on the reservation and the order of events (Hart 2006; Munson 2007). Economic development initiatives that benefit a tribe would have a positive impact on the tribal council. Whatever avenue a tribe chooses to pursue, may depend on wealth, the leadership of the council, the structure of government, and the size or power of the tribal leadership. However, the data on role of tribal leadership across reservations is not available and unobservable in this study.

Figure 3. Tribal Leadership? Directionality between Water Rights and Casino



Effects water right quantification may have on the tribal nation be not be able to be easily numerically measured. For example, water quantification may have an intrinsic value for nation. Furthermore, water right quantification may not may impact the tribe immediately. It may take 10 or 20 years after a tribe quantifies its water rights to put the water rights to use.

This section discussed the theory of change to identify possible linkages between casinos and water rights quantification in reservation economic development. It is uncertain why some tribes choose to quantify their water rights first and then operate a casino and why others choose to operate a casino and then quantify their water rights first. Quantified water rights may help tribes to establish casino and resort operations, a casino may strengthen tribal water claims, and tribal leadership may play a role in which comes first. Furthermore, there may be no relationship between casino and water rights. Theories of change become relevant in later chapters when examining models and results.

CHAPTER THREE

DATA

I. OVERVIEW OF STATES AND VARIABLES SELECTED FOR STUDY

Twelve states in the western U.S. allocate water under the doctrine of prior appropriation (Alaska, Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming). California and Alaska are not included in this study because tribal reservations in these two states have different reservation landscapes and histories compared to many reservations located in other western states. California has over 100 federally recognized tribes, with small plots of land that generally do not have agriculture. Alaska has both large and small reservations, but they share a different history than mainland tribes in terms of colonialism and establishment, and they depend on coastal resources such as fishing.

Water rights are typically quantified by tribes who have agriculturally dominant economies. Water quantification allows agriculturally dependent tribes to irrigate their fields in the dry western climates. Tribes with fishing dominant economies have a different development emphasis. Coastal reservations in Oregon and Washington typically have fishing dominant economies and these reservations were excluded from this study, so the effects of water rights quantification and leasing on agriculture dominant tribal economies could be observed. Ninety-five reservations fit the criteria for inclusion in the western U.S. This study examines 95 tribes located in the following ten states: Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.

Table 2. Variable Names, Definitions, and Sources for 95 Tribes* studied in 2010 and 2015 (or a total 190 observations)

Variable Name	N	Definition	Source
Casino	190	If a tribe operates at least one casino (Casino=1) or if not (Casino=0)	National Indian Gaming Commission
Water Rights	190	If a tribe has quantified its water rights (Water Rights=1) or if not (Water Rights=0)	Various Sources
Location	190	If a reservation's address or it's tribal headquarters' address is located less than 51 miles of driving distance from a major city (Location=1) or if not (Location=0). A major city is defined as one of the top three most populous cities in one of the western states selected for this study or one of the top ten most populous cities with at least 100,000 residents.	Address: Tribal website or Google Population of cities in each state: Demographics by Cubit Driving distance to major city (miles): Google Maps
Unemployment	174	The percentage of the population 16 years and over who are actively seeking a job.	Census Bureau
Income	180	The mean family income in inflation-adjusted dollars for the year examined.	Census Bureau
Education	186	The percentage of the population who are high school graduates or higher	Census Bureau
Value of Agricultural Products Sold	66	The gross market value of all agricultural products sold before taxes or production expenses in $1000. It is the total number of sales regardless of who received he payment i.e. partners, landlords, contractors, etc.	United States Department of Agriculture, Census of Agriculture
Year	190	If data was observed in 2010 (Year=0) or if data was observed in 2015 (Year=1)	-

The name and location of tribes was established through National Conference of State Legislatures, the Census Bureau, and the Bureau of Indian Affairs.

Data was collected for seven variables across the 95 tribes: (1) *Casino,* (2) *Water Rights,* (3) *Location,* (4) *Unemployment,* (5) *Income,* (6) *Education,* (7) *Value of Agricultural Products Sold*. Most of the data was accumulated from the National Gaming Commission, U.S. Census Bureau, and the USDA Census. Refer to the Table 2, to see the where each variables data was gathered from and their definitions. The next four sections will discuss the data in greater detail. Section two, Agricultural Data, will discuss *Value of Agricultural Products Sold.* Section three, Economic Variables, will discuss *Casino, Location, Unemployment, Income,* and *Education*. Lastly, section four, will discuss *Water Rights*. A robust analysis of the continuous variables is provided in Table A.C.4. where the five smallest and five largest variables are listed.

II. AGRICULTURAL DATA

The USDA, National Agricultural Statistics Service performed an agriculture census in 2007 and 2012 at the reservation level. The year 2007 was the first-time USDA performed a census at the reservation level. The USDA made a concerted effort to get individual reports from every Native American reservation in the country. If this was not possible on some reservations, a report was obtained from knowledgeable tribal officials (2012 Census of Agriculture - History 2017; 2007 Census of Agriculture - History 2011). Less than 80 out of 312 federal tribes responded to the USDA survey. Only 32 tribes of the 95 tribes in this study responded to the survey in 2007 and only 34 tribes of the 95 tribes in this study responded to the survey in 2012 (See Table A.C.1).

I assembled data from the USDA on the market value of agricultural products sold. It is the total number of sales or gross market value of all agricultural products sold

before taxes or production expenses. On average, a reservation receives about 50.5 million dollars a year from its agricultural products between 2007 and 2012 (see Table 3).

Table 3. Agriculture Summary Statistics of the 95 Tribes in the Western U.S.

Variable	N	Mean	Standard Deviation	Minimum	Maximum
Value of Agricultural Products Sold	66	$50.5 mil	$88 mil	$22 mil	$571mil

III. ECONOMIC VARIABLES

Quantitative reservation-level data was gathered from the U.S. Census Bureau American Community Survey's (ACS) five-year estimates on a reservation level. The five-year estimates collected data over sixty months. These estimates provide the most reliable data available on a reservation level versus the ACS three-year or one-year estimates. The ACS began conducting survey data collection on tribal reservations in 2006, so the only time periods available with five-year estimates are 2010 and 2015.

The Census Bureau procedure means that data in 2010 was gathered during 2006 to 2010 and data in 2015 was gathered from 2011 to 2015. For simplicity purposes, I will refer to the first period as 2010 and the second period as 2015. On the other hand, the USDA collected its data in 2007 and 2012. The way this paper handles this is by placing USDA data collected in 2007 alongside data gathered from 2006 to 2010 from the Census Bureau and USDA data gathered in 2012 is placed with data gathered from 2011 to 2015 from the Census Bureau. The two periods (2010 and 2015) over 95 reservations provides a total of 190 unbalanced observations.

Income and unemployment are used as economic development indicators in this study. Income is the sum of all forms of earnings received per family in inflation adjusted

dollars for the year examined. So, the income gathered in 2010 was adjusted for inflation in 2010 and the income in 2015 was adjusted for inflation in 2015. While it would have been better to determine the real income of a reservation by measuring changes in the price level of a market basket of goods on each reservation that data was unavailable. The data collected from the Census Bureau reveals that on average a family on the reservations examined earned about $50,000 a year (refer to Table 4).

Unemployment data was also collected from the Census Bureau. It is the percent of individuals over the age of sixteen who are activity looking for a job divided by all individuals currently in the labor force. However, average unemployment levels on the reservations was over 17 percent of between 2010 and 2015. This is over three times the U.S. national unemployment level.

Table 4. Economic Variables Summary Statistics of the 95 Tribes in the Western U.S.

Variable	N	Mean	Standard Deviation	Minimum	Maximum
Location	190	42%	49%	0	1
Unemployment	174	18.90%	11.63%	2.50 %	82.40%
Income ($)	180	49,900	13,700	21,100	114,000
Education	186	79.35%	9.81%	44.40%	100%

Note: Location is the percentage of all tribes which are close to a major city.
Unemployment is the percent of people over the age of 16 who are actively seeking a job.
Income is the mean annual household income.
Education is the percentage of people who have attained a high school diploma or higher.

Education can help tribes become less dependent on the extraction of natural resources, increase average household income, and create a brighter future for the tribal people. It can be a key to improved prosperity (Hopi Education Endowment Fund 2007). Education level data was collected from the Census Bureau and is defined as the percent

of individuals with at least a high school diploma. About 79 percent of individuals on the 95 reservations examined had at least received a high school diploma.

In addition, Liechenko (2003), Partidge and Rickman (2007), and Rosser (2005) discuss the importance of the location of a reservation and how locational factors affect poverty rates. The location of a tribal reservations plays a role in their economic development. Isolation can hinder development and access to jobs. Location data was gathered for this study from Google Maps as an economic indicator. The *Location* variable took a value of one if a tribe was located less than 51 miles from a major city and if not it took a value of zero. A city was classified as a major city if it was one of the top ten largest cities in a state with a population of more than 100,000 people, or it was one of three largest cities in a state out of the ten western states observed in this study.

The cities' population size was sourced from Demographics by Cubit. Each tribal headquarters address or reservation address was mapped to each major city by Google Maps. If both the address for the tribal headquarters and the reservation address was unavailable, another major tribal department was selected and its address was used. The addresses were found either by Google Maps or from information provided on the tribe's website. The shortest driving distance was selected in miles. The same location data is used for both 2010 and 2015. Only 42 percent of the reservations included have their tribal headquarters located within 50 miles to a major city and 30 percent of tribal headquarters are located more than 100 miles away from a major city.

IV. WATER RIGHTS AND CASINO DATA

IV. A. Water Rights

Water rights data was gathered from a multitude of news articles, court decrees, settlements, tribal and federal documents, and scholarly papers. Various search engines were used to locate any sources regarding a tribe quantifying its water rights. If I could find a document stating a tribe had its water rights quantified, I stated it had quantified water rights. When no information could be found, I assumed the tribe did not quantify its water rights. Water rights data can be difficult to verify as there is not a centralized data base on this topic. However, settlements approved by Congress and litigation rulings are accompanied by public records and news coverage.

The water rights variable is binary. For the 2010 data set, a one was placed if the tribe had quantified its water rights in 2010 or any year prior to 2010. A zero was placed if a source provided the tribe had not quantified its water rights or no information was found. For the 2015 data set, a one was placed if the tribe had quantified its water rights in 2015 or any year prior to 2015. This data will provide the first comprehensive set of water rights in the western U.S. (See Table A.C.1 and A.C.2). About 49 percent of the reservations in this study quantified their water rights.

Reservations with quantified water rights have major economic differences compared to reservations without quantified water rights. In the first period of this study, 49 reservations had not quantified their water rights, while 46 had. By 2015, 47 reservations have quantified their water rights. On average, reservations with quantified water rights had more casinos than ones without quantified water rights across all reservations. This was also true for those 32 reservations in 2010, and 34 reservations in

2015, which responded to the USDA agricultural survey (See Table 5 and Table 6). This difference is statistically significant as indicated by the t-test on the difference in means. The t-value was calculated using the pooled method with equal variables. Both the pooled and Satterthwaite t-tests gave similar results. Inspection of the data also indicates that reservations with quantified water rights also tend to be located further away from major cities than their counterparts, although this result is not significant.

Table 5. Water Right Quantification - Difference in Means for All 95 Reservations

Variable	Unquantified Water Rights	Quantified Water Rights	Difference	t-value
Casino	42.27 %	76.34 %	-34.08 %	-5.06***
Location	42.27 %	40.86 %	1.41 %	0.20
Unemployment	18.59 %	16.96 %	1.63 %	0.92
Income ($)	48,654	51,160	- 2,505	-1.23
Education	79.56 %	79.13 %	0.43	0.30
USDA Survey Respondent	23.71%	46.24%	-22.53 %	-3.34***

Significant at a *10 percent, ** 5 percent, and *** 1 percent

Note: Casino is the percentage of tribes with a casino.
Location is the percentage of all tribes which are close to a major city.
Unemployment is the percent of people over the age of 16 who are actively seeking a job.
Income is the mean annual household income.
Education is the percentage of people who have attained a high school diploma or higher.
USDA Survey Respondent is the average number of reservations who choose to reply to the USDA Agricultural survey between those who have quantified or not quantified their water rights.

Table 6. Water Right Quantification - Difference in Means for All Only USDA Agricultural Survey Respondents

Variable	Unquantified Water Rights	Quantified Water Rights	Difference	t-value
Casino	56.52 %	88.37 %	-31.85 %	-3.11***
Location	34.78 %	37.21 %	2.43%	0.19
Unemployment	15.82 %	17.81 %	-2.00%	-0.95
Income ($)	49,955	48,223	1,732	0.69
Education	82.67 %	77.48 %	5.19	2.30**

Significant at a *10 percent, ** 5 percent, and *** 1 percent

Note: Casino is the percentage of tribes with a casino.
Location is the percentage of all tribes which are close to a major city.
Unemployment is the percent of people over the age of 16 who are actively seeking a job.
Income is the mean annual household income.
Education is the percentage of people who have attained a high school diploma or higher.

IV. B. Casino

Casinos also play a major role in economic welfare of tribes. Tribal gaming provides direct revenue, jobs, investment in other industries, infrastructure, and the revenue can help revitalize tribal traditions. For example, the Washoe Tribe has partnered with the Poarch Creek Indian (PCI) Gaming Authority to build a casino in Nevada along Highway 365 which runs close to the California border. It will be built next to the Washoe's convenience store, gas station, and Wa She Shu Travel Plaza. The $11.78 million Wa She Shu Travel Plaza is currently under construction and set to open March 2016. The Washoe-Parch Creek tribal casino will open shortly after. It anticipates hiring approximately 80 people to work at the casino and 20 people to work at the travel plaza. The Tribe hopes that its business ventures create more jobs and revenue to facilitate economic development on its reservation (Indian Country Today 2015). The casino facilities will also serve as a place for tribes to perform native dances, songs, and rituals. Consequently, casinos are an important variable to consider (Piner and Paradis 2004).

Data on casinos was collected from the National Indian Gaming Commission's Gaming Tribe Report. The casino variable was created with a one if a tribe had at least one casino, and a zero if not. To determine if the tribe had opened a casino after 2010, each tribe's ordinance date was examined. The Indian Gaming Regulatory Act requires each tribe to get its gaming ordinance approved by the Commission chair before opening a casino. No tribe had a gaming ordinance approval date after 2010, so the same casino data was used for both 2010 and 2015. Fifty-nine percent of all tribes in this study have at least one casino. When looking at the difference of means between tribes which operate at least one casino to tribe which do not, a tribe's water quantification status was consistently significant across all reservations and reservation who responded to the USDA agricultural survey (See Table 7 and Table 8).

Table 7. Casino Operation - Difference in Means for All 95 Reservations

Variable	No Casino Operation	Casino operation	Difference	t-value
Water Rights	28.21 %	63.39 %	-35.19 %	-5.06***
Location	33.33 %	47.32 %	-13.99 %	-1.93**
Unemployment	20.45 %	16.02%	4.43 %	2.46***
Income ($)	$47,010	$51,731	- $4,720	-2.28**
Education	79.06 %	79.53 %	-0.47 %	-0.32
USDA Survey Respondent	19.23%	45.54%	-26.30 %	-3.87***

Significant at a *10 percent, ** 5 percent, and *** 1 percent

Note: Casino is the percentage of tribes with a casino.
Location is the percentage of all tribes which are close to a major city.
Unemployment is the percent of people over the age of 16 who are actively seeking a job.
Income is the mean annual household income.
Education is the percentage of people who have attained a high school diploma or higher.
USDA Survey Respondent is the average number of reservations who choose to reply to the USDA Agricultural survey between those who have quantified or not quantified their water rights.

Table 8. Casino Operation - Difference in Means for All Only USDA Agricultural Survey Respondents

Variable	No Casino Operation	Casino operation	Difference	t-value
Water Rights	33.33 %	74.51%	-41.18 %	-3.11***
Location	20.00 %	41.18 %	-21.18 %	-1.50
Unemployment	19.47 %	16.43%	3.04 %	1.28
Income ($)	44,607	55,067	- 5,459	-1.97**
Education	80.23 %	79.01 %	1.21 %	0.45

Significant at a *10 percent, ** 5 percent, and *** 1 percent

Note: Casino is the percentage of tribes with a casino.
Location is the percentage of all tribes which are close to a major city.
Unemployment is the percent of people over the age of 16 who are actively seeking a job.
Income is the mean annual household income.
Education is the percentage of people who have attained a high school diploma or higher.

It would have been advantageous to include data which indicate the size of a tribal casino such as the number of slots a casino has, the number of employees, or the amount of water used by the casino. However, such data was not available.

IV. C. The Relationship Between Water Rights and Casinos

From the overview of the data, there seems to be a relationship between tribes which have quantified their water rights and tribes which operate a casino. The mechanism for what causes this relationship is not known.

The data illustrates that about half of the tribes in this study have quantified their water rights. The variable *Water* Rights indicates whether a tribe has quantified water rights through a formal litigation or settlement process, where the variable was given a value of 1 if the tribe had quantified its water rights and a value of 0 if not. Over half of the tribes also operate at least one casino. The variable Casino indicates whether a tribe operates at least one casino or not, where a value of 1 was given if a tribe operated at

least one casino and a value of 0 if not. *Water rights* and *Casino* may have some type of relationship (see Figure 4 and 5 below). If we compare the number of tribes which have quantified their water rights to those which have not, we see that tribes which have quantified their water rights have less casino operations than those which have not quantified their water rights. Then if we look at the number of tribes which operate at least one casino to those which do not, we observe the same phenomena.

Figure 4. Comparing Tribes Which Operate A Casino To Those Which Do Not

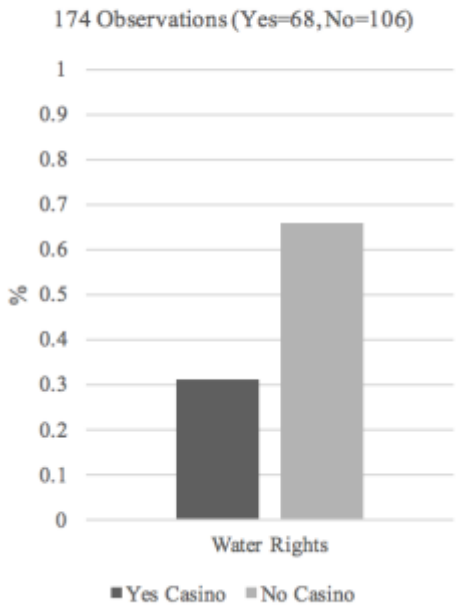
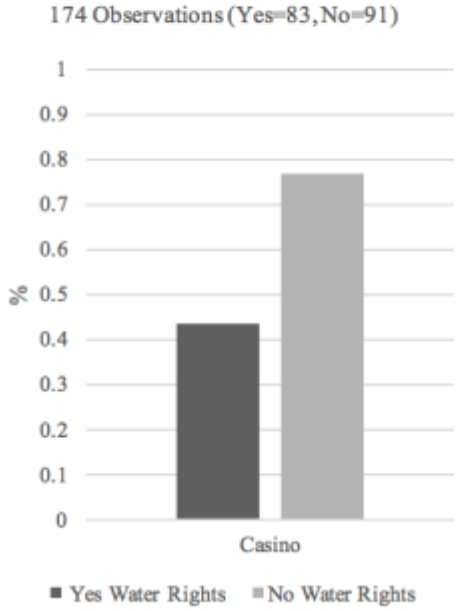


Figure 5. Comparing Tribes Which Have Quantified Their Water Rights To Those Which Have Not



However, if we only look at 34 reservations which responded to USDA's agricultural survey, the exact opposite phenomena are occurring (See Figure 6 and 7). If we look at the number of tribes who have quantified their water rights to those who have not, the tribes who have quantified their water rights have more casino operations than those who have not quantified their water rights. And if we look at the number of tribes who operate at least one casino to those who do not, the tribes who operate a casino have

a higher water quantification rates. These differences may occur because the tribes who responded to the USDA's Agricultural Survey may be different than the one who did not respond to the Survey.

Figure 6. Comparing Tribes Which Operate A Casino To Those Which Do Not

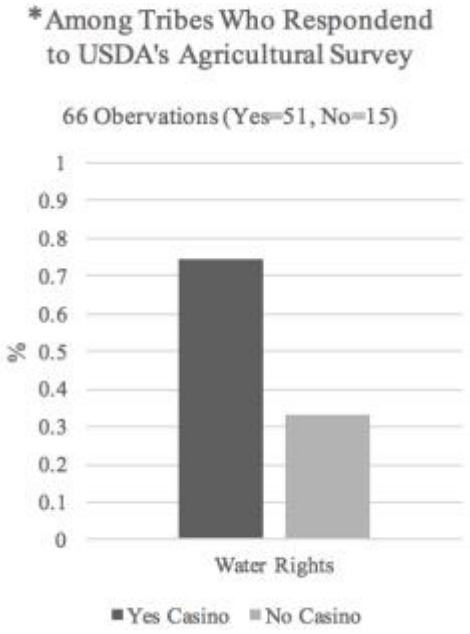
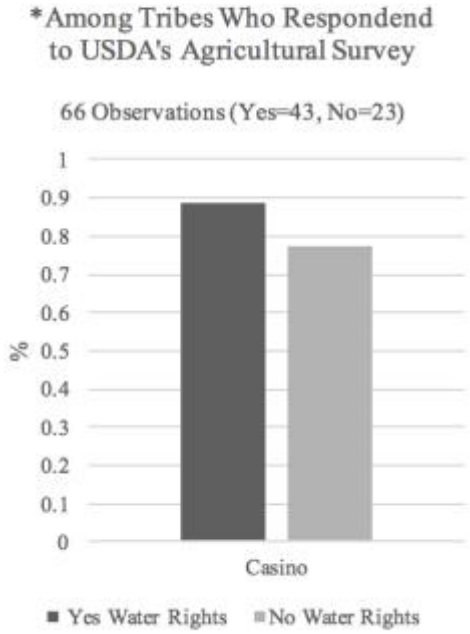
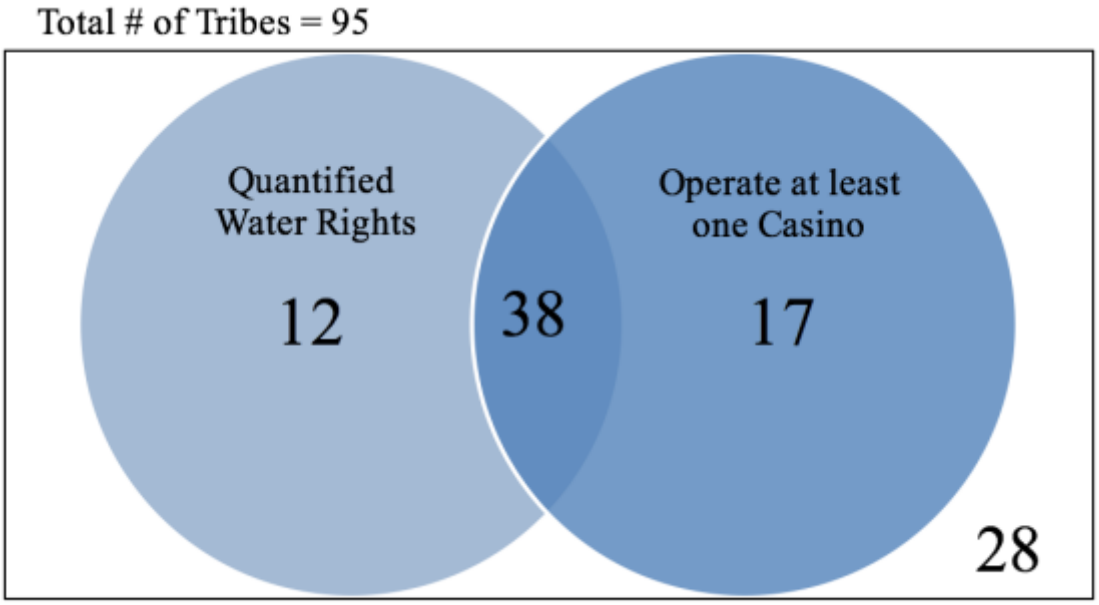


Figure 7. Comparing Tribes Which Have Quantified Their Water Rights To Those Which Have Not



Referring to Figure 8, 12 of the 95 tribes in this study have only quantified their water rights. Seventeen of the 95 tribes only operate at least one casino. Twenty-eight tribes do not have quantified water rights and do not operate a casino. Thirty-eight tribes have both quantified their water rights and operate at least one casino.

Figure 8. Venn Diagram of Tribes with Quantified Water Rights v. Casinos in 2015



Regarding the tribes who have both a casino and quantified water rights, 22 out of the 38 quantified their water rights first and then choose to operate a casino. Details on the timing effects can be examined in Table A.C.2. in the Appendix. Considering the 22 tribes who quantified their rights first and then choose to operate a casino, the tribes had their water rights for an average of 10 years before operating at least one casino. On the other hand, the 16 tribes which operated a casino first and then quantified their water rights, operated a casino for an average of 11 years before quantifying their water rights. Only one reservation, the Yavapai Prescott in Arizona, quantified their water rights and began to operate a casino in the same year, 1995.

CHAPTER FOUR

MODELS

I. COMPARING CHARACTERISTICS OF RESERVATIONS BASED ON QUANTIFYING WATER RIGHTS

Probit models were used to study the characteristics of reservations which have quantified their water rights, compared to those which have not. This study examines various statistical relationships between tribes operating a casino and quantifying water rights. Difference-in-difference models, first-difference models, and simultaneous systems would be more ideal than probit models in studying why some tribes choose to quantify their water rights and some do not. These other approaches were attempted, but were not suitable due to the limited data available in this study.

The probit models do not aim to define the possible causal relationships between tribes operating a casino and quantifying water rights. As mentioned previously, the direction of causality is not clear. It could be that a reservation had quantified water rights and then decided to operate a casino or that they wanted to operate a casino so they quantified their water rights or there is no causal relationship. I did report this timing issue in Table A.C.2. in the Appendix. I looked at if water rights came first for tribes in this study and then reported the (1) number of years a tribe had water rights before operating a casino and (2) the number of years a tribe had a casino before quantifying its water rights. As mentioned previously, casinos offer revenue and employment sources to tribes. They are also major water consumers due to daily business operations and because they often include a golf course as part of the casino resort.

Probit models were used to compare the characteristics of reservations because the dependent variables, *Water Rights* and *Casino*, are dichotomous. The probit function uses the quantile function associated with normal distribution. The method uses the inverse of the cumulative distribution function so the probability of a variable will be less than or equal to the given probability (between 0 and 1) (Studenmund and Cassidy 2011).

The probit model for water rights is specified below in Model 1. Variations of Model 1 were run to check for robustness. The results are reported in Table 9 and Table 10 in the Results section of this Thesis. As mentioned in the Data section, the *Water Rights* variable takes a value of 1 if the reservation has quantified its water rights or a value of 0 if not. *Casino* is also binary variable where a 1 was placed if a reservation had at least one casino and 0 if not. *Value of Agricultural Products Sold* is the market value of agricultural products sold. *Education* is the percent of persons on each reservation who have graduated from high school or pursued higher education. And *Income* is the average total earnings received per family in inflation adjusted dollars. If *Income* data was collected for households in 2010 the dollars were adjusted for inflation for 2010, as the base year. When income data was collected for households in 2015, the dollars were adjusted for inflation for 2015 as the base year. Since we are looking at two time periods in the model, the binary variable *Year* was used. If the time is 2010 the *Year* variable takes a value of 0 and if the time is 2015 it takes a value of 1.

Model 1: Water Rights = f(Casino, Education, Income, Year, ...)

Below Model 2 is also denoted, with *Casino* as the dependent variable, using the probit function. As mentioned in Model 1's discussion, *Casino, Water Rights,* and *Year*

are binary variables. Model 2 also uses the binary variable *Location*. The *Location* variable accounts for increased likely casino visitors for tribes located closer to major metropolitan areas. The variable takes a value of 1 if the reservation's address or tribal headquarters is located less than 51 miles from one of the three most populous cities in the state or one of the ten most populous cities in the state which have over 100,000 residents. If it does not fit any of the criteria the variable takes a value of 0. *Unemployment* is the percent of individuals over the age of sixteen who are activity looking for a job.

Model 2: Casino = f(Water Rights, Location, Unemployment, Year)

While the logit model could have been utilized to model binary outcomes, it is not able to account for non-constant error variances. Both logit and probit models were estimated and yielded similar results. Other estimators, such as OLS were not used because they may have predicted values out of the (0,1) range and the general assumptions are violated due to modeling binary outcomes with nonlinear functional forms i.e. heteroskedascity (Albright 2015; Studenmund and Cassidy 2011).

II. MODELING ECONOMIC EFFECTS OF WATER RIGHTS QUANTIFICATIONS

To examine the effects of water rights quantification on reservation income and unemployment levels, the Ordinary Lease Squares (OLS) method, sometimes referred to as linear least squares, was utilized. This method estimates the unknown parameters by minimizing the sum of squares of the observed responses in the data by the predicted responses from the linear functions set of explanatory variables, known as error terms.

This maximum likelihood estimator provides the minimum-variance mean-unbiased estimation given the error terms are normally distributed (Studenmund and Cassidy 2011). Since the dependent variables, income and unemployment, are non-dichotomous OLS can be used for econometric modeling. Other methods were attempted, such as first-difference method, but due to the limited data precise results could not be obtained (See Table C.19.).

The models for income (Model 3) and unemployment (Model 4) are given below. Variations of these models were run to check for robustness. The results are reported in Table 11 and 12 in the Results section and the heteroskedascity and multicollinearity results are reported in Table A.E.1 and Table A.E.2 in Appendix E.

Model 3: Income = f(Casino, Education, Year, ...)

Model 4: Unemployment = f(Casino, Education, Year,...)

Income is the average total earnings received per family in inflation adjusted dollars. While *Unemployment* is the percent of individuals over the age of sixteen who are activity looking for a job divided by all individuals currently in the labor force. We expect to see similar results for *Unemployment* and *Income*. They are both being used here are economic indicators for water rights. It is important to note that the *Water Rights* variable is not being used as an independent variable in these models. While *Water Rights* is expected to directly affect unemployment and income on reservations, it does not explicitly reveal a relationship between income or unemployment. Therefore, *Casino* and *Value of Agricultural Products Sold* are substituted in the model.

Like Model 1 and Model 2, we use *Value of Agricultural Products Sold*, *Education* and *Year*. *Value of Agricultural Products Sold* and *Education* are continuous variables where *Value of Agricultural Products Sold* is the market value of agricultural products sold and *Education* is the percent of persons on each reservation who have graduated from high school or pursued higher education. *Year* is a binary variable which takes a value of 0 for observations in period 2010 and 1 for the observations in period 2015.

CHAPTER FIVE

RESULTS

I. THE DIFFERENCES BETWEEN RESERVATIONS WHICH QUANTIFY THEIR WATER RIGHTS AND THOSE WHICH DO NOT

Probit models were applied to binary dependent variables (1) *Water Rights* and (2) *Casino* to study the characteristics of reservations quantifying their water rights compared to those which do not. Two variations of Model 1 were run. Model 1.A looked at the *Water Rights* as a function *of Casino, Education, Location, Casino*Location* (an interaction term between Casino and Location), and *Year*. Model 1.A's data set includes 90 tribes observed in 2010 and 90 tribes observed in 2015 for a total of 180 observations. While this study collected data for 95 reservations in the western U.S., several reservations had missing *Income* observations from the Census Bureau. Those reservations with missing observations were dropped. Model 1.B included the variable Value of Agricultural Products Sold. The second model was applied to only reservations which responded to the USDA Agricultural Survey, which translates to a total of 66 observations where 32 tribes were observed in 2010 to and 34 tribes were observed in 2015.

Model 1.A's results indicate a significant positive relationship between *Water Rights* and *Casino* (see Table 9) . The results suggest that if a tribe does have a casino, it is 33 percent more likely to have quantified its water rights (at a 99 percent confidence interval). All other variables in the model were insignificant. The predicted probabilities were calculated using the coefficients, where the cumulative distribution function of the standard normal was used. The probability of Water Rights taking the current level is 56 percent.

Table 9. Water Rights Probit Model 1 Results

Dependent Variable	**Water Rights**			
	Model 1.A		**Model 1.B**	
N	**180**		**66**	
	β coefficients	Marginal Effects (Water Rights =1)	**β** coefficients	Marginal Effects (Water Rights =1)
Intercept	-0.27		3.89*	
			(2.06)	
Casino	**0.92*** **	**0.33**	**0.62**	**0.16**
	(0.26)		**(0.54)**	
Value of Agricultural Products Sold			0.15**	0.04
			(0.07)	
Education	-0.01	-0.00	-0.05	0.01
			(0.03)	
Income	0.05	0.02	-0.17	0.05
	(0.07)		(0.24)	
Location	-0.15	-0.06	-0.18	0.05
	(0.34)		(0.91)	
Location*Casino	-0.02	-0.01	0.39	0.10
	(0.43)		(1.01)	
Year	-0.01	-0.00	0.39	0.08
	(0.20)		(0.38)	
McFadden's LRI	0.09		0.26	
McKelvey-Zavoina	0.17		0.71	
Log-Likelihood	-113.40		-31.64	

Significant at a *10 percent, ** 5 percent, and *** 1 percent
and standard errors in parentheses

Model 1.B, which included the *Value of Agricultural Products Sold*, shows no significant relationship between *Water Rights* and *Casinos* but it does show a significant positive relationship between the *Value of Agricultural Products Sold* and *Water Rights*. As a tribe sells an additional ten million in agricultural products, it is 4 percent more likely to have a casino. The probability of *Water Rights* taking the current level in this model is 67 percent.

Model 2 looks at *Casino* as a function of *Water Rights, Unemployment, Location* and *Year*. The data set includes 82 tribes observed in 2010 to and 92 tribes observed in 2015 for a total of 174 observations. While this study collected data for 95 reservations in the western U.S., several reservations had missing *Unemployment* observations from the Census Bureau and the missing observations were dropped in Model 2.

Model 2 reveals that when a tribe has quantified its water rights, it is 29 percent more likely to have a casino (See Table 10). Any direction of causality between the variables is uncertain, but this model reveals they are positively related to one another (at a 99 percent confidence interval). As a tribe's unemployment levels increases by 1 percent, it is 1 percent less likely to have a casino, at a 95 percent confidence interval. It is uncertain if a reservation's unemployment levels are higher because it does not have a casino or because it is not able to operate a casino. Location was also significant at a 5 percent level. If a reservation or its tribal headquarters address is located less than 51 miles from a major city, it is 2 percent more likely to have a casino than reservations locations further than 51 miles from a major city. The last variable in Model 2, *Year*, is insignificant.

The predicted probabilities of Model 2 are also calculated using its coefficients. The probability a tribe has a casino taking the current level is 60 percent.

Table 10. Casino Probit Model 2 Results (N=185)

Dependent Variable	**Casino**	
	β coefficients	Marginal Effects (Water Rights =1)
Intercept	-0.01 (0.23)	
Water Rights	**0.86***** **(0.20)**	**0.29**
Unemployment	-0.02** (0.01)	-0.01
Location	0.47** (0.20)	0.16
Year	0.06 (0.20)	0.02
McFadden's LRI	0.12	
McKelvey-Zavoina	0.24	
Log-Likelihood	-108.88	

Significant at a *10 percent, ** 5 percent, and *** 1 percent
and standard errors in parentheses

Model 1.A and Model 2 examine all the reservations for which complete data on Income or Unemployment was available, and not just the reservations which replied to the USDA Agricultural survey. In Model 1.A., *Casino* has a significant positive correlation with *Water Rights* and in Model 2, *Water Rights* has a significant correlation with *Casino*. As a result, *Casino* and *Water Rights* seem to have a significant positive relationship with one another, but it is uncertain which way the interaction occurs (Refer

to Section II. Literature Review - Theory of Change for more details). Due to lack of data, simultaneous models could not be successfully run.

In Model 1.B., with the smaller data set, *Casino* has no effect on *Water Rights*. It is uncertain what these results indicate. It may be that casino has no effect on whether a tribe quantifies its water rights or not, on the reservations who choose to reply to the USDA survey or the effects of casino on water rights quantification are not clear on this small sample. Refer to Table A.D.1, to see additional probit model results.

II. ECONOMIC EFFECTS OF WATER RIGHTS QUANTIFICATIONS

Economic effects of water rights quantification were examined through Model 3 and Model 4. *Income* at the reservation household level is the dependent variable of Model 3 and *Unemployment* is the dependent variable of Model 4. Four variations of independent variables were run on Model 3 and four variations were run on Model 4. The same variations of independent variables on Income in Model 3 were run on Model 4.

Model 3.A looks at *Income* as a function of *Casino, Education, Location, Location*Casino,* and *Year* (See Table 11). The data set for Model 3.A. includes 90 tribes observed in 2010 and 90 tribes observed in 2015 for a total of 180 observations. The results found that *Casino, Education,* and *Location* are significant. If a tribe has a casino its average annual household income increases by $6,200. If a tribe's average high school or higher attainment level increases by one percent, its income will increase by $500 a year. Lastly, if a tribe is located close to a major city its income will increase by $5,700.

Next, Model 3.B. includes the variable the Value of Agricultural Products Sold. So, the data set for Model 3.B. includes 66 observations, where 32 tribes were observed in 2010 and 34 tribes were observed in 2015. As mentioned in the preceding results, this

Table 11. Income OLS Model 3 Results

Dependent Variable	**Income** (**β** coefficients)			
	Model 3.A	**Model 3.B**	**Model 3.C**	**Model 3.D**
N	**180**	**66**	**180**	**66**
Intercept	0.97 (1.43)	-1.06 (0.97)	0.90 (1.50)	-0.85 (1.02)
Casino	**0.62** **(0.26)**	**0.56** **(0.35)**	**0.57*** **(0.30)**	**0.62*** **(0.34)**
Water Rights			**0.15** **(0.23)**	**-0.16** **(0.44)**
Value of Agricultural Products Sold		0.03*** (0.01)		0.03*** (0.01)
Education	0.05*** (0.02)	0.07*** (0.01)	0.05*** (0.02)	0.06*** (0.01)
Location	0.57** (0.27)	0.77** (0.33)	0.57** (0.27)	0.76** (0.32)
Location*Casino	-0.51 (0.37)	-0.66* (0.39)	-0.51 (0.37)	-0.65* (0.38)
Year	-0.07 (0.18)	0.10 (0.19)	-0.07 (0.18)	0.11 (0.18)
R-squared	0.14	0.43	0.14	0.44
Adjusted R-squared	0.12	0.37	0.11	0.37

Significant at a *10 percent, ** 5 percent, and *** 1 percent
and White's standard errors in parentheses

is because Model 3 includes *Value of Agricultural Products Sold* agricultural variable, which has limited data available. Also, in the econometric models, *Value of Agricultural Products Sold* is now in ten million dollar units, and *Income* is in ten thousand dollar units.

Model 3.B. indicates that the variables *Casino* and *Year* have no significant effect on Income. However, as a tribe increases its *Value of Agricultural Products Sold* by $10 million its annual household income on the reservation will increase by $300 (significant at a 1 percent level). If education level increases by one percent, *Income* will increase by $700 a year. Also, if a tribe is close to a major city its household income will increase by almost $7,700, but if a tribe is close to a major city and it has a casino its income will decrease by $6,600.

Next, Model 3.C. and 3.D. look at *Water Rights* effect on *Income*. Model 3.C. examines Income as a function of *Casino, Water Rights, Education, Location, Location*Casino,* and *Year*. *Water Rights* has no significant effect on *Income* on the reservations in this study. *Location*Casino* and *Year* are also insignificant in this model (See Table 11). However, if a tribe has a casino the income on a reservation will increase by $5,700 a year. If education level increase by one percent, income will increase by $500 a year. Also, if a reservation is close to a major city its average annual household income will increase by $5,700.

Lastly for Model 3, Model 3.D. includes the *Value of Agricultural Products Sold*. So, it examines Income as a function of *Casino, Water Rights, Value of Agricultural Products Sold, Education, Location, Location*Casino,* and *Year. Casino, Value of Agricultural Products Sold, Education, Location* and *Location*Casino* all have a

significant effect on Income. If a tribe has a casino, its income levels increase by $6,200. If the value of agricultural products sold increases by ten million dollars, income levels will increase by $300. Stipulate a tribe is located close to a major city its income levels will increase by $7,600. However, if a tribe is located close to a major city and it has a casino its income levels will decrease by $6,500.

Nevertheless, in Model 3.D. *Water Rights* again has no significant effect on *Income*. This is unexpected, especially since *Casino* has a significant positive relationship with three out of the four variations of Model 3. And Model 1.A and Model 2 results indicated that *Casino* and *Water Rights* have a significant positive relationship with one another. I also examined *Income* as a function of *Casino* only and it was significant at a 5 percent level. However, when I examined Income as a function of *Water Rights* only it was not significant. The statistical results indicate that casino has a significant positive effect on tribal income levels, and *Water Rights does not* .

Model 4 looks at *Unemployment* as the independent variable and, as mentioned earlier, four variations of dependent variables are run. Model 4.A. looks at *Unemployment* as a function of *Casino, Education, Location, Location*Casino,* and *Year* (See Table 12). The data set for Model 4.A. includes 90 tribes observed in 2010 and 90 tribes observed in 2015 for a total of 180 observations (same as Model 3.A.). The results found that *Casino, Education,* and *Year* are significant. If a tribe has a casino its average unemployment rate decreases 6.23 percent. If a tribe's average high school or higher attainment level increases by one percent, its unemployment level will decrease by less than half a percent. Lastly, unemployment increased by 5.55 percent from the first period (2006 to 2010) to the second period (2010 to 2015).

Table 12. Employment OLS Model 4 Results

Dependent Variable	**Unemployment** (**β** coefficients)			
	Model 4.A	**Model 4.B**	**Model 4.C**	**Model 4.D**
N	**185**	**66**	**185**	**66**
Intercept	49.04*** (9.21)	45.26*** (8.98)	49.20*** (9.43)	41.92*** (9.38)
Casino	**-6.23***** **(2.44)**	**-2.99** **(3.34)**	**-6.09***** **(2.38)**	**-3.87** **(3.41)**
Water Rights			**-0.41** **(1.55)**	**2.59** **(2.02)**
Value of Agricultural Products Sold		-0.27*** (0.08)		-0.29*** (0.07)
Education	-0.39*** (0.10)	-0.34*** (0.11)	-0.39*** (0.10)	-0.31*** (0.11)
Location	-1.84 (2.99)	-5.45 (3.32)	-1.86 (2.99)	-5.30 (3.73)
Location*Casino	5.14 (3.39)	6.17 (3.78)	5.14 (3.38)	6.00 (4.09)
Year	5.55*** (1.53)	5.10*** (1.82)	5.56*** (1.53)	4.89*** (1.85)
R-squared	0.17	0.24	0.18	0.25
Adjusted R-squared	0.15	0.16	0.15	0.16

Significant at a *10 percent, ** 5 percent, and *** 1 percent
and White's standard errors in parentheses

Model 4.B. adds the variable the *Value of Agricultural Products Sold*. Therefore, the data set consists of 66 observations. The *Value of Agricultural Products Sold, Education,* and *Year* are significant in this model. So if the *Value of Agricultural Products Sold* increases by $10 million, unemployment will decrease by about a quarter of a percent. If *Education* increases by one percent, then *Unemployment* will decrease by 0.34 percent. And the model indicates that *Unemployment* increased by 5.10 percent from the first period to second period.

Next Model 4.C. and Model 4.D add the variable *Water Rights* to the model. Model 4.C looks at all the reservations and consists of 185 observations. *Casino, Education,* and *Year* are significant and *Water Rights, Location,* and *Location*Casino* are insignificant in this model. Therefore, in Model 4.C., if a tribe has a casino, *Unemployment* decreases 6.09 percent; if *Educatio*n increases by 1 percent, *Unemployment* decreases by 0.39 percent; and *Unemployment* increases by 5.56 from period one to period 2.

Lastly, Model 4.D. looks at *Unemployment* as a function of *Casino, Water Rights,* the *Value of Agricultural Products Sold, Education, Location, Location*Casino,* and *Year*. Here only the *Value of Agricultural Products Sold, Education,* and *Year* are significant. *Water Rights* is again insignificant as well as *Casino, Location,* and *Location*Casino*. So, if the *Value of Agricultural Products Sold* on a reservation increases, *Unemployment* decreases by 0.29 percent. If *Education* increases by one percent, *Unemployment* decreases by 0.31 percent. Also, from period one to period two *Unemployment* increased by 4.89 percent.

Across Models 3 and 4, *Water Rights* is consistently insignificant and exhibits no statistically significant effect on economic characteristics on reservations in this study. In addition, *Year* was significantly related to *Unemployment* in all 4 variations of Model 4, but not with any variations of Model 3. *Location* had a significant relationship with Income in all variations of Model 3, but had no statistically significant relationship with *Unemployment*. These results could be due to the limited data at hand. Other attempted OLS models are summarized in Table A.D.2.

All eight variations of Model 3 and 4 were Best Linear Unbiased Estimator (BLUE) so OLS could be used to run the models and read the results with confidence. The models did have heteroskedascity, so White's standard errors were used to calculate significance. For some models, only White's test was significant for heteroskedascity, or only Breusch-Pagan results were significant. For other models, both White's test and Breusch-Pagan was significant for heteroskedascity. Heteroskedascity was checked by the White and Breusch-Pagan tests (See Table A.E.1. for Model 3 and Table A.E.2. for Model 4 for heteroskedascity and multicollinearity results). Multicollinearity was not prevalent in the models. Multicollinearity was checked through both collinearity tables and variation inflation factors (VIF). The variables of interest do not have high VIFs. High VIFs did exist for Location and Location*Casino. These are caused by the inclusion of interaction terms, with products of other variables and are not something to be concerned about.

First Difference models were of interest for this analysis but gave insignificant results (See Table A.D.3). Due to limited data, Difference-In-Difference and simultaneous equations models could not be successfully implemented.

CHAPTER SIX

DISCUSSION AND CONCLUSION

Tribes in the U.S. faced centuries of struggle due to European colonialism. As European settlement proceeded, Native Americans were relocated to reservations which represent only a fraction of territory they use to control. Reservations serve as a homeland and in 1908 the *Winters v. U.S.* formally recognized Native Americans have the right to use and manage water on their reservations. While tribes have water rights, the quantification of those rights must be addressed through litigation, multi-party negotiations, or congressionally approved water rights settlements. To date, research has been vague on the effects of water quantification on tribal economies. This study analyses (1) the characteristics of reservations quantifying their water rights compared to those who do not and (2) the effects of water rights quantification on reservation economic characteristics.

Most tribal reservations are in the Western U.S. and fall under the prior appropriation water rights system. Therefore, this study includes 95 reservations located in 10 states in the western U.S. (See Table A.C.1). Data was compiled from the U.S. Census Bureau, USDA, water specialists, court decrees, news articles, and scholarly papers. The information on reservations is limited. The U.S. Census Bureau and the USDA began to collect data on the reservation level in just the last ten years. While the data set assembled in this study provides an opportunity to look more comprehensively at tribal water rights in the western U.S., more data should be available in the future.

Probit models were used to analyze the characteristics of reservations quantifying their water compared to those who have not. Results found that tribes who operate

casinos and have higher revenues from agricultural goods are more likely to have quantified water rights. And if a tribe has quantified water rights they are more likely to operate a casino. The probit models illustrate that *Casino* and *Water Rights* are positively related with one another. However, the direction of causality is not clear. It uncertain whether water rights quantification encourages tribes to operate a casino or tribes which desire to operate casinos seek water rights quantification.

The effects of water rights quantification on reservation income and unemployment are modeled through OLS. Economic characteristics where regressed on water rights, but no significant relationships are found. However, Model 1 and Model 2 demonstrated that water rights quantification is highly related to with whether a tribe operates a casino (*Casino*) or has high agricultural revenues (*Value of Agricultural Products Sold*). So, the income and unemployment models used *Casino* and *Value of Agricultural Products Sold* as their primary variables of interest. The regression results denoted that tribes with casinos and higher agricultural revenue had increased income and lower unemployment levels. Results from this study can help tribes design water policies to create sustainable economies on tribal reservations.

Water rights quantification appears to have a positive effect on tribal economies, though the mechanisms are not clear. Due to limited data, the results do not draw a clear picture. Some important variables were not available, i.e. size of casinos, number of slots, water allocation, health rates, number of gas stations or supermarkets, etc. While two time periods were available, only one reservation from this study quantified water rights between 2010 and 2015. Location and casino data did not change during the periods. And because data is limited in this way, it is not possible to use models such as the First

Difference model to account for variables that could not be observed. In future work on this topic with this type of data, cluster analysis could be useful. In addition, an event history analysis of settlements could be useful. This type of analysis starts from a selected base year, and predicts in which year a given tribe finalizes a water quantification. Once a tribe has a quantification, it "drops out" of the sample. This operates like a logit regression across multiple years, and may clarify causality issues involving casinos, water right quantification and reservation economic development. Another type of analysis that could be useful for this type of data is Robust Analysis, in which econometric models are run with observations that contain extreme values in key variables removed from the sample in order to examine the effect of extreme values on econometric findings. Table A.C.4. in appendix provides examples of extreme values in some variables used in the models.

In the future, it will be helpful to create comprehensive data bases for tribal reservations. Relevant data such as size of casinos, water allocation and number and characteristics of businesses operating on the reservations are not accessible. Collecting, reporting and analyzing information regarding tribal water resource and economic development topics needs to be conducted in collaboration with tribes, recognizing tribal governments as sovereign managers of reservation natural resources.

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APPENDICES

APPENDIX A. SEMINARS AND CONFERENCES ATTENDED, PRESENTATIONS GIVEN

I. SEMINARS AND CONFERENCES ATTENDED

*Sorted by date attended

Water Resources Research Center (WRRC) Annual Conference, 28 March 2017, WRRC, The University of Arizona, Tucson, Arizona.

College of Agriculture and Life Sciences Research Poster Forum. 22 March 2017, The University of Arizona, Tucson, Arizona.

Indigenous Peoples Climate Justice Movements: A Conversation with Dr. Kyle White (Associate Professor at Michigan State University), 8 March 2017, The University of Arizona, Tucson, Arizona.

Fall Fest 2016, A Community Event Talk on Climate Chance as Experienced by Tribal Communities with Speaker Rebecca Tsosie (Regents' Professor of Law with the Indigenous Peoples Law and Policy (IPLP) Program), 20 September 2016, Institute of the Environment, University of Arizona, Tucson, Arizona.

Just Transitions: Energy, Water, and Local Economic Development on the Navajo Nation by Jihan Gearon (Executive Director of Black Mesa Water Coalition and Panel Discussion, 21 April 2016, Tucson, Arizona.

Liquid Assets: Investing for Impact in the Colorado Basin with Speakers Ricardo Bayon, Peter Culp, and Tom Melton, 23 October 2015, The Kinship Webinar Series.

Native Waters on Arid Lands Tribal Summit, Second Annual Meeting, 9-10 November 2016, Las Vegas, Nevada.

II. PRESENTATIONS AT SEMINARS AND CONFERENCES

*Sorted by date of presentation

Deol, Suhina, Isaaks, Rowan and Bonnie Colby. "Trading Money, Water and Risk: Innovative Arrangements Between Cities, Farms, Tribes and Environmental Interests." Water Resources Research Center (WRRC) Annual Conference. The University of Arizona, Tucson. 28 March 2017. Poster Presentation.

Deol, Suhina and Bonnie Colby. "Tribal Water, Poverty, and Regional Water Challenges." College of Agriculture and Life Sciences Research Poster Forum. The University of Arizona, Tucson. 22 Mar. 2017. Poster Presentation.

Deol, Suhina, Isaaks, Rowan and Bonnie Colby. "Trading Money, Water and Risk: Innovative Arrangements Between Cities, Farms, Tribes and Environmental Interests." College of Agriculture and Life Sciences Research Poster Forum. The University of Arizona, Tucson. 22 Mar. 2017. Poster Presentation.

Deol, Suhina. “Tribal Water and Development in Western U.S..” Glad Slam by the Graduate and Professional Student Council. The University of Arizona, Tucson, Arizona. 22 Mar. 2017. Speech.

Deol, Suhina and Bonnie Colby. "Tribal Water, Poverty, and Regional Water Challenges." Fall Fest 2016. The University of Arizona, Tucson. 20 September 2016. Poster Presentation.

APPENDIX B. EXTENDED LITERATURE REVIEW

I. METHODS FOR COLLECTING MATERIAL

Literature on tribal water appropriation history, water settlements, and economic enterprises was reviewed over two years, beginning with references from my research supervisor, Dr. Bonnie Colby. My thesis chairs Dr. Satheesh Aradhyula and Dr. Paul Wilson also provided guidance on scholarly papers, news articles, and econometrics readings. I attended several seminars, talks, and conferences to collect material and investigate additional information related to my research topic. Lastly, I used search engines, such as Google, the University of Arizona Libraries, ResearchGate, and miscellaneous news and economic journals sources.

II. THE ALLOTMENT, REORGANIZATION, AND DETERMINATION ERAS

The federal government created reservations for various tribal groups across the nation. The 1887 Dawes Act, the beginning of the Allotment era, divided reservations into sections and allocated those sections of land to Indian families. The Dawes Act was intended to encourage Indians to farm and to integrate into Anglo-American society. However, many times reservation land was dry and infertile which caused Indian families to rely on government rations for food and daily supplies. The Act also introduced fractionation or the original allottee (head of family) had to divide the land equally among his/her heirs once he/she passed away. The system of fractionation continued among the original allottee heirs' heirs and this causes a single parcel of land to be owned by hundreds or thousands of people (Crane-Murdoch 2016; Grogan 2011).

In 1934, Congress passed the Indian Reorganization Act, Reorganization era, which stopped assigning land allotments to Indian families because there was little left to

allot. Then surplus land was auctioned. The government sold 60 million acres of land to white homesteaders to encourage U.S. settlement in the West (Crane-Murdoch 2016). While considerable tribal land disappeared and several tribes were terminated, the Reorganization Act did authorize tribes to form their own tribal governments.

More recently, the Indian Civil Rights Act of 1968 was passed to remedy the negative effects of earlier Native American polices by helping tribes gain control over their own development goals and programs (Bissell 2004). Then in the early 1970s, Self-Determination era, the government gave some powers to the tribal governments through acts such as the Indian Education Assistance and Self-Determination Act of 1975. In 1983, the Indian Land Consolidation Act allowed tribes to exchange and buy interest from landowners at fair market value; nevertheless, the Indian Land Consolidation Act was poorly funded. Since many tribes are in chronic debt they were not able to purchase large amounts of land (Kendall, Spilde, Taylor 2015; Crane-Murdoch 2016).

Over the past few decades, tribes have been treated more as sovereign nations, with many governmental powers. Today, there is a great need for sustainable economic development on reservations and effective political rule by the tribal governments to decrease poverty and unemployment rates on the reservations (Kendall, Spilde, Taylor 2015).

III. TRIBAL INFRASTRUCTURE

Tribal reservations are often compared to developing nations in terms of their infrastructure. Many reservations have areas which lack access to telephones, electricity, internet or water. Only 39 percent of Native Americans living on the reservation have access to a telephone, while 94 percent of Native Americans living off the reservation

have access to phones in their homes (Bissell 2004). Lack of technology on reservations causes major hurdles for Native Americans gaining employment in a technology-driven economy because many jobs today require some computer skills. This limits business development on the reservation.

The Telecommunications Act of 1996 was created to increase telecommunications access, especially in high-cost rural areas where costs of providing service are high. The Act made a commitment to tribal reservations by encouraging telecommunications competition and providing reasonable rates. Originally the 1984 Lifeline Assistance Program gave discounts to low-income households on their monthly phone bill. In 1987, the Link-Up American program helped cover the costs to set-up a telephone service in low-income households. By 2000, there were over 52,000 tribal Lifeline Assistance subscribers and there were about 18,500 tribal Link-Up Assistance subscribers in 2001(Bissell 2004).

While some tribes want to further develop technology on their reservations, they face many barriers in developing technology such as lack of capital, nonexistent infrastructure, and complex legal structures. There is some concern among tribal populations that technology will cause tribal traditions to be lost in the younger generation. Furthermore, costs to develop phone lines, maintain them, and pay for the service are unaffordable and inaccessible to most tribes.

For example, the Hopi Reservation has an elementary school which could access a free internet service provided by a nearby university, but the school could not afford a $600 monthly telephone bill to connect to the service. When the Navajo Nation set up a fiber optics line to provide telecommunications services, it was not able to provide the

services because it was left out of important agreement details through the New Mexico State Highway Department and the local phone company due to right of way issues. In addition, La Jolla and Pala tribes in southern California were not able to proceed with a high-speed internet project because of the rugged terrain the reservations are located on (Bissell 2004).

Regarding electricity generation on Indian reservations, if tribes developed alternative energy sources, they could generate an estimated $1 trillion in revenue, create new jobs, and protect the environment. However, as of 2011, there is only one commercial tribal renewable energy project. Tribal reservations across the U.S. have the capacity to produce four times the amount of electricity currently produced in the U.S. through solar and wind power (Dreveskracht 2011).

Most efforts on reservations to aid alternative energy development have been toward incentivizing investments. However, antiquated legal structures are blocking renewable projects and the laws need to be restructured to aid alternative energy development. The Indian Energy Act of 2005 (IEA) provides grants and loans through the Department of Energy (DOE) to tribes who want to develop solar and wind energy. The IEA is the most comprehensive Indian-specific energy legislation to date and it created the Tribal Energy Resource Agreement (TERA), a master agreement with the Secretary of Interior, which allows tribes to enter leases and business agreements without Secretarial approval. The leases will have a thirty-year limit and are renewable once for another thirty years. However, since 2005, no tribe has entered TERA because the costs outweigh the benefits (Dreveskracht 2011).

Reservations also lack water delivery structures and are concerned about natural habitat destruction due to the construction of dams. Poor land conditions along with drought and flooding on reservations also cause concern. It makes it difficult for the tribes to farm the land and receive regular income from agriculture. Reservations develop programs to better manage water supplies and tribes seek methods to develop infrastructure. For example, the Hopi Reservation in Arizona have aquifers stressed from multiple users, so they are implementing programs to help protect, restore, manage, and maintain their water supplies i.e. Hopi Water Resources Program and the Hopi Integrated Resource Management Plan. Several issues are impacting agriculture and stressing aquifers on the reservation (Singletary 2014).

The Shoshone-Pauite Tribes settled their water rights after four decades. The settlement will help deliver an assured amount of water to homes and business in the western U.S. by paying tribes two billion dollars. Tribes hope this money will help develop infrastructure and jobs on the reservation (Western Farm Press 2013). In 2016, the Navajo also achieved a partial water rights settlement which allowed it to draw water from the San Juan River, tributaries of the river, aquifers, and Lake Powell. However, much of the water is low quality and the groundwater is polluted with arsenic. The Navajo Nation plans to use the water for drinking and housing purposes. It hopes the settlement will help business development and give water access organizations on the reservation such as schools, offices, and tribal programs (Fonseca 2016).

IV. ECONOMIC ENTERPRISES

Tribal Nations seek, if possible, to have diverse sectors of income. Major streams of revenue are generated from gaming, business, tourism, tobacco and alcohol tax, mining and agriculture income. Business enterprises differ reservation to reservation and depend on a reservation's culture, location, and history. For example, the Pyramid Lake Reservation in Nevada has businesses such as lake camping and fishing (Tribal Enterprises 2016). While the Zuni Reservation in New Mexico has local businesses such as grocery/gas stations, restaurants, arts and crafts, and health care (Zuni Tribal Enterprise 2016). On the other hand, Fort Duchesne in Utah has large cattle, oil and natural gas businesses on the reservation (About the Utes 2016).

Other tribes, such as the Tohono O'odham have large casinos which generate revenue for the reservation's economy. From 1988 to 2013, tribal gaming has increased in popularity. There are now more than 440 tribal gaming operations in 31 U.S. states and revenue has increased from $100 million to $28 billion (Akee et al. 2015). The funds have helped improve life on the reservations and helped some tribal governments move closer to fiscal independence. In the past two decades' tribal members' incomes have increased, more females entered the labor force, unemployment rates fell, and reservation housing quality rose (Akee et al. 2015).

However, as more tribal gaming operations were developed, state and local governments demonstrated backlash and attempted to shut down the tribal gaming businesses. In 1988, the Supreme Court passed the Indian Gaming and Regulatory Act which created the National Indian Gaming Commission and a three-class structure that gave detailed roles of tribal, state, and federal governments. Class Three involves high-

stakes card games and slot machines (Akee et al. 2015; Gonzales et al. 2007; Piner and Paradis 2004).

In this class, the tribe must get permission to build the facility from the state government in the state where the operation is to be located. The state cannot generate tax-revenue from tribal casinos but it can take tribal contribution or reimbursement. In addition, states could veto Class Three gambling from taking place within their borders and place limits on number of electronic gaming machines. Class One (low-stakes social gambling) and Class Two (bingo, poker, pull-tabs games) do not require a state governments consent. Furthermore, the 1988 act requires revenues from gambling to fund tribal welfare. Many tribal governments are investing the money from gaming operations in developing health care services, law enforcement, and education on the reservation (Akee et al. 2015; Gonzales et al. 2007; Piner and Paradis 2004).

Gaming has shown to been widely successful among diverse tribal communities. It helps tribes have a sustainable source of income and have less dependence on undependable federal funds/grants. It increases number of jobs available to tribal members therefore decreasing unemployment rates. Additional revenue from gaming is helping tribes put money in enhancing education on the reservation and developing new businesses. For example, many tribes are developing hotels, shopping malls, and gas stations near the casino to take advantage of the customer traffic. Plus, tribes are developing other sectors on the reservation to add to their economic diversity such as: elder care services (Tohono O'odham), telephone services (Gila River Indian Community), artifact repatriation (San Carlos Apache), and banking (Citizen Potawatomi Nation) (Akee et al. 2015; Gonzales et al. 2007; Piner and Paradis 2004).

Mining and energy resource development have also been a major revenue source for tribes, but the negative impacts of mining cause controversy on reservations. The U.S. Department of Interior (DOI) estimates there are fifteen million acres of tribal land with potential energy and mineral resources such as oil, gas, coal, and copper (Maura 2011). Arizona, Colorado, Montana, Utah, Oklahoma, Wyoming, and New Mexico have major concentrations of tribes with significant mineral and energy resources. Tribes may improve their nations' economies through energy or resource developments. However, in 2009, the Hopi Tribe received 88 percent of their revenue from coal mining while its unemployment rate was still over 50 percent (Maura 2011).

Currently, 4,620 energy leases exist on tribal lands in the mainland with 4,272 producing oil and gas, six producing coal, and others extracting various other resources (Maura 2011). Today, the Crow Tribe in Montana has a major coal operation with Westmoreland Coal Co, the Hopi Tribe in Arizona has one with Peabody Energy, and the Navajo Nation in Arizona has deals with BHP Billiton and Peabody Energy. The Northern Cheyenne Tribe in Montana has significant coal reserves, but has opted not to mine them. The Tohono O'odham Nation in Arizona has several operational cooper mines, while the San Carlos Apache and other tribes in Arizona are fighting to keep cooper mining off tribal lands. Oil and gas is being extracted on 43 federally recognized tribal or allottee lands (Maura 2011).

Tribes most involved in gas and oil production are - the Blackfeet Nation in Montana; the Three Affiliated Tribes in North Dakota; the Assiniboine and Sioux tribes in Montana; the Jicarilla Apache Nation in New Mexico; the Navajo Nation in Arizona; New Mexico and Utah; the Osage Nation in Oklahoma; the Southern Ute Indian Tribe in

Colorado; the Ute Indian Tribe of the Uintah and Ouray Reservation in Utah; the Ute Mountain Ute Tribe in Colorado; and the Eastern Shoshone and Northern Arapaho Tribes of the Wind River Reservation in Wyoming. Uranium mining has been ceased on tribal lands. It was prevalent at the Laguna Pueblo in New Mexico, the Navajo Nation and Spokane Tribe (Maura 2011).

In recent years, the Navajo Nation and Ute Tribe are seeking protection from pollution and are seeking renewable-energy technology. The federal government has also compensated tribes for failing to fulfill its trust responsibility regarding exploitation of tribal resources. For example, the Navajo Nation filed a lawsuit against the government from 1946 to 2012 addressing undesignated water rights, improper compensation from mining companies, and health concerns created by uranium mining. The U.S. just agreed to a $554 million settlement which will help the Navajo Nation deal with its water rights, mining and health dilemmas (AOL News 2014).

APPENDIX C. EXTENDED DATA

I. RESERVATIONS WATER RIGHTS, CASINO, LOCATION, AND AGRICULTURAL DATA

*Tables begin on the next page.

Table A.C.1. Tribes' Water Rights, Casino, Location, and Agriculture Data

N	Federally Recognized Tribes (Sorted Alphabetically)	Water Rights				Casino		Casino & Water Rights	Location	Agriculture Data
		Yes/ No	Document Name	Type	Year Passed	Yes/ No*	Year Passed**	C=Casino W=Water B=Both, & N=None	Driving Distance to Major City (<51 miles)	Yes/ No
1	Acoma Pueblo and Off Reservation Trust Land, NM	No				Yes	1994	C	No	No
2	Battle Mountain Reservation, NV	No				No		N	No	No
3	Blackfeet Indian Reservation and Off Reservation Trust Land, MT	Yes	Blackfeet Water Rights Settlement Act of 2015	Settlement	2015	Yes	1997	B	No	Yes
4	Burns Paiute Indian Colony and Off Reservation Trust Land, OR	No				No		N	No	Yes
5	Campbell Ranch, NV	No				No		N	No	No
6	Carson Colony, NV	Yes	Fallon Paiute Shoshone Indian Tribes Water Rights Settlement Act of 1990 - TITLE II Truckee-Carson-Pyramid Lake Water Settlement	Settlement	1990	Yes	1998	B	Yes	No
7	Pueblo de Cochiti, NM	No				No		N	Yes	Yes (Only 2012)
8	Cocopah Reservation, AZ	Yes	Arizona v. California	Court Decree	1963	Yes	1994	B	No	Yes
9	Coeur d'Alene Reservation, ID	No				Yes	1994	C	Yes	Yes

10	Colorado River Indian Reservation, AZ--CA	Yes	Arizona v. California	Court Decree	1963	Yes	1994	B	No	Yes
11	Colville Reservation and Off Reservation Trust Land, WA	Yes	Colville Confederated Tribes v. Walton	Court Decree	1978	Yes	1995	B	No	Yes
12	Cow Creek Reservation and Off Reservation Trust Land, OR	No				Yes	1994	C	No	No
13	Crow Reservation and Off Reservation Trust Land, MT	Yes	Crow Tribe Water Rights Settlement Act of 2010	Settlement	2010	Yes	1994	B	No	Yes
14	Dresslerville Colony, NV	Yes	Fallon Paiute Shoshone Indian Tribes Water Rights Settlement Act of 1990 - TITLE II Truckee-Carson-Pyramid Lake Water Settlement	Settlement	1990	Yes	1998	B	Yes	No
15	Duck Valley Reservation, NV--ID	Yes	Omnibus Public Land Management Act of 2009 - TITLE X Water Settlements, Subtitle C - Shoshone-Paiute Tribes of the Duck Valley Reservation Water Rights Settlement	Settlement	2009	No		W	No	No
16	Duckwater Reservation, NV	No				No		N	No	No
17	Elko Colony, NV	No				No		N	No	No
18	Ely Reservation, NV	No				No		N	No	No
19	Fallon Paiute Shoshone Colony and Off Reservation Trust Land, NV	Yes	Fallon Paiute Shoshone Indian Tribes Water Rights Settlement Act	Settlement	1990	No		W	No	No
20	Fallon Paiute Shoshone Reservation and Off Reservation Trust Land, NV	Yes	Fallon Paiute Shoshone Indian Tribes Water Rights Settlement Act	Settlement	1990	No		W	No	No
21	Flathead Reservation, MT	Yes	Salish and Kootenai Water Rights Settlement Act of 2016	Settlement	2016	Yes	1997	B	No	Yes
22	Fort Apache Reservation, AZ	Yes	Claims Settlement Act of 2010, TITLE III—White	Settlement	2010	Yes	1993	B	No	No

			Mountain Apache Tribe Water Rights Quantification							
23	Fort Belknap Reservation and Off Reservation Trust Land, MT	Yes	Fort Belknap-MT Compact of 2001	Settlement	2001	Yes	2002	B	No	Yes
24	Fort Hall Reservation and Off Reservation Trust Land, ID	Yes	Fort Hall Indian Water Rights Act	Settlement	1990	Yes	1994	B	Yes	Yes
25	Fort McDermitt Indian Reservation, NV--OR	No				No		N	No	No
26	Fort McDowell Yavapai Nation Reservation, AZ	Yes	Fort McDowell Indian Community Water Rights Settlement Act	Settlement	1990	Yes	1993	B	Yes	Yes
27	Fort Mojave Reservation and Off Reservation Trust Land, AZ--CA--NV	Yes	Arizona v. California	Court Decree	1963	No		W	No	Yes
28	Fort Peck Indian Reservation and Off Reservation Trust Land, MT	Yes	Fort Peck-Montana Compact of 1985	Settlement	1985	Yes	1994	B	No	Yes
29	Fort Yuma Indian Reservation, CA--AZ	Yes	Arizona v. California	Court Decree	1963	Yes	1995	B	No	Yes
30	Gila River Indian Reservation, AZ	Yes	Gila River Indian Community Water Rights Settlement Act of 2004	Settlement	2004	Yes	1994	B	Yes	Yes
31	Goshute Reservation, NV--UT	No				No		N	No	No
32	Havasupai Reservation, AZ	No				No		N	No	Yes
33	Hopi Reservation and Off Reservation Trust Land, AZ	No				No		N	No	No
34	Hualapai Indian Reservation and Off Reservation Trust Land, AZ	No				No		N	No	No
35	Isleta Pueblo, NM	No				Yes	1994	C	Yes	Yes (Only 2012)
36	Jemez Pueblo, NM	No				No		N	Yes	Yes (Only 2012)
37	Jicarilla Apache Nation Reservation and Off Reservation Trust Land, NM	Yes	Jicarilla Apache Tribe Water Settlement Act	Settlement	1992	Yes	1994	B	No	No
38	Kaibab Indian Reservation, AZ	No				No		N	No	Yes

39	Kalispel Reservation and Off Reservation Trust Land, WA	No				Yes	1997	C	No	No
40	Kootenai Reservation and Off Reservation Trust Land, ID	No				Yes	1994	C	No	No
41	Laguna Pueblo and Off Reservation Trust Land, NM	No				Yes	1995	C	Yes	No
42	Las Vegas Indian Colony, NV	Yes	Determination of Relative Rights in and to the Waters of the Las Vegas Artesian Basin	Settlement	1999	Yes	1994	B	Yes	No
43	Lovelock Indian Colony, NV	No				No		N	No	No
44	Maricopa (Ak Chin) Indian Reservation, AZ	Yes	Ak-Chin Indian Community Water Rights Act, followed by Ak-Chin Indian Water Rights Settlement Act	Settlement	1984	Yes	1993	B	Yes	Yes
45	Mescalero Reservation, NM	Yes	State v. Lewis	Court Decree	1993	Yes	1996	B	Yes	No
46	Moapa River Indian Reservation, NV	No				Yes	1994	C	Yes	No
47	Nambe Pueblo and Off Reservation Trust Land, NM	Yes	Claims Settlement Act of 2010, TITLE VI Aamodt Litigation Settlement of the Claims Settlement Act of 2010	Settlement	2010	Yes	2005	B	Yes	No
48	Navajo Nation Reservation and Off Reservation Trust Land, AZ--NM--UT	Yes (in NM only)	Navajo Nation San Juan Basin in New Mexico Water Rights Settlement Agreement of 2010	Settlement	2010	No	2003	W	No	Yes
49	Nez Perce Reservation, ID	Yes	Nez Perce Tribe - Snake River Water Rights Act of 2004	Settlement	2004	Yes	1995	B	Yes	Yes
50	Northern Cheyenne Indian Reservation and Off Reservation Trust Land, MT--SD	Yes	Northern Cheyenne Indian Reserved Water Rights Settlement Act	Settlement	1991	Yes	1993	B	No	Yes

51	Northwestern Shoshone Reservation, UT	No				No		N	Yes	No
52	Ohkay Owingeh, NM	No				Yes	1994	C	Yes	No
53	Paiute (UT) Reservation, UT	Yes	Shivwits Band of the Paiute Indian Tribe of Utah Water Rights Settlement Act	Settlement	2000	No		W	No	No
54	Pascua Pueblo Yaqui Reservation, AZ	Yes	CAP contract with Secretary of the Interior	Settlement	1980	Yes	1993	B	Yes	No
55	Picuris Pueblo, NM	No				No		N	No	No
56	Pueblo of Pojoaque and Off Reservation Trust Land, NM	Yes	Claims Settlement Act of 2010, TITLE VI Aamodt Litigation Settlement of the Claims Settlement Act of 2010	Settlement	2010	Yes	1994	B	Yes	No
57	Pyramid Lake Paiute Reservation, NV	Yes	Fallon Paiute Shoshone Indian Tribes Water Rights Settlement Act of 1990 - TITLE II Truckee-Carson-Pyramid Lake Water Settlement	Settlement	1990	No		W	Yes	No
58	Reno Sparks Indian Colony, NV	No				No		N	Yes	No
59	Rocky Boy's Reservation and Off Reservation Trust Land, MT	Yes	Chippewa Cree Tribe of the Rocky Boy's Reservation Indian Reserved Water Rights Settlement Act	Settlement	1999	Yes	1993	B	Yes	Yes
60	Salt River Reservation, AZ	Yes	Salt River Pima-Maricopa Indian Community Water Rights Settlement Act	Settlement	1988	Yes	1996	B	Yes	Yes
61	San Carlos Reservation, AZ	Yes	San Carlos Apache Tribe Water Rights Settlement Act	Settlement	1999	Yes	1994	B	No	Yes
62	Sandia Pueblo, NM	No				Yes	1994	C	Yes	No
63	San Felipe Pueblo, NM	No				Yes	1994	C	Yes	No

64	San Ildefonso Pueblo and Off Reservation Trust Land, NM	Yes	Claims Settlement Act of 2010, TITLE VI Aamodt Litigation Settlement of the Claims Settlement Act of 2010	Settlement	2010	No		W	Yes	No
65	Santa Ana Pueblo, NM	No				Yes	1994	C	Yes	No
66	Santa Clara Pueblo, NM	No				Yes	1998	C	Yes	No
67	Santo Domingo Pueblo, NM	No				No		N	Yes	Yes (Only 2012)
68	Skull Valley Reservation, UT	No				No		N	No	No
69	Southern Ute Reservation, CO	Yes	Colorado Ute Indian Water Rights Final Settlement Agreement	Settlement	1986	Yes	1993	B	Yes	No
70	South Fork Reservation and Off Reservation Trust Land, NV	No				No		N	No	No
71	Spokane Reservation and Off Reservation Trust Land, WA	Yes	United States v. Anderson, U.S. Ct. of Appeals, 9th Cir, 1984	Court Decree	1984	Yes	1996	B	Yes	Yes
72	Stewart Community, NV	Yes	Fallon Paiute Shoshone Indian Tribes Water Rights Settlement Act of 1990 - TITLE II Truckee-Carson-Pyramid Lake Water Settlement	Settlement	1990	Yes	1998	B	Yes	No
73	Summit Lake Reservation and Off Reservation Trust Land, NV	No				No		N	Yes	No
74	Taos Pueblo and Off Reservation Trust Land, NM	Yes	Claims Resolution Act of 2010, TITLE V Taos Pueblo Indian Water Rights Settlement of 2010	Settlement	2010	Yes	1995	B	No	No
75	Tesuque Pueblo and OffReservation Trust Land, NM	Yes	Claims Settlement Act of 2010, TITLE VI Aamodt Litigation Settlement of the Claims Settlement Act of 2010	Settlement	2010	Yes	1994	B	Yes	No

76	TimbiSha Shoshone Reservation and Off Reservation Trust Land, CA--NV	Yes	Timbisha Shoshone Homeland Act	Settlement	2000	No		W	No	No
77	Tohono O'odham Nation Reservation and Off Reservation Trust Land, AZ	Yes	Arizona Water Rights Settlement of 2004	Settlement	2004	Yes	1993	B	No	Yes
78	Tonto Apache Reservation, AZ	No				Yes	1993	C	No	No
79	Turtle Mountain Reservation and Off Reservation Trust Land, MT--ND--SD	No				Yes	1994	C	No	No
80	Uintah and Ouray Reservation and Off Reservation Trust Land, UT	Yes	1992 Act To authorize addition Act to authorize additional appropriations for the construction of the Buffalo Bill Dam & Reservoir, Shoshone Project, Pick-Sloan MO Basin Program, WY-TITLE V Ute Indian Rights Settlement Act	Settlement	1992	No		W	No	No
81	Umatilla Reservation, OR	No				Yes	1994	C	No	Yes
82	Ute Mountain Reservation and Off Reservation Trust Land, CO--NM--UT	Yes	Colorado Ute Indian Water Rights Final Settlement Agreement	Settlement	1986	No		W	Yes	No
83	Walker River Reservation, NV	No				No		N	No	No
84	Warm Springs Reservation and Off Reservation Trust Land, OR	Yes	Confederated Tribes of the Warm Springs Reservation Water Rights Settlement Agreement	Settlement	1997	Yes	1995	B	No	Yes
85	Washoe Ranches Trust Land, NV--CA	Yes	Fallon Paiute Shoshone Indian Tribes Water Rights Settlement Act of 1990 - TITLE II Truckee-Carson-Pyramid Lake Water Settlement	Settlement	1990	Yes	1998	B	Yes	No
86	Wells Colony, NV	No				No		N	No	No

87	Wind River Reservation and Off Reservation Trust Land, WY (Araphoe/Shoshone)	Yes	Wind River, Araphoe, Shoshone, and Big Horn Litigation	Court Decree	1992	Yes	1995/ 2004	B	Yes	Yes (Only 2012)
88	Winnemucca Indian Colony, NV	No				No		N	No	No
89	Yakama Nation Reservation and Off Reservation Trust Land, WA	Yes	Acquavella adjudications	Court Decree	2006	Yes	1994	B	No	Yes
90	Yavapai Apache Nation Reservation, AZ	No				Yes	1993	C	No	Yes
91	Yavapai Prescott Reservation, AZ	Yes	Yavapai-Prescott Indian Tribe Water Rights Settlement Act	Settlement	1995	Yes	1995	B	No	No
92	Yerington Colony, NV	No				No		N	No	No
93	Yomba Reservation, NV	No				No		N	No	No
94	Zia Pueblo and Off Reservation Trust Land, NM	No				No		N	Yes	No
95	Zuni Reservation and Off Reservation Trust Land, NM--AZ	Yes (in AZ only)	Zuni Indian Tribe Water Rights Settlement Act of 2003	Settlement	2003	No		W	Yes	Yes (Only 2012)

Note:

Water Rights sources are given at the end of Section III. .

Casino sources:
*****_Gaming Tribe Report_. Rep. National Indian Gaming Commission, 26 Jan. 2017. Web. 5 Mar. 2017. <https://www.nigc.gov/map/>.

******Gaming Ordinances." Gaming Ordinances | National Indian Gaming Commission. National Indian Gaming Commission, n.d. Web. 16 Apr. 2017. <https://www.nigc.gov/general-counsel/gaming-ordinances >.

Location sources include Google Maps and Demographics by Cubit.

Table A.C.2. Contrasting Tribes' Water Rights and Casino Data

N	Tribes	Water Rights		Casino		Casino & Water Rights	For B Only- Casino & Water Rights			
		Yes/ No	Year Passed	Yes/ No	Year Passed	C=Casino W=Water B=Both, & N=None	Water Rights Came First (Yes/No)	Number of Years Tribe had Water Rights Before Casino	Number of Years Tribe had Casino Before Water Rights	Water Rights and Casino were Granted in the Same Year
1	Acoma Pueblo and Off Reservation Trust Land, NM	No		Yes	1994	C				
2	Battle Mountain Reservation, NV	No		No		N				
3	Blackfeet Indian Reservation and Off Reservation Trust Land, MT	Yes	2015	Yes	1997	**B**	No		18	
4	Burns Paiute Indian Colony and Off Reservation Trust Land, OR	No		No		N				
5	Campbell Ranch, NV	No		No		N		8		
6	Carson Colony, NV	Yes	1990	Yes	1998	**B**	Yes			
7	Pueblo de Cochiti, NM	No		No		N				
8	Cocopah Reservation, AZ	Yes	1963	Yes	1994	**B**	Yes	31		
9	Coeur d'Alene Reservation, ID	No		Yes	1994	C				
10	Colorado River Indian Reservation, AZ--CA	Yes	1963	Yes	1994	**B**	Yes	31		
11	Colville Reservation and Off Reservation Trust Land, WA	Yes	1978	Yes	1995	**B**		17		
12	Cow Creek Reservation and Off Reservation Trust Land, OR	No		Yes	1994	C	Yes			
13	Crow Reservation and Off Reservation Trust Land, MT	Yes	2010	Yes	1994	**B**	No		16	
14	Dresslerville Colony, NV	Yes	1990	Yes	1998	**B**	Yes	8		

15	Duck Valley Reservation, NV--ID	Yes	2009	No		W				
16	Duckwater Reservation, NV	No		No		N				
17	Elko Colony, NV	No		No		N				
18	Ely Reservation, NV	No		No		N				
19	Fallon Paiute Shoshone Colony and Off Reservation Trust Land, NV	Yes	1990	No		W				
20	Fallon Paiute Shoshone Reservation and Off Reservation Trust Land, NV	Yes	1990	No		W				
21	Flathead Reservation, MT	Yes	2016	Yes	1997	**B**	No		19	
22	Fort Apache Reservation, AZ	Yes	2010	Yes	1993	**B**	No		17	
23	Fort Belknap Reservation and Off Reservation Trust Land, MT	Yes	2001	Yes	2002	**B**	Yes	1		
24	Fort Hall Reservation and Off Reservation Trust Land, ID	Yes	1990	Yes	1994	**B**	Yes	4		
25	Fort McDermitt Indian Reservation, NV--OR	No		No		N				
26	Fort McDowell Yavapai Nation Reservation, AZ	Yes	1990	Yes	1993	**B**	Yes	3		
27	Fort Mojave Reservation and Off Reservation Trust Land, AZ--CA--NV	Yes	1963	No		W				
28	Fort Peck Indian Reservation and Off Reservation Trust Land, MT	Yes	1985	Yes	1994	**B**	Yes	9		
29	Fort Yuma Indian Reservation, CA--AZ	Yes	1963	Yes	1995	**B**	Yes	32		
30	Gila River Indian Reservation, AZ	Yes	2004	Yes	1994	**B**	No		10	
31	Goshute Reservation, NV--UT	No		No		N				
32	Havasupai Reservation, AZ	No		No		N				
33	Hopi Reservation and Off Reservation Trust Land, AZ	No		No		N				
34	Hualapai Indian Reservation and Off Reservation Trust Land, AZ	No		No		N				
35	Isleta Pueblo, NM	No		Yes	1994	C				

36	Jemez Pueblo, NM	No		No		N				
37	Jicarilla Apache Nation Reservation and Off Reservation Trust Land, NM	Yes	1992	Yes	1994	**B**	Yes	2		
38	Kaibab Indian Reservation, AZ	No		No		N				
39	Kalispel Reservation and Off Reservation Trust Land, WA	No		Yes	1997	C				
40	Kootenai Reservation and Off Reservation Trust Land, ID	No		Yes	1994	C				
41	Laguna Pueblo and Off Reservation Trust Land, NM	No		Yes	1995	C				
42	Las Vegas Indian Colony, NV	Yes	1999	Yes	1994	**B**	No		5	
43	Lovelock Indian Colony, NV	No		No		N				
44	Maricopa (Ak Chin) Indian Reservation, AZ	Yes	1984	Yes	1993	**B**	Yes	9		
45	Mescalero Reservation, NM	Yes	1993	Yes	1996	**B**	Yes	3		
46	Moapa River Indian Reservation, NV	No		Yes	1994	C				
47	Nambe Pueblo and Off Reservation Trust Land, NM	Yes	2010	Yes	2005	**B**	No		5	
48	Navajo Nation Reservation and Off Reservation Trust Land, AZ--NM--UT	Yes (in NM only)	2010	No	2003	W				
49	Nez Perce Reservation, ID	Yes	2004	Yes	1995	**B**	No		9	
50	Northern Cheyenne Indian Reservation and Off Reservation Trust Land, MT--SD	Yes	1991	Yes	1993	**B**	Yes	2		
51	Northwestern Shoshone Reservation, UT	No		No		N				
52	Ohkay Owingeh, NM	No		Yes	1994	C				
53	Paiute (UT) Reservation, UT	Yes	2000	No		W				
54	Pascua Pueblo Yaqui Reservation, AZ	Yes	1980	Yes	1993	**B**	Yes	13		
55	Picuris Pueblo, NM	No		No		N				

56	Pueblo of Pojoaque and Off Reservation Trust Land, NM	Yes	2010	Yes	1994	**B**	No		16	
57	Pyramid Lake Paiute Reservation, NV	Yes	1990	No		W				
58	Reno Sparks Indian Colony, NV	No		No		N				
59	Rocky Boy's Reservation and Off Reservation Trust Land, MT	Yes	1999	Yes	1993	**B**	No		6	
60	Salt River Reservation, AZ	Yes	1988	Yes	1996	**B**	Yes	8		
61	San Carlos Reservation, AZ	Yes	1999	Yes	1994	**B**	No		5	
62	Sandia Pueblo, NM	No		Yes	1994	C				
63	San Felipe Pueblo, NM	No		Yes	1994	C				
64	San Ildefonso Pueblo and Off Reservation Trust Land, NM	Yes	2010	No		W				
65	Santa Ana Pueblo, NM	No		Yes	1994	C				
66	Santa Clara Pueblo, NM	No		Yes	1998	C				
67	Santo Domingo Pueblo, NM	No		No		N				
68	Skull Valley Reservation, UT	No		No		N				
69	Southern Ute Reservation, CO	Yes	1986	Yes	1993	**B**	Yes	7		
70	South Fork Reservation and Off Reservation Trust Land, NV	No		No		N				
71	Spokane Reservation and Off Reservation Trust Land, WA	Yes	1984	Yes	1996	**B**	Yes	12		
72	Stewart Community, NV	Yes	1990	Yes	1998	**B**	Yes	8		
73	Summit Lake Reservation and Off Reservation Trust Land, NV	No		No		N				
74	Taos Pueblo and Off Reservation Trust Land, NM	Yes	2010	Yes	1995	**B**	No		15	
75	Tesuque Pueblo and OffReservation Trust Land, NM	Yes	2010	Yes	1994	**B**	No		16	
76	TimbiSha Shoshone Reservation and Off Reservation Trust Land, CA--NV	Yes	2000	No		W				
77	Tohono O'odham Nation Reservation and Off Reservation Trust Land, AZ	Yes	2004	Yes	1993	**B**	No		11	
78	Tonto Apache Reservation, AZ	No		Yes	1993	C				

79	Turtle Mountain Reservation and Off Reservation Trust Land, MT--ND--SD	No		Yes	1994	C				
80	Uintah and Ouray Reservation and Off Reservation Trust Land, UT	Yes	1992	No		W				
81	Umatilla Reservation, OR	No		Yes	1994	C				
82	Ute Mountain Reservation and Off Reservation Trust Land, CO--NM--UT	Yes	1986	No		W				
83	Walker River Reservation, NV	No		No		N				
84	Warm Springs Reservation and Off Reservation Trust Land, OR	Yes	1997	Yes	1995	**B**	No		2	
85	Washoe Ranches Trust Land, NV--CA	Yes	1990	Yes	1998	**B**	Yes	8		
86	Wells Colony, NV	No		No		N				
87	Wind River Reservation and Off Reservation Trust Land, WY (Araphoe/Shoshone)	Yes	1992	Yes	1995/ 2004	**B**	Yes	3		
88	Winnemucca Indian Colony, NV	No		No		N				
89	Yakama Nation Reservation and Off Reservation Trust Land, WA	Yes	2006	Yes	1994	**B**	No		12	
90	Yavapai Apache Nation Reservation, AZ	No		Yes	1993	C				
91	Yavapai Prescott Reservation, AZ	Yes	1995	Yes	1995	**B**				Same Year
92	Yerington Colony, NV	No		No		N				
93	Yomba Reservation, NV	No		No		N				
94	Zia Pueblo and Off Reservation Trust Land, NM	No		No		N				
95	Zuni Reservation and Off Reservation Trust Land, NM--AZ	Yes (in AZ only)	2003	No		W				

Table A.C.3. Water Leasing Off the Reservation

N	Geography	Water Leasing	Lessor/ Lessee	Start - End Dates	Water Quantity (afa)	Water Type	Water Use	Lease payments
1	Fort McDowell Yavapai Nation Reservation, AZ	Yes	(1) Phoenix; (2) Phelps Dodge Corporation [4]	(1) 99 years; (2) NA [4]	(1) 4,300; (2) NA [7]	ISW (CAP) [4]	NA	(1) $5.5 million; (2) NA [7]
2	Gila River Indian Reservation, AZ	Yes	(1) Salt River Project (SRP); (2) Phoenix; (3) Scottsdale; (4) Goodyear; (5) Peoria; (6) Chandler; (7) Glendale; (8) Mesa; (9) Phelps-Dodge CAP [8]	(1) 'Long-term' [4]; (2) 100 [7] (3) NA; (4) NA; (5) NA; (6) NA; (7) NA; (8) NA; (9) 50 years [4]	(1) NA; (2) 15,000 (3) 12,000; (4) 7,000 (5) 7,000; (6) NA; (7) NA; (8) NA; (9) 12,000 with 10,000 option [11]	ISW (CAP) [4]	Re-charge projects for long-term credits for CAP [4]	(1) NA; (2) $ 27.2 million (3) NA; (4) NA (5) NA; (6) NA; (7) NA; (8) NA; (9) Up front paymet of $4.8 million *In general, 1993 rate: $1,203 paf and 2006 rate: $1,760 paf [11]

3	Jicarilla Apache Nation Reservation and Off Reservation Trust Land, NM	Yes [2]	(1) Public Service Company of New Mexico (PNM); (2) Santa Fe, NM; (3) San Juan Refining Co.; (4) San Juan Basin Waterhaulers Association; (5) Elks Lodge No. 1747 (Farmington, NM); (6) PNM, Arizona Public Service Company, BHP Navajo Coal Company; (7) Gallup, NM; (8) U.S. Bureau of Reclamation; (9) Club at Las Campanas; (10) Sipapu Recreational Development	(1) Jan. 1, 2006 to Dec. 31, 2027; (2) Oct. 27, 2005 to Dec. 31, 2057; (3) Jan. 1, 2006 to Dec. 31, 2015; (4) Jan. 1, 2006 to Dec. 31, 2015; (5) Jan. 1, 2006 to Dec. 31, 2015; (6) Jan. 1, 2007 to Dec. 31, 2016; (7) 40 years; (8) 2012 to Sept. 30, 2013; (9) Jan. 1, 2013 to Dec. 31, 2022; (10) Jan. 1, 2013 to Dec. 31, 2013	(1) 16,200; (2) 3,000; (3) 500; (4) 200; (5) 15; (6) 8,500; (7) 7,500; (8) 5,300; (9) 600; (10) 100	SW	(1) Coal mining, irrigation of reclaimed lands, electrical generation, San Juan Generating Station; (2) Municipal water supply; (3) Industrial use, petroleum refinery; (4) Industrial use, oil and gas drilling; (5) Water supply, municipal use; (6) Drought protection for electrical generating station and coal mining; (7) Municipal supply; (8) In-stream flow to protect endangered silvery minnow; (9) Water supply for luxury residential development, Sante Fe, NM; (10) Water supply (ski area)	(1) “USBR CRSP Rate” - $2,033,073 (non-reimbursable reserve free, credited toward usage), $42,120 for O&M0; (2) $1.5 million per year - $300,000 per year “holding rights” until contract was approved; (3) $100 paf (4) $100 paf; (5) $90 paf; (6) $110 paf - $220, 000 increased by 10% per year (non-reimbursable fee, credited toward supply); (7) “Fair Market Value” (FMV) - $30,000 per year hold fee until delivery begins; (8) $81 paf - $42,930 non-refundable advance payment; (9) $82 paf - $39.32 paf in “project fees”; (10) $82 paf

4	Maricopa (Ak Chin) Indian Reservation, AZ	Yes	Del Web Corporation for Anthem in Phoenix, AZ [3]	1996 to 2096 [11]	10000 [11]	ISW [3]	Company's development [11]	$12 million upfront payment ($1,200 paf) [11]
5	Navajo Nation Reservation and Off Reservation Trust Land, AZ--NM--UT	Yes [2]	(1) Navajo Generating Station and Peabody (2) Santé Fe (3) Gallup (4) Small short term leases (5) Public Service Company (6) Arizona Pubic Service Company (7) BHP Navajo Coal Company	(1) 'Long-term', (2) 52 years, (3) 40 years, (4) 1 to 2 years, (5-7) 9 years	(1) NA, (2) 3,000 (3) 7,500, (4) NA, (5-7) 8,500	(1) SW and (2-7) ISW	NA	(1 and 3-7) NA (2) $30,000 per year
6	Paiute (UT) Reservation, UT	Yes [14]	(1) Virgin River, (2) Santa Clara river, and (3) St. George Project, and (4) GW beneath reservation	Up to 100 years	8000 ((1) 4,000, (2) 1,900, (3) 2,000 and (4) 100 *correspond with Water Location)		NA	
7	Salt River Reservation, AZ	Yes [11]	(1) Phoenix; (2) Chandler; (3) Glendale; (4) Scottsdale; (5) Tempe; (6) Mesa; (7) Gilbert; (8) Two Indian Communities; (9) Three irrigation districts	99 years	(1) 3,203; (2) 2,586; (3) 1,814; (4) 60; (5) 60; (6) 1,669; (7) 4,088; (8) 32,000; (9) NA	ISW (CAP)	NA	(1) NA; (2) NA; (3) NA; (4) NA; (5) NA; (6) NA; (7) NA; (8) $56 M from local water users; (9) $16 million for allocated CAP water *$9 million from local cities ($3.6 million of the total $9 million was from the City of Phoenix)

8	San Carlos Reservation, AZ	Yes	(1) Phelps Dodge Corporation; (2) Phoenix; (3) Scottsdale; (4) Gilbert [4]	(1) 50 years; (2) NA; (3) 100 years; (4) NA [11]	(1) 14,000; (2) NA; (3) 12,500; (4) NA [1]	ISW (CAP) [11]	(1) Mining purposes; (2) NA; (3) Urban needs; (4) NA [11]	(1) $1,200 paf with partial up-front payment and partial in annual payments; (2) NA; (3) Upfront payment of $1,200 paf; (4) NA [11]
9	Tohono O'odham Nation Reservation and Off Reservation Trust Land, AZ	Yes	(1) Tucson; (2) Asarco; (3) FICO [6]	(1) NA; (2) 25 years; (3) NA [11]	(1) NA; (2) 10,000; (3) NA [11]	ISW (CAP) [11]	(1) NA; (2) Mining; (3) NA [11]	(1) $1.5 million; (2) NA; (3) NA [11]
10	Uintah and Ouray Reservation and Off Reservation Trust Land, UT	Yes [4]	Bonneville area	ends 2042	35,500	NA	NA	
11	Yavapai Prescott Reservation, AZ	Yes [10]	Scottsdale, AZ	NA	NA	NA	NA	NA

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II. EXAMINATION OF EXTREMES IN DATA VALUES

Table A.C.4. Five of the Smallest and Largest Values of Selected Variables

	Rank	Location	Income	Un-employment	Edu-cation	Number of Casinos	Value of Agricultural Products Sold
Smallest	1	2.9	23891	0	52.9	0	22
	2	4.5	28137	2.5	60	0	201
	3	8.5	28298	4.5	60.5	0	257
	4	9	30262	5	60.5	0	308
	5	10.3	32091	5.2	62.5	0	370
Largest	6	253	74746	41.4	90.5	4	134953
	7	253	77018	41.9	90.6	4	140060
	8	253	78944	44.8	92	4	178282
	9	262	83476	50.7	92.4	4	190174
	10	348	84291	52.9	93.7	4	571100

APPENDIX D. ATTEMPTED MODELS AND RESULTS

Table A.D.1. Attempted Probit Model Results

	Probit Models		
Dependent Variable	Water Rights	Casino	
Independent Variables			
Intercept	2.63	-0.29	-0.87**
	(2.25)	(0.19)	(0.44)
Water Rights		0.92***	0.90***
		(0.20)	(0.20)
Casino	0.75*		
	(0.46)		
Value of Agricultural Products Sold	0.14**		
	(0.06)		
Education	-0.05*		
	(0.03)		
Income			0.12
			(0.06)
Unemployment	0.03		
	(0.03)		
Location		0.42**	0.37*
		(0.20)	(0.21)
Year	0.18	-0.05	-0.05
	(0.39)	(0.20)	(0.20)
N	66	180	180
McFadden's LRI	0.266	0.107	0.119
McKelvey-Zavoina	0.699	0.203	0.222
Log-Likelihood	-31.338	-106.972	-105.619

Significant at a *10 percent, ** 5 percent, and *** 1 percent

Table A.D.2. Attempted OLS Model Results

	OLS Models					
Dependent Variable	Income			Unemployment		
Independent Variables						
Intercept	1.06	1.00	-0.57	47.78***	47.97***	39.75***
	(0.84)	(0.85)	(0.96)	(6.83)	(6.88)	(9.24)
Water Rights		0.14	-0.17		-0.49	2.66
		(0.21)	(0.23)		(1.75)	(2.16)
Casino	0.46**	0.41**	0.53**	-4.10**	-3.94**	-2.51
	(0.20)	(0.21)	(0.25)	(1.69)	(1.79)	(2.41)
Value of Agricultural Products Sold			0.03**			-0.30***
			(0.01)			(0.12)
Education	0.05***	0.05***	0.06***	-0.38***	-0.38***	0.30***
	(0.01)	(0.01)	(0.01)	(0.09)	(0.09)	(0.11)
Year	-0.03	-0.03	0.15	5.23***	5.23***	4.78***
	(0.19)	(0.19)	(0.19)	(1.65)	(1.66)	(1.87)
N	180	180	66	185	185	66
R^2	0.125	0.128	0.412	0.162	0.162	0.238
Adjusted R^2	0.110	0.108	0.363	0.148	0.144	0.175
F-value	8.40	6.40	8.41	11.66	8.72	3.75

Significant at a *10 percent, ** 5 percent, and *** 1 percent

Table A.D.3. Attempted First Difference Model Results

	First Difference Models			
Dependent Variable	Income		Unemployment	
Intercept	0.15	0.16	2.93**	3.06**
	(0.12)	(0.12)	(1.45)	(1.43)
Water Rights		-0.63		-9.78
		(0.64)		(7.42)
Value of Agricultural Products Sold	0.02	0.02	-0.33	-0.30
	(0.02)	(0.02)	(0.26)	(0.26)
Education	0.04**	0.04**	0.53***	0.60***
	(0.02)	(0.02)	(0.18)	(0.19)
N	29	29	29	29
R^2	0.21	0.24	0.28	0.33
Adjusted R^2	0.15	0.14	0.23	0.25
F-value	3.40	2.58	5.18	4.13

Significant at a *10 percent, ** 5 percent, and *** 1 percent

APPENDIX E. HETEROSKEDASTICITY AND MULTICOLLINEARITY RESULTS

Table A.E.1. Income OLS Model 3 Heteroskedascity and Multicollinearity Results

Dependent Variable	**Income**			
	Model 3.A	**Model 3.B**	**Model 3.C**	**Model 3.D**
N	**180**	**66**	**180**	**66**
Variance Inflation (VIF)				
Intercept	0	0	0	0
Casino	1.67	1.54	1.81	1.66
Water Rights			1.14	1.28
Value of Agricultural Products Sold		1.33		1.35
Education	1.03	1.17	1.03	1.23
Location	2.91	6.46*	2.91	6.47*
Location*Casino	3.87	7.28*	3.87	7.28*
Year	1.03	1.07	1.03	1.07
Significant when VIF>4*				
White's Test	63.68***	25.33	97.45***	36.29*
Breusch-Pagan	6.67	11.71*	7.20	12.51*
Significant at a *10 percent, ** 5 percent, and *** 1 percent				

Table A.E.2. Unemployment OLS Model 4 Heteroskedascity and Multicollinearity Results

Dependent Variable	**Unemployment**			
	Model 4.A	**Model 4.B**	**Model 4.C**	**Model 4.D**
N	**185**	**66**	**185**	**66**
Variance Inflation (VIF)				
Intercept	0	0	0	0
Casino	1.64	1.54	1.77	1.66
Water Rights			1.12	1.28
Value of Agricultural Products Sold		1.33		1.35
Education	1.02	1.17	1.02	1.23
Location	2.89	6.46*	2.90	6.47*
Location*Casino	3.83	7.28*	3.83	7.28*
Year	1.03	1.07	1.03	1.07
Significant when VIF>4*				
White's Test	27.36***	20.62	31.62**	26.16
Breusch-Pagan	17.93***	15.77**	21.73***	19.38***
Significant at a *10 percent, ** 5 percent, and *** 1 percent				