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Contrasting Management Styles and Differing Outcomes of Capping and Orphaning of Utah Oil and Gas Wells by Conditions and Land Types

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CONTRASTING MANAGEMENT STYLES AND DIFFERING OUTCOMES OF CAPPING AND ORPHANING OF UTAH OIL AND GAS WELLS BY CONDITIONS AND LAND TYPES

by

Maxwell C. Parson

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ABSTRACT

Contrasting management styles and differing outcomes in capping and orphaning of Utah oil wells by conditions and land types

by

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The issue of public lands management and ownership in the West has long been contentious. This thesis takes a quantitative approach examining outcomes of the rates at which oil and gas wells in the state of Utah are orphaned and/or capped. A brief examination of differences in management styles between wells on tribal, federal, state, and private land reveal tribal wells have the highest bond associated with their leases, followed by state and private as they operate under a unified system, and finally federal wells. Further, state and private leases allow for a much longer period of inactivity before a well is required to be capped or designated orphaned as compared to tribal and federal leases. The primary variable of interest was the management style which was captured using the type of land a well was located on. Additional variables, such as proximity to water, towns, and protected areas were also included to account for potential reasoning outside of management style. Findings indicate that orphanings occur at a statistically significant higher rate on state owned land as opposed to federal and private, and wells on tribal land have no recorded orphanings. No proximity measurements were significant. The proposed explanations for this disparity are two-fold: First, the longer periods of

inactivity permitted by the State simply increase the chance a lessee will dissolve, leaving the well orphaned. Secondly, potential access to a greater amount of land upon which to drill incentivizes lessees to cap wells upon federal land at a higher rate. Wells on Tribal and private land both allow for a more individualized approach and additional contractual agreements that minimize orphanings. Notably, no orphanings have occurred on any tribal land since recordkeeping began in the 90s. This analysis demonstrates that the state of Utah's management system results in a higher rate of orphanings, and in addition paves the way for comparative analyses in other aspects of land management. This allows for a more nuanced discussion and better understanding of differences in management systems and outcomes.

(35 pages)

PUBLIC ABSTRACT

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The issue of public lands management and ownership in the West has long been contentious. This thesis takes a quantitative approach examining outcomes of the rates at which oil and gas wells in the state of Utah are orphaned and/or capped. Findings indicate that orphanings occur at a statistically significant higher rate on state owned land as opposed to federal and private, and wells on tribal land have no recorded orphaning. No other variables were significant in their relationship to orphaning. The proposed explanations for this disparity are two-fold: First the longer periods of inactivity permitted by the state simply increase the chance a lessee will dissolve, leaving the well orphaned. Secondly, potential access to a greater amount of land upon which to drill incentivizes lessees to cap wells upon federal land at a higher rate. Tribal and private wells both allow for a more individualized approach and additional contractual agreements that minimize orphanings. This analysis demonstrates that the state of Utah's management system results in a higher rate of orphanings, and in addition paves the way for comparative analyses in other aspects of land management. This allows for a more nuanced discussion and better understanding of differences in management systems and outcomes.

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INTRODUCTION

The question of who should own and manage lands in the western United States has long been a source of contention between the states, federal government, and private interests. This fight continues both on the ground and in state legislatures. As recently as 2012, the Utah legislature demanded the transfer of federal lands "back" to the state via the passage of the Utah Transfer of Public Lands Act (HB0148 2012). Though the federal government rejected this claim, it paints a picture of malcontent within western states as to how lands are managed. Within Utah, Arizona, New Mexico, Colorado, Wyoming, Montana, Nevada, Oregon, Washington, California, and Idaho at least 25% of their respective land is owned by the federal government. Our primary state of interest, Utah, has 64.9% of its land federally controlled. While the discussions about control and management of lands in the West have often been a political or economic debate. Little to no work has been done to attempt and answer this question quantitatively. This is the purpose of this thesis. To do so, I measure the differences in outcomes of the respective controlling entities management styles, firstly, via the orphaning rates of oil and gas wells within Utah, and secondly, the average time to cap wells should they become orphaned. While the extraction is not directly managed by the entity who controls the land (Federal agencies, State agencies, Tribal authorities, or Private owners), they are responsible for the health of the land they occupy, and in instances of orphaning they may assume control of said well.

Contentions regarding control of western lands began with the Federal government's decision to change how it oversaw the selling of lands in the West at the beginning of the 20th century (Makley, 2017, p. 10). Unlike the process previously, the

federal government decided maintaining this land for future generations was of greater importance than the parceling and selling of the land to either the states or private investors. This would lay the groundwork for the next century of conflict, constantly bubbling below the surface and, at times, erupting in violence. The Sagebrush Rebellion saw ranchers and state politicians pit themselves against federal regulators in the 1970s and 1980s, standoffs such as Cliven Bundy's in 2014 (Makley, 2017, p. 101), and the Sugar Pine Mine incident in 2015 (Wiles 2016) saw individuals take up arms against the federal government in an attempt to obtain control of these lands.

The primary area of study in this case will be Utah for two reasons. First, they are the only state with a law demanding the handover of federal lands. Secondly, oil and gas are a pertinent aspect of the Utah economy. Further, the division of wells on private, state, and federal land is approximately equal relative to their respective land distributions. All of this is to provide context for the current state of public lands within the Western United States and Utah specifically.

BACKGROUND

Oil and gas wells are prevalent through much of the western United states and Utah is no exception. With 22,532 oil and gas wells drilled or currently active within the State it offers up a robust population to examine. While drilling and extraction of oil and gas is not overseen by the respective entities, they each have their own management styles and legal requirements affecting outcomes discussed herein. Specifically, I concern myself with the capping of wells. The purpose of this research is to determine what factors lead to the orphaning and then capping of wells, and what effect the different management styles of the respective entities have on these outcomes. Other factors will be considered

including proximity to census locations, proximity to protected lands (State/National parks, forests, and monuments), and proximity to water ways. This will reveal not only whether management style factors into the long-term care of these wells but what other potential factors play a role.

To best present the data obtained through my research I find it pertinent to offer a brief explanation as to the general systems and language by which oil and gas wells operate. The primary unit of analysis for this paper will be individual oil and gas wells. There are other types of wells within the state, however due to their relative infrequency and the larger range of regulatory requirements they are outside the scope of this analysis. The wells within the state of Utah are on one of four types of land: state, federal, tribal, or private. There are three types of management styles with State and private wells operating under a unified system and separate systems for federal and tribal land. Upon completion of extraction from a well the well is legally required to be capped which entails concrete being poured into the bore hole to a set depth dependent upon the total depth of the well and a cap being placed over the top of the bore hole. The specifics are dependent on the type of land the well was drilled upon. While this capping is legally required upon each type of land it does not always happen. This may be due to the dissolution of the lessee or the abandonment of the well. In these cases, the well is considered orphaned and the responsibility to cap it falls upon the controlling entity. The orphaning and capping process are unique to each entity and will be discussed further below. I will first discuss the economic impact of uncapped and/or orphaned wells.

Economic Impact of Uncapped and Orphaned Wells

The economic impact of these uncapped/orphaned wells can be three-fold. First is the direct cost to the controlling entity to pay for the capping of the well. The average cost to decommission (plug and cap) a well is $20,000 with an average depth of 3,466 feet. This number can vary drastically as costs increase some 20% per additional 1,000 feet of depth. Compounding this cost is the age of the well, what it is extracting, and even the surrounding topographical features. (Raimi et al, 2021, p. 1). Should the lessee cease to exist, or the controlling entity is unable to secure the amount due, the cost of capping these wells falls directly to the taxpayer via the funding of orphaned well departments at the federal and state level, each responsible for capping on their respectively managed lands. Orphaned wells upon tribal land fall under the purview of the Bureau of Indian Affairs and in theory, as no orphanings have been recorded, would receive some federal funding to decommission these orphaned wells. Secondly, should there prove to be instances of leakage or other environmental damage, the cost to rehabilitate the land can exceed $76,000 (Raimi et al, 2021, p. 1) again falling to the taxpayers. Finally, and especially pertinent to Utah, are the economic costs of poorly managed lands, as the state collects approximately $2.12 billion in tourism via taxes annually (Kem C. Gardner Policy Institute 2024). Should companies frequently abandon these wells it could hamper the tourism industry within the state as travelers choose to spend time and money elsewhere. Remnants of drilling equipment and sinkholes near populace centers could detract from the outdoor tourism culture Utah cultivated over the years. Thus, there is an economic incentive for the controlling entities to ensure companies are adhering to their agreed upon leases or risk shifting these responsibilities to the taxpayer.

Environmental Impact of Uncapped and Orphaned Wells

Environmental impacts are the second major concern regarding these orphaned wells. These can be divided into three primary areas of interest. First is potential contamination of water supplies. This is primarily facilitated by the seepage of oil and other contaminants into surrounding groundwater. This can come both in the form of surface spillage into water ways as well as subterranean seepage into groundwater wells. While data on the latter is unavailable to Utah specifically, 22% of well water contamination incidents were caused by this subterranean seepage in Ohio and 14.2% in Texas in 2011(Kang et al, 2023, p. 4).

The second concern is the release of noxious gases from these uncapped wells. While methane is the primary gas released, these orphaned wells can also release benzene, hydrogen sulfide, toluene, ethylbenzene, and xylenes, which are all known carcinogens (Kang et al, pg. 5, 2023). The release of methane gas is of concern due to its' impact as a greenhouse gas. While the impacts of the later contaminants are contained to approximately 1km from the orphaned well, (Shonkoff et al, 2021, p. 13) some 4.6 million people live within this radius and 35% of orphaned wells are within 1km of groundwater nationwide. (Kang et al, 2023, p. 1).

The third and final area of concern is the impact on the area surrounding these wells. While the first two impacts concerned the health of the populace surrounding these wells, the local ecosystems can be heavily impacted by orphaned wells beyond the negative impacts described above. Increased sinkholes, decreases in edible vegetation, and rusting and degrading equipment all impact the health of ecosystems near these abandoned wells (U.S. Department of the Interior 2024). In sum, orphaned wells are not

simply blights upon the landscape but can actively harm the health of both the surrounding populace and ecosystems if not managed appropriately.

MANAGEMENT SYSTEMS IN UTAH

The three management systems in Utah are Tribal, State, and Federal. The primary areas of interest of these systems are those associated with the capping, abandonment, and bonding of wells as these impact the failure to cap and the orphaning of wells directly. While each entity also controls the permitting of wells (thereby allowing drilling in the first place), those rules and regulations are not pertinent to this study. The three different management styles will now be discussed in greater detail below.

Utah (State and Private)

The Utah system of oil and gas well management operates under Title R649 of the Utah legal code with Drilling and Operating Practices being covered by §R649-3-1 through §R649-3-40. In particular §R649-3-1, §R649-3-8, §R649-3-24, and §R649-3-36 cover bonding, casing program, plugging and abandonment of wells, and shut-in and temporarily abandoned wells. Bonding for Utah wells is based upon the depth of the well. Wells up to 1,000 feet a bond of at least $1,500 shall be posted, wells between 1,000-3,000 feet shall have a bond of $15,000, wells between 3,000-10,000 shall have a bond of $30,000, and wells in excess of 10,000 feet shall have a bond of $60,000 (Utah Division of Oil, Gas and Mining. 2022). The lessee shall also have the option to procure a blanket bond to cover all wells in the state, for these all wells less than 1,000 feet in depth a bond of $15,000 shall be required and wells in excess of 1,000 feet in depth shall require a

bond of $120,000 (Utah Division of Oil, Gas and Mining 2022). The bond shall be released upon completion of capping and rehabilitation of surface lands. In a scenario wherein the lessee fails to adhere to the above terms the state shall step in and complete any work to cap the well using funds from the established bond. Should excess funds be left after completion of this work they shall be returned to the lessee. Conversely, the state may pursue legal action in order to recoup its own costs should the cost to cap and rehabilitate exceed the amount bonded in the lease.

Utah also allows for wells to be marked as temporarily abandoned or shut-in for a period of twelve consecutive months. Should the lessee desire to maintain the well in such status for a longer period, it requires approval from the Utah Division of Oil, Gas, and Mining (UDOGM). The lessee must also give adequate reasoning and demonstrate the integrity of the well such that environmental damage is not a concern. This approval is valid for up to 5 years at which point another approval is required or the well shall be capped accordingly. Should the lessee not comply with these requirements the bond is considered forfeited and UDOGM shall proceed with the plugging and capping of the well. The only legal distinction between wells on private land and wells on state owned land are the requirements regarding rehabilitation. Private landowners are allowed to negotiate terms with the lessee as to how their land be left, though it must comply with minimum state requirements. Additionally, private owners may make additional terms outside the scope of what the State requires.

Federal

The federal system of oil and gas well management operates under the Code of Federal Regulations Title 43 Subtitle B Chapter II Subchapter C. The section relating to oil and

gas operations is Part 3100. The two most pertinent sections are CFR§3162.3-4 regarding well abandonment, and CFR§3104.2 -CFR§3104.3 regarding bonding of wells. Bonding for federal wells is required in the sum of $10,000 dollars for a singular well or a lump bond for all wells may be posted in the sum of $25,000 dollars to cover an entire state, or $150,000 to cover all wells nationwide. The bond shall be returned if the lessee complies with all requirements of the lease including the appropriate plugging, capping, and rehabilitation of the well and surrounding lands.

As for temporary abandonment, federal regulations allow for a 30-day period. Any continued abandonment requires approval by the controlling entity and may not exceed a total of twenty-four consecutive months. Federal leases are to be terminated should the well be unable to meet payment requirements, which is generally due to a lack of production. In these circumstances the well is then required to be plugged, capped, and approved by the controlling entity prior to abandonment. Should the drilling entity fail to abide by the terms of their lease the federal government shall reclaim control of the land upon which the well sits and shall take whatever the cost of capping and rehabilitation of surrounding land from the lessees' bond. Should the funds from the bond exceed the costs required to adequately plug and cap the well, the remainder shall be returned to the original lessee.

Tribal

Wells upon Tribal lands are subject to a unique combination of federal, Bureau of Indian Affairs (BIA), and Tribal requirements. The bonding and leasing processes are covered by the Bureau of Indian Affairs in Title 25 Chapter I §211.24 of the Code of Federal Regulations (Bureau of Indian Affairs, Department of Interior 2024.). If mineral rights

regulations are included in a given tribe's constitution, they exert supremacy if they do not directly conflict with existing federal regulations. The bonding costs are unique and set at an amount "sufficient to ensure compliance with all of the terms and conditions of the lease." Therefore, the actual amount required is determined by the tribal council in a particular region with approval required by the BIA. Bonds for regions of a reservation that cross over into multiple states are set at $75,000, and nationwide bonds are set at $150,000 though both are subject to approval at the discretion of the Secretary of the BIA. All other restrictions and requirements are the same as federal, listed above, but may be superseded by tribal constitutions should they include references to resource extraction.

Comparison

The major differences between the state and federal management systems are the bonding costs and timeframe for abandonment. The time allowed by the state of Utah regarding abandonment exceeds the federal timeframe to the point where a Utah well could be temporarily abandoned or shut in indefinitely. This is not possible under the federal framework. However, federal bond costs are significantly lower than the State's once a well exceeds a depth of 1,00 feet. The average depth of a well has exceeded this number every year in Utah between 1960 and 2022 (Utah Geological Survey 2023). Further, Utah's bond prices are based upon the average cost to cap a well as of 2002 (Utah Division of Oil, Gas and Mining 2022) whereas federal bonding requirements have remained the same for nearly 60 years (Groom 2023). Utah also requires a bond of the actual capping and rehabilitation amounts should the lessee break the terms of their lease to cover the costs incurred by the State. These costs may not always be recouped

however, where the lessee has ceased to exist thereby passing any additional cost to the State. Even just pursuing these payments takes time and resources which the state may be unwilling to commit. For tribal lands, while the bond for an individual well is not set, and subject to negotiation and approval by the BIA, the costs on these lands are much higher statewide and nationwide than either the federal or State. This, combined with the additional levels of approval by the BIA and tribal councils makes for much greater oversight than the federal or state/private systems.

METHODS

The data acquired for these analyses was obtained via UDOGM from their well search publication (Utah Division of Oil, Gas and Mining (n.d.)). The database includes all wells within the State including those on tribal and federal land. To limit the scope of the analysis, only oil and gas wells were reviewed. This included multiple types of drilling methods, including dry hole, standard, and water/gas injection wells. The initial data was able via a CSV download for each land type. These files included a link for each well offering further information on each well including pertinent dates and location. For wells included in the random sample this location data was imported into google earth pro where each well was listed as a point on the map. Additional mapping data was made available via Utah.gov which included GPS locations for all towns within the state of Utah (Utah Geospatial Resource Center 2024). Distance based variables were collected by centering circles of assorted sizes (dependent upon the variable being measured) upon the individual wells.

In order to best analyze any potential trends regarding the capping and orphaning of wells within the state of Utah a slate of three different analyses were undertaken. The

first two used a complementary log-log (cloglog) model to examine statistical significance. The first was an analysis of all plugged or orphaned wells within the state. This population was chosen as those wells which are currently active may or may not end up orphaned and thus are outside the scope of this analysis. As such, the capping and plugging of a well was considered a success and the orphaning of a well was considered a failure. This is representative of all management entities' legal modus operandi. Each well was individually examined to determine its "Active Orphaning" status. For the purposes of this analysis a well is considered actively orphaned if at any point in time the well was uncapped and orphaned with no responsible owner, meaning the controlling entity takes responsibility for capping. This omits the less concerning situation where a well was orphaned post-capping due to the fact that plugged wells pose substantially less risk economically and environmentally. This population was examined only by the entity with regulatory jurisdiction of the land upon which the well resides. The second analysis was a random sample of 400 wells from the above population. The smaller sample size allowed me to measure proximity to waterways (.25-, .5-, 1-, and 2- mile radii), proximity to towns within Utah (5- and 10-mile radii), and proximity to protected lands such as state or national parks (5-, 10-, and 25-mile radii). These variables are then incorporated into the statistical model to control for their potential effects. The final analysis did not use a model but instead examined the average time taken by the controlling entity to cap a well once it had been listed as orphaned. Here again state and private are listed separately due to potential differences despite orphanings being managed by the state exclusively. Though it does not offer any predictive power it allows us to examine the differences in response time after a well has been orphaned.

A complimentary log-log model is a binary response model that is exceptionally useful in situations wherein the responses are heavily skewed in one direction due to its asymmetry. In our scenario active orphaning is a relatively rare event with only 158 instances out of the total population of 6,967 oil and gas wells. As such, traditional symmetrical models such as logit and probit are less powerful interpreters and predictors than the complimentary log-log for this study.

OPERATIONALIZATION

As mentioned in the previous section the dependent variable for this analysis is "Active Orphaning." I use this to describe whether a well was a "failure" or a "success." It is a binary variable where a value of 1 indicates cases wherein the well being examined had no responsible owner and was uncapped. A value of 0 represents a well that was successfully plugged and abandoned by a lessee rather than the controlling entity. The current status of the well is not being examined as there are both cases of wells being orphaned post-capping as well as instances of companies purchasing orphaned wells post-capping where the well was orphaned and capped by the state. In both instances simply relying upon the current designation of the well does not capture the true rate of success and failure when it comes to orphaning or the cost economically and environmentally.

The primary independent variable of interest is that of "land type" which represents the entity with regulatory jurisdiction. This is a stand in for managements system/style and is captured using private, state, or federal coding. While wells upon tribal land were included in the overall population no orphanings have been recorded with these wells. The consequences and potential reasons for which will be discussed

later but for the purposes of our clog-log models these wells had to be removed as they caused perfect linearity to occur. Though private and state wells operate under a unified management style I felt it pertinent to separate out the two as the ability for private owners to require additional rehabilitation, write their own contracts, and pursue capping outside of the state's requirements (litigation or 3rd party capping) made for a unique case separate from the state despite having the same legal requirements. For the above variables, the following hypotheses were proposed. The null hypothesis is *H0: There is no relationship between the type of land a well is on and the rate of active orphaning* and the alternative hypothesis is *H1: There is a relationship between the type of land a well is on and the rate of active orphaning*.

All other variables were included in order to best identify patterns in active orphaning rates. Proximity to waterways acts as a marker for wells that may be more likely to cause environmental damage as wells closer to groundwater have the ability to impact a larger area as the water carries oil and other pollutants downstream. The hypotheses for this variable are as follows, *H0: There is no relationship between proximity to water and the rate of active orphaning* and *H1: There is a relationship between proximity to water and the rate of active orphaning*.

Proximity to towns and census locations acts as a marker for public pressure to cap. Wells near populations have a greater potential to harm the health of individuals via seepage into drinking water and the release of carcinogenic gases. Additionally, wells that are in close proximity to cities and towns may be more visible and could lead to more pressure from those nearby to cap these wells specifically. The inverse could be true for wells that are comparatively remote as they may not have any additional pressure

associated to cap beyond legal obligation. The hypotheses associated with this variable are as follows, *H0: There is no relationship between proximity to towns and census locations and the rate of active orphaning* and *H1: There is a relationship between proximity to towns and census locations and the rate of active orphaning*.

Lastly, proximity to protected lands captures the same potential for visibility, or lack thereof, as proximity to towns and census locations. Specifically, as these areas are primarily used for recreational activities it has the potential to impact the tourism industry within the state, which as discussed above makes up a sizable portion of the Utah economy. The hypotheses for this variable are as follows, *H0: There is no relationship between proximity to protected areas and the rate of active orphaning* and *H1: There is a relationship between proximity to protected areas and the rate of active orphaning*.

All of the above variables were measured for each individual well as the closest measured intercept that it does not exceed. For a given well, if it is .75 miles away from water, 6 miles from a census location, and 15 miles from a protected area the corresponding variable would be recorded as water 1, census 10, and park 25. For instances where the well was outside the measured distances a 0 was recorded, though functionally due to the variables being observed as strings rather than numbers a stand in such as OUTSIDE could have been used, but 0 was the most efficient way to record this data. Land type was also recorded as a string.

The only other potentially confounding variable would be related to time, whether some of these wells were abandoned during particular eras, either due to economic conditions or regulatory ones. However, this is not functionally measurable due to no record keeping on the timing of orphaning until 2005 or later. While this may sound

shocking it is due to the fact that orphaned wells were not tracked or overseen until 1992 when the state of Utah created their Orphan Well Program (Orphan Well Program 2024). This program manages the capping of orphaned wells on state and private land. The federal government had no such unified program and instead each land manager (BLM, USFS, etc....) had their own individual program creating a disjointed approach to capping. Only in 2023 did the Department of the Interior establish the Orphaned Wells Program Office as part of the Bipartisan Infrastructure Law (Orphaned Wells Program Annual Report to Congress 2023). In sum, the handling of orphaned wells in a systematic manner is a relatively new phenomenon and while the orphanings may have occurred farther in the past all that can be measured is the respective entities response to these orphanings and that begins in 2005. This means no survival model or variable of time would adequately capture any potential trends, thus making them immaterial to our research. Should more accurate records eventually be made available they would be a welcome addition to this research.

ANALYSIS

Table 1

Full Population Analysis

	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	-3.9868	0.1195	-33.356	< 2e-16 ***
Well Land: Private	0.1929	0.1911	1.009	0.312736
Well Land: State	0.7302	0.1938	3.769	0.000164 ***

Note. N = 6,967

Pseudo R2 (McFadden's)=.009

Predicted Probability: State:3.78% Federal:1.84% Private:2.23%

As seen in Table 1 an analysis of the entire population of wells using Active Orphaning as the dependent variable shows an extreme level of significance in relation to wells upon state land. Specifically, we can be 99.9% confident that there is a statistically significant relationship between wells being on state owned land and active orphaning, with a positive z value indicating that wells upon state land are more likely to be orphaned than those upon private or federal. This leads us to reject our null hypothesis of *"There is no relationship between land type and the rate of active orphaning."* Beyond the statistical significance of wells upon state land, the most interesting finding displayed here is the lack of significance associated with wells upon private land despite them operating under a unified system with wells upon state land. Prior to theorizing as to why this may be the case as well as why state wells are more likely to be orphaned, we must examine this data

more thoroughly. As discussed above a random sample of four hundred wells was taken from this population and additional variables were measured, the results of which can be seen below.

Table 2

Random Sample Analysis

	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	-4.10052	1.07256	-3.823	0.000132 ***
Well Land: Private	0.75592	0.75685	0.999	0.317901
Well Land: State	1.56433	0.62425	2.506	0.012213 *
Distance from Town: 10-miles	0.70981	0.68234	1.04	0.298218
Distance from Town: 5-miles	0.65964	0.73491	0.898	0.36941
Distance from Water: 0.25-miles	-0.69445	1.08429	-0.64	0.521867
Distance from Water: 0.5-miles	-0.59092	1.0806	-0.547	0.584486
Distance from Water: 1-miles	0.41678	0.82154	0.507	0.611934
Distance from Water: 2-miles	0.06387	1.05403	0.061	0.951683
Distance from Park: 10-miles	-1.51933	1.46265	-1.039	0.298921
Distance from Park: 25-miles	0.47277	1.08679	0.435	0.663553
Distance from Park: 5-miles	-0.40849	1.20426	-0.339	0.734454

Note. N = 400

Pseudo R2 (McFadden's)=.104

Predicted Probability: State:7.61% Federal:1.64% Private:3.47%

Table 2 identifies a singular variable of significance. Which is again, wells located on land owned by the state, though at a lower level of significance than when examining the entire population. Specifically, this analysis shows that we can be 95% confident that there is a statistically significant relationship between wells being on state owned land and the likelihood they will be actively orphaned, with a positive z value indicating that wells upon state land are more likely to be orphaned than those upon private or federal. This level of significance leads us to reject our null hypothesis of *"There is no relationship between land type and the rate of active orphaning."* This reduced level of significance is most likely due to variance within the random sample as the total number of active orphans across the various land types is not exactly proportional to the overall population. The lack of significance, and the failure to reject the null hypothesis for any other variable in this model is surprising. While there is a general trend of lower Z-scores associated with proximity to water, census locations, and protected lands it is not at a significant level. Base assumption would indicate that wells that could have a larger environmental or health impact would be prioritized in their capping, but as seen above, this is not the case. The sample being examined is small compared to the overall population, meaning the trends identified may not hold true for the entire population.

Table 3

Average time to cap from Active Orphaning Analysis

	Federal	State	Private
Average Days to Cap	2236.15	1879.18	1010.33
Uncapped Wells	11	9	23
Wells Below Average Time to Cap	9	9	1
Wells Above Average Time to Cap	2	0	22

Note. N= 45 Federal, 42 State, and 22 Private

As seen in Table 3, the average time to cap is different between the three land types, with the difference between each being in years and months rather than simply days or weeks. The difference between federal and state capping is most apparent, as the number of uncapped wells above their average is quite close. The data is less conclusive on private wells as all but one uncapped orphaned well on private land is above its average, indicating that the average time to cap will increase in the future. If all those wells were capped today the private average would instead become 1684.78 days between orphaning and capping, which is in line with the hypothetical state average of 1686.76 days, and both still are below the hypothetical federal average of 2236.15 days. The above listed data is only a snapshot of the current status of orphaned wells in Utah.

SUMMARY

The findings above indicate that wells are actively orphaned at a statistically significant higher rate upon state land as compared to federal and private land. Thus, we

reject our null hypothesis. As for why this is the case, I contend it is a combination of management systems and legal requirements in place as well as access to markets. At the state level the higher bonding requirements ought to, in theory, reduce orphanings as there is less of a financial incentive to do so. However, these orphanings are not only lessees walking away but can also stem from bankruptcy or dissolution. The longer periods of inactivity permitted by the state simply allow for an increased probability of a lessee going under as compared to the hard two-year limit implemented by the federal government. The other reason I propose is due to market access and opportunity cost. The federal government has a greater amount of land upon which to drill which incentivizes lessees to cap wells upon federal land at a higher rate so they can drill on other federal lands. Additionally, as seen in Table 3, the state moves more quickly than its federal counterparts when it comes to addressing these orphaned wells, though the time to cap is still on average in an excess of five years indicating that in every way other than the time allowed to remain inactive the state is more aggressive than the federal government in addressing orphanings.

As to why this is not seen with private wells, despite them operating under the same management system as wells on state land, much like wells on tribal land, private wells are also subject to an additional level of oversight. In both instances, they are allowed additional restrictions and a more individualized process for wells. For private wells, the owner of the land may require additional work to be done regarding rehabilitation and may even require an additional separate bond exclusively between them and the lessee using their land. The landowner is also more able to interact with the extraction entity on a regular basis and is arguably more invested in their private property

purely from the aspect of scale. Even should the state care deeply about its public lands the sheer amount makes such individualized interaction untenable. The same applies to wells upon tribal lands as the area is smaller than that which is owned by the federal government.

In sum, the state government sets a higher bond likely to deter orphaning and in cases where orphaning does occur the bond will cover more potential costs but allows longer periods of inactivity which increases the chances of a lessee dissolving, though the state does respond more rapidly when these orphanings do occur. Despite federal bonding requirements being lower, failure to abide by these requirements may block access to drilling nationwide. Due to the large amount of land managed, and previously compartmentalized approach, the federal government is slower to remedy orphanings that do happen. Tribal and private wells are able to take a more individualized approach to wells due to the smaller amounts of land and wells under their control. The combination of this individualized approach and higher bonds means tribal lands are uniquely resilient to orphaning and orphanings on private land happens at a rate that is statistically insignificant, however due to the state taking care of orphaned wells upon private land the time to remedy is comparable with wells on state land.

MOVING FORWARD

While this analysis considered itself exclusively with oil and gas wells within Utah the process used lends itself well to other areas of management. Lands management is so much more than oil and gas wells and while the data and trends examined and

uncovered in this thesis are significant it is only a small piece of the greater discussion surrounding ownership and management of lands in the Western US. The most obvious next course based upon this research is to expand the states examined to all of those in the Western US allowing for a comparison of how the states in general compare to the federal government. Perhaps Utah is an outlier and has an excess of orphaned wells when compared to its western neighbors, or the federal government may uniformly have fewer orphaned wells. Proposed changes to the federal code that may see bonding prices increase 10-20x (Groom 2023) meaning this analysis may be worth conducting again in 5-10 years' time. This process in turn lends itself to examination of other aspects of lands management including water quality, mining, game animal health, non-game animal health, grazing land health, and forest health. In conjunction with oil and gas wells this would allow for a more wholistic examination of the differences in outcomes of state and federal management styles which in turn allows for an entirely new area of conversation to occur when discussing who should control public lands.

CONCLUSION

While the findings herein have been shown to be statistically significant, their functional significance cannot be understated either. While the rates of active orphaning may only vary by 1.94% between federal and state, this is a projected difference of thirty-seven more actively orphaned wells than if the state were in line with the federal rate. When including private wells under state management this number changes to a projected difference of forty-six more actively orphaned wells. As discussed above, the costs of these wells are very real not only in their environmental and health impacts, but also in

their dollar cost. As it now stands the projected cost of capping these wells on state land would be $14.9 million. This estimation is conservative, as it is using the average cost to cap and ignores the depth of Utah wells and the state's rugged topography. While zero orphaned wells should be the goal, there are clear steps that Utah can take to reduce their rate of active orphaning. In doing so they would not only be saving the taxpayers money but helping protect their health and the health of the environment.

This thesis aims to open up a new area of research regarding management and ownership of public lands in the Western US. Many have written about the legal status of these lands, and many have made emotional appeals about the same. Though rich literature exists surrounding the measurement of various outcomes in regard to land management, often by the controlling entity themselves, little to no work has been done comparing these various outcomes across management styles. This is the first step in creating a more wholistic literature on exactly that. By taking a comparative and quantitative approach to measuring and discussing management strategies and their respective outcomes, this work allows for a more data driven approach to discussing the issue of lands management in the west. To be sure, the issues will always be rooted in political dealings due to the political and legal nature of the dispute but by increasing the amount of information available and increasing the quality of the information available perhaps this issue may be debated with less violence and potentially put to rest. If not, perhaps the agencies responsible for the land will be better able to identify problems within their own management strategies, resulting in a healthier and more harmonious relationship with the land, which is the ultimate goal of all lands management.

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APPENDIX

Well Data: https://doi.org/10.7910/DVN/MR4MF0