Is There a Subnational Resource Curse in the United States? Evidence From a Geographically Weighted Regression Analysis

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Is there a subnational, state-level "Resource Curse" in the United States? It may be that the lack of a consensus on the existence of a subnational Resource Curse is because the results of previous inquiries have been contingent upon a state's level of national political centralization. US states, having much autonomy in their constitutional and institutional design, are decentralized power centers that may be disparately susceptible to the phenomenon of the Resource Curse. Given this decentralization, I hypothesize that a subnational resource exists in the contiguous United States. Using a Geographically Weighted Regression Analysis in ArcGIS, point data from the USGS, and corruption data FiveThirtyEight, I find evidence that a given US state's increased density of mining and high-value mineral sites is associated with higher corruption ratings as measured by two separate indices. Future research will integrate other high-value natural resources – namely, proven oil reserves – into this analysis.

INTRODUCTION

The Resource Curse hypothesis is a captivating facet of the literature that seeks to explain why a state's endowment with bountiful natural resources may actually result in weak political institutions and, therefore, lower levels of economic growth in the long-run.[1] Richard Auty first introduced this idea in the early 1990s and shifted the way scholars thought about low quality institutions and their relationship with geography. Columbia University's Jeffrey Sachs and Andrew M. Warner further cemented the Resource Curse into the literature with *Natural Resource Abundance and Economic Growth* (1997).

Sachs and Warner used a model measuring the statistical relationship between the share of a country's GDP that comes from natural resource exports and future economic growth while controlling for 9 other predictors of growth tendency.[2] In Sachs et. al (1997)[3], a simple correlation between export-led growth (with the growth of manufactured exports used as a proxy) and overall economic growth underpins the possible validity of the following explanation: Natural resource abundance decreases the need for export-led growth[4]; export sectors in such economies are not as likely to be competitive; thus, export-led growth is less

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[1]("Brief History: The Resource Curse," 2010)

[2]From the methodological section of Warner and Sachs' Natural Resource Abundance and Economic Growth

[3]Sachs, J.D., Radelet, S., Lee, J.-W., 1997. Economic growth in Asia. Prepared as background for Asian Development Bank's study: Emerging Asia: Changes and Challenges. HIID Discussion Paper no. 609, May 1997.

[4]Sachs et. al (1997) uses log growth of exports of manufactures multiplied by initial shares 1970 as the Dependent Variable and log natural resource exports as a share of GDPe in 1970 as its Explanatory Variable

likely to occur.

Gylfason et al. (1999) and Gylfason (2000) offer a different explanation for Resource Curse's effect on growth, stating that potential entrepreneurs and innovators will seek high wages in sectors related to the state's endowed wealth, and, therefore, the state will see less growth catalyzing activity.[5]

The explanation for the Resource Curse that I aim to test in this paper, however, is of a more political nature and can be described as such: Governments require revenues; governments will choose the simplest way to acquire those revenues; the presence of easily extracted, high-value resources presents governments with a simple way of maintaining revenues; in the absence of such resource abundance, governments tend to invest in quality institutions that will allow taxpayers to thrive with the purpose of acquiring tax revenues; thus, resource abundance incentivizes governments not to invest in high quality, development-oriented political institutions.

This theory is described in the European Economic Review's summary of the Resource Curse,

> "Since natural resource rents are concentrated and (in some cases) easily appropriable, government officials in such countries are tempted into rent-seeking and possible corruption rather than pro-growth activities. Natural resource countries would thus experience lower innovation, lower entrepreneurial activity, poorer governments and lower growth. Also important are Auty (2000)'s points about how the political process gets captured in resource-abundant economies. This is another form of crowding in which a predatory state eclipses the developmental state."[6]

[5]Summarized by the European Economic Review in May, 2001

[6]European Economic Review, Volume 45, Issues 4-6. The review summarizes the Resource Curse literature

An Institution Based Explanation of Economic Growth?

According to latter theory of the Resource Curse's cause – the theory that this paper tests at the subnational level – the causal relationship can be described as such:

Presence of Natural Resources -> Poor Political Institutions -> Increased Corruption

It is intuitive that poor institutions and high levels of corruption affect a state's economic growth. Furthermore, the concept of the Resource Curse exists in tandem with what is often called the Settler's Hypothesis; which, among other things, contends that the quality of a state's institutions is the chief explanatory variable in determining the long-run prosperity of that state.[7] (Acemoglu et al. 2001) This is most evident in the disparities between border-towns across the globe. Any visitor to both Nogales, Sonora (Mexico) and Nogales, Arizona (USA), two cities 3.2 miles from one another[8], will certainly observe the difference between the quality of life[9] of the two cities' constituents.[10]

Yet, this seems to contradict the logic of the Resource Curse. If it is the presence of natural resources that determines a state's institutions, and border-towns presumably have similar natural resource endowments, why is it that some border towns would have such different institutions (and therefore, economic outcomes)? One answer to this question is that the municipality's institutions are determined by the presence of natural resources in that country or province as a whole, not the local municipality. In other words, the Resource Curse functions on a much larger scale than

[7]Acemoglu et. al (2001), (pp. 1369) of the American Economic Review Vol. 91 No.5

[8]According to Google Maps

[9]In this paper, "quality of life" or "prosperity" are defined in conventional terms. For example, a high quality of life in a state is typically determined by high rates of life satisfaction or per-capita GDP

[10]For further reading, see What Makes Nations Rich? One Economists Big Answer, in (Acemoglu, 2009) for Esquire Magazine

that of two border-towns. It affects institutions at the subnational and national levels. As such, one shouldn't compare Nogales and Nogales's levels of natural resources, but compare Mexico and the United States to explain the different institutions in the two Nogales.

Sachs' and Acemoglu would agree that poor institutions are a cause of weak growth, but have different approaches in explaining why the poor institutions exist in the first place. Acemoglu et. al (2001), *The Colonial Origins of Comparative Development: An Empirical Investigation*, explains the current lot of the various territories colonized by European empires from the 15th century onward by contending that the quality of the institutions installed in these newly colonized territories was contingent upon whether or not the colonizer intended to settle Europeans there or exploit the natural resources of that territory with the labor of native peoples and a European minority ruling class.[11] In their research, determining whether a territory was a "settler colony" was done by determining if the territory had particularly high settler mortality (typically due to disease).[12]

Acemoglu, Johnson, and Robinson summarize their theory's causal arrow as such:

> "Potential Settler Mortality -> Settlements -> Early Institutions -> Current Institutions -> Current Performance"[13]

A commonly cited comparison is that of Jamaica and Canada. Jamaica was "cursed" by abundant sugar and boasted dismal settler mortality rates of 130/1000 settlers. Jamaica was thus not deemed a settler territory and the quality of installed institutions reflected that. This, in an Acemoglian framework, at least partially determines Jamaica's poor growth in recent decades. Canada, on the other hand, was not thought to be a land of riches at the time of its initial English settlement.[14] The French philosopher, Voltaire, famously quipped during the French and Indian War,

> "You know that these two nations are at war for a few acres of snow in Canada, and that they spend over this beautiful war much more than Canada is worth."[15]

Moreover, Canada's settler mortality was estimated to be 16.1/1000, 8 times lower than that of Jamaica.[16] For the British, it is clear why a different colonial approach would be taken in Canada with regard to institutional design.

METHODOLOGY

Who is correct about the cause of poor political institutions? I aim to help answer that question by answering whether or not the Resource Curse manifests itself at a subnational level. To do this, I use the contiguous United States as a case study. To clean the model of omitted variables that may be difficult to include or ascertain, as might happen if one looked at comparative international data, I use the "natural experiment" of the US states to analyze how the presence of mining and mineral sites affects a state's institutions (note that these sites are not a proxy for all high-value natural resources). The United States is an excellent candidate for this analysis because its federal system allows US states to shape their own institutions, but is still centralized enough to rid this analysis of some endogeneity.

[11] See 7

[12] In Acemoglu et. al (2001), Settler mortality rates are used to estimate the effect of institutions on economic performance (pg. 1369), noting that mortality rates serve as a proxy for determining which sets of institutions would be installed (pg. 1374)

[13] Acemoglu et. al 2001, American Economic Review pg. 1370

[14] The first Canadian oil well was not drilled until 1858, the British had been in Canada since the early 17th century. ("Cupids, Newfoundland: Canada's First English Settlement | The Canadian Encyclopedia," 2015), ("Canada's Oil & Gas Milestones | oilandgasinfo.ca," 2016)

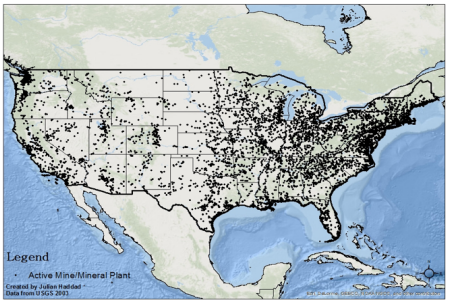
[15] Warfare Quotes: Voltaire ("Shmoop," 2016)

[16] All Data on Jamaican and Canadian Settler Mortality Rates from Appendix Table A2, Acemoglu et. Al 2001: American Economic Review pg. 1398

First, I use shapefile data from the US Geological Survey on active mines and mineral plants in the United States in the form of point data.[17] Though I was working with string variables, I speculated that the density of those string variables might be a useful way of visually illustrating the distribution of mineral resources in the United States. Using the Density tool in ArcGIS, I plotted the density of mining and mineral sites masked by the USA shapefile.[18]

Experimental Design

FIGURE 1



It is clear from Figure 1 that active mines and mineral plants in the US are concentrated in the Northeast and Great Lakes regions, with some mines scattered throughout the rest of the country. Figure 2 illustrates this distribution in the form of a density map. Figure 3 is a spatial interpolation of the active mines and mineral sites in the United States. In other words, it plots where one would expect to find mines and mineral sites given the data at hand.

Making a map of subnational institutional quality, however, is complicated by the fact different measures of institutional quality may indicate disparate levels of corruption in the same subnational state. What defines a strong or high-quality institution is, of course, not universally agreed upon. For the sake of simplicity and staying within the framework of research on the Resource Curse, I sought data that illustrated relative levels of government transparency and internal government accountability. Our first indicator is Convictions (for corruption) per Capita. This, however, is hardly a perfect indicator of corruption or poor institutional quality. As one might imagine, a state with endemic corruption might have less convictions due to judicial corruption. From a qualitative perspective, however, one could argue this is less likely to be an issue in the United States, which ranked as the world's 18th least corrupt country in 2016 by Transparency International[19] and has had a score (with 100 being the cleanest and 1 being the most corrupt) between 71 and 78 over the past two decades.[20] In short, convictions per capita is a far-from-perfect measure of corruption, but it is a measure that can be expressed quantitatively and therefore made it a useful supplement to this inquiry. Each state was ranked 1-50 (1 being the least corruption convictions per capita; 50 being the most) and the relevant data was compiled by the Center for Public Integrity's in their 2015 State Integrity Investigation.

In order to strengthen my research design through the addition of a more holistic measure of corruption, I also included an index of political reporters' ratings of how corrupt the areas of government they reported on were from the same 2015 State Integrity Investigation.

> "They asked them about illegal corruption ("the private gains in the form of cash or gifts by a government official, in exchange for providing specific benefits to private individuals or groups") and legal corruption ("political gains in the form of campaign contributions or endorsements by a government official, in exchange for

[17]("Active mines and mineral plants in the US in 2003," 2017)

[18]For the purposes of this paper, I look only at the contiguous United States using the most recent year the data on this subject matter was available: 2003

[19]From Transparency International's 2016 report, https://www.transparency.org/country/USA

[20]According to Trading Economics' reference to past Transparency International Reports at ("United States Corruption Index | 1995-2019 Data | 2018-2020 Forecast | Historical," 2017)

providing specific benefits to private individuals or groups, be it by explicit or implicit understanding)."[21]

Each US state was assigned a numerical score based on the aforementioned interviews.

The data, then reworked by FivethirtyEight, listed each state by their ranking of least to most corrupt by either their Reporter Rating or Corruption Convictions Per Capita. I transferred that data to a .csv document and included central Latitude and Longitude for each state. After cleaning the data for use in ArcGIS, I joined it with the subnational US shapefile data from gadm.org. Then, I displayed the gradation of each corruption index, with red being the most corrupt in both exercises.

[21]Many thanks to FiveThirtyEight, whose team cleaned much of the data provided in the State Integrity Investigation to make it more accessible: (Enten, 2015)

FIGURE 2

Active Mines and Mineral Plants in the US (USGS 2003)

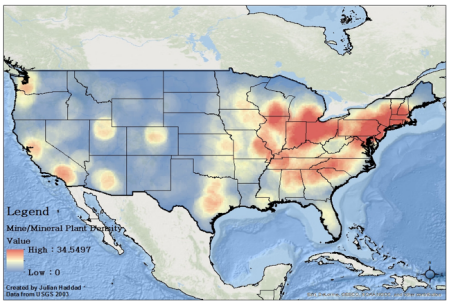


FIGURE 3

Spatial Interpolation:
Active Mines and Mineral Sites (USA 2003)

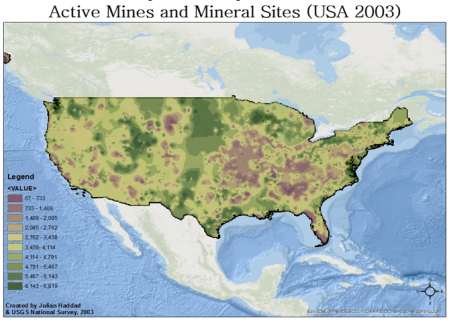


FIGURE 4

Reporter Ratings of Corruption in US States (2015)

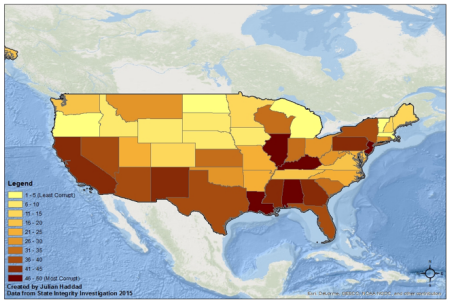


FIGURE 5

Reporter Ratings of Corruption in US States (2015)
& Active Mining / Mineral Sites (USGS 2003)

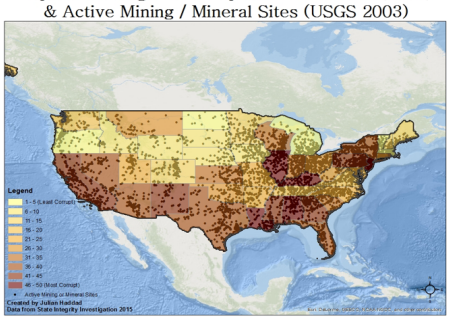


FIGURE 6

Corruption Convictions Per Capita in US States (2015)

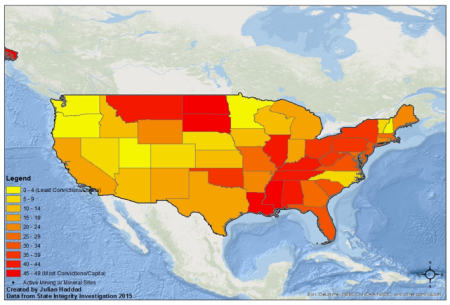


FIGURE 7

Corruption Convictions Per Capita in US States (2015)
& Active Mining / Mineral Sites (USGS 2003)

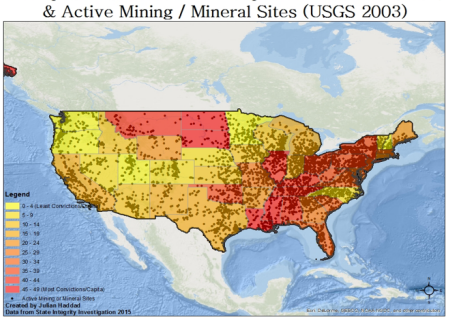
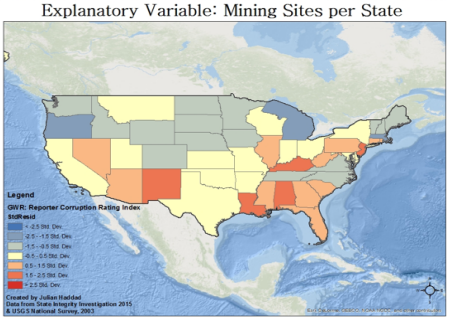


FIGURE 8

GWR: Dependent Variable: Reporter Corruption Rating Index
Explanatory Variable: Mining Sites per State



Expressing Corruption Indices in Excel and ArcGIS

To get a preliminary idea of how my hypothesis mapped onto the real world, I made the corruption indices transparent for each iteration and displayed all active mineral sites under them. Figure 5 and Figure 7 both show that the density of mining and mineral sites appears to be correlated with higher ratings of corruption. In Figure 7, we see that California *should* be "more corrupt" with regard to convictions per capita than it is shown to be based on its density of mining sites. The model maps on better in California, additionally, when predicting the relationship between the Reporter Rating Index and mining site. This may indicate weakness in the model, that corruption and poor institutions manifest themselves differently in different states, or some combination of both assertions.

To move forward in a more statistically robust manner, I conducted two Geographically Weighted Regressions using the GWR tool in ArcGIS. After rasterizing the point data on US mining and mineral sites to include a field that stated the frequency of a US state containing mining and mineral sites, I used this frequency variable as the explanatory variable and Convictions per Capita / Reporter Rating Index as the dependent variables in both two regressions.

FIGURE 9

GWR: Dependent Variable: Convictions Per Capita
Explanatory Variable: Mining Sites per State

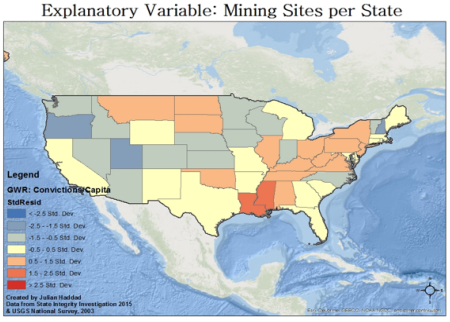


TABLE 1. Geographically Weighted Regression 1

Dependent Variable: State Reporter Ratings Index	
Explanatory Variable: State Mining/Mineral Site Density	
Bandwidth	906.72059168746637
Residual Squares	9268.9485610693318
Effective Number	2.0050357116263844
Sigma	13.754332323309887
AICc	416.58076750803411
R2	0.11583956492184466
R2Adjusted	0.097702745659552948

TABLE 2. Geographically Weighted Regression 2

Dependent Variable: Convictions per Capita Index	
Explanatory Variable: State Mining/Mineral Site Density	
Bandwidth	39.691624442777467
Residual Squares	9543.592349782266
Effective Number	4.2610689781310898
Sigma	14.289484198508344
AICc	421.41620422367481
R2	0.12514925884983297
R2Adjusted	0.064109167643533804

RESULTS

We observe a higher adjusted R-squared in the GWR analyzing the relationship between Reporter Ratings and Mining/Mineral site density and this is visualized in the GWR maps. In Figures 8 and 9, a more neutral color indicates that the model holds more true in that area, as it indicates the lowest amount of standard errors. Synthesizing both maps, we see that the model is the most accurate when observing Tin deposits the mid-south of the country (Texas, Oklahoma,etc.) as well as in California in both iterations of the regression.

This analysis indicates that there is indeed a correlation between the density of mining and mineral sites and a US state's propensity to have poorer political institutions as indicated by two measures of corruption, where corruption serves as a proxy for poor-quality institutions. The discrepancies between the rating of each state's political institutions based on the two measures of corruption remains an issue with the experimental design. Another limitation to this investigation is the sole focus on mining and mineral site density, since minerals are not the only type of high-value natural resource that one would reasonably expect to "trigger" the Resource Curse. Further research should also include oil reserves and other high-value natural resources as they relate to corruption.

This investigation, though, adds evidence to the notion that the Resource Curse exists at a subnational level and, specifically, the notion that easily extracted resources can result in predatory governments. The significance of this research and the literature as a whole is clear. Understanding the causes of poor institutions is the first step to improving those institutions and the quality of life of their constituents. Even within the United States' highly developed economy, it is fascinating to observe that the Resource Curse hypothesis gives insight into the institutions of subnational governments; and, that the developed world may

not be immune to the effects of the Resource Curse through its subnational manifestations.

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