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Impact of local government revenue and spending during oil and gas booms in the Rocky Mountain States

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IMPACT OF LOCAL GOVERNMENT REVENUES AND SPENDING DURING OIL AND GAS BOOMS IN THE ROCKY MOUNTAIN STATES

By

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Rural counties in the U.S. Rocky Mountain States have historically experienced oil and gas cycles that increase employment opportunities and income during early and peak phases, but in the long run are unable to sustain growth. This paper examines the important question of how counties can use rents obtained from oil and gas extraction to sustain growth after a boom. Other research focuses on whether resource abundance is a curse or a blessing and explores political and market mechanisms to explain the relationship between resources and observed growth. The theory of weak sustainability argues that if rents from the extraction of non-renewable resources are reinvested into other forms of capital growth can be sustained. Using panel data from 1969-1998, I use a difference in differences fixed effects model to test the theory of weak sustainability using local government spending as a proxy for investment choices. I find that boom counties do receive rents and do spend a statistically significant higher amount on highways and education. With some limitations, I also find high per capita changes in highway spending are related to lower per capita income levels in the post bust period, while high per capita changes in education were related to higher levels of per capita income for the same period.

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Chapter 1: Introduction

Rural communities that have historically been dependent on natural resource extraction for economic growth are particularly susceptible to booms and busts. Booms occur when new discoveries are made or when commodity prices rise. Then when prices fall busts occur and the area can be worse off than before the boom occurred. The boom can create an influx of non-local, and in many cases transient, workers. This can diminish social cohesion. Housing prices may be driven upward which can drive out permanent residents. Unemployment rates may increase from pre-boom rates, because population has increased but jobs outside of the natural resource industry have diminished. Other jobs may diminish because the upward pressure on wages causes closure of other businesses. This may lower per capita income from pre-boom levels. The extra population may result in excess usage of community infrastructure and natural amenities making the area less attractive to new populations. In short, the idea of a boom sounds appealing because employment opportunities and income rise quickly, but in reality may be detrimental to a community.

New discoveries and increases in commodity prices can create new communities or bring new life to stagnant communities. At some point commodity prices begin to fall and a bust period follows. During the bust, employment opportunities, incomes, and populations fall. There is a common bumper sticker in the Rocky Mountain States - "Please God, just give me one more oil boom, I promise not to blow it next time." The hope is the next time they will save and invest during the boom to improve sustainable well-being after the boom. The cycle is so prevalent the Center for the American West held a conference in 2002 entitled *Boom and Bust in the American West*. The conference was a gathering of researchers and policymakers designed to provide insights to westerners on the role of the boom and bust cycle in the American West. One of the seven desired qualities of a sustainable west, detailed in the conference report, is a more precise wording of the common bumper sticker, "A West that takes advantage of the opportunities presented by a boom, to make long term investments that would soften the severity of a future bust" (Limerick 2002). This goal forms the basis of this research – how can local governments

take advantage of the opportunities and invest rents to sustain growth rates and mitigate the severity of a bust?

Rural communities in the Rocky Mountain west of the United States have been particularly susceptible to the boom and bust cycle since the 1540 failed Spanish expedition (Limerick 2002). Since that time, communities have sprouted and died based on coal, gold, copper, oil and gas, and the presence of other natural resources. Oil and gas booms have been particularly important in shaping communities of the Rocky Mountains since the middle of the last century because of vast new discoveries and large fluctuations in prices. Florence, Colorado has the claim to fame of being the second commercial drilled oilfield in the United States (1860s), and the first in the Rocky Mountains (Colorado Oil and Gas Association 2012). Wyoming's first commercial oil sale of 150 barrels to Union Pacific Railroad also occurred in the late 1860s (Roberts n.d.). But it was almost 50 years later when the first Wyoming boom occurred in 1908 near Casper (American Oil and Gas Historical Society n.d.). New Mexico's first commercial drilling occurred in 1922 in the San Juan Basin. Utah's oil and gas history is more recent with the first commercial drilling occurring in the Unita Basin in 1948. And, in North Dakota the first discovery was of the vast Williston Basin in 1951 (American Oil and Gas Historical Society 2017).

Two factors ensure that the west will continue to experience booms and will have the opportunity to finds methods to sustain growth after the boom. First, the United States became an exporter of natural gas for the first time in 2016. And second, as illustrated in Figure 1 there are many large shale plays in the region. Haelefe and Morton (2009) argue for slowing the pace of oil and gas development and production as a method to improve long-term outcomes. However, it seems unlikely that small rural communities will have the ability to impact world oil and gas prices or alter the pace of development. Research focusing on how local policymakers can invest incomes to improve outcomes will provide valuable insights.

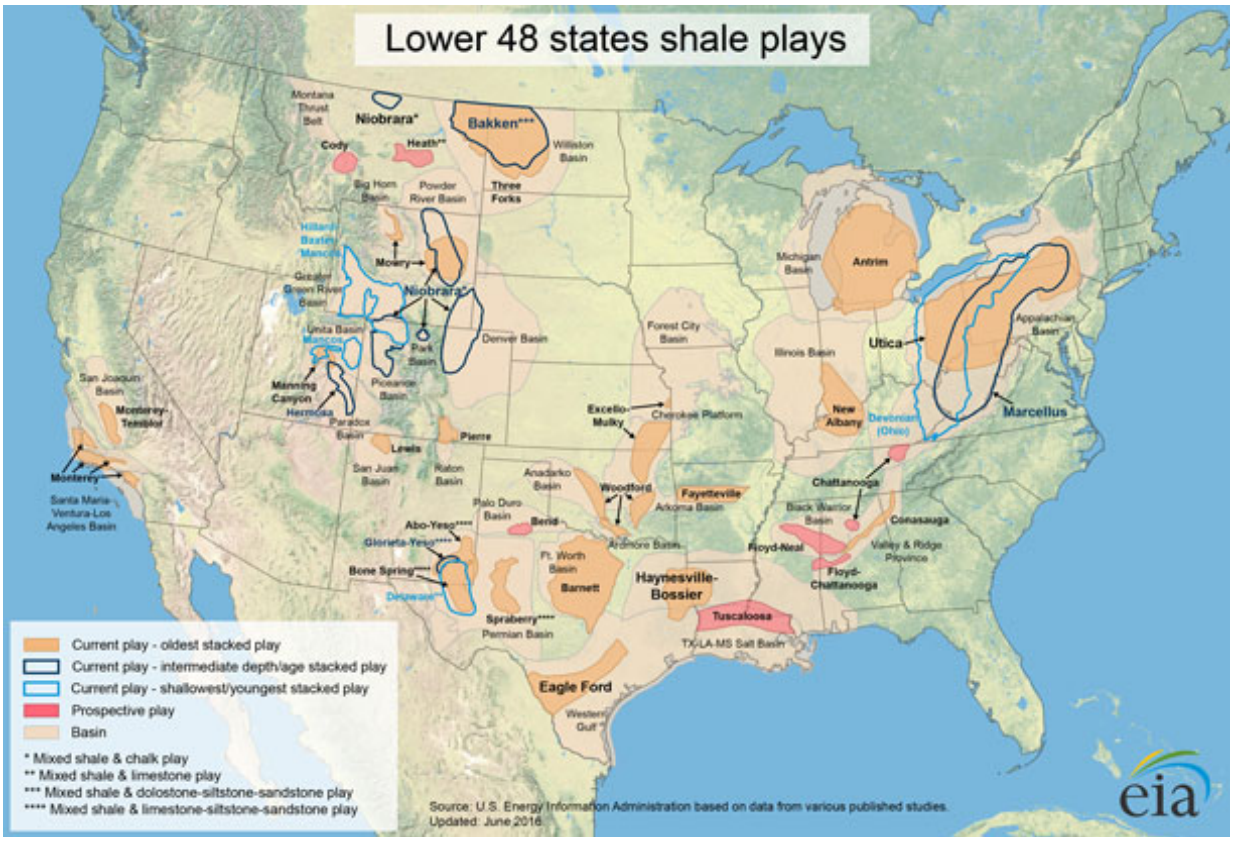


Figure 1: Shale plays in the lower 48 states

The importance of studying this question, of how rural communities can invest during booms to minimize the impacts during the busts, goes beyond gaining a better understanding of the boom and bust cycle. Rural communities in the United States are having trouble retaining populations and improving the well-being of their citizens, particularly those that are more remote, and they are important to a region. In the west, these communities are important for food, energy, water, and economy and many are struggling both economically and socially (Headwaters Economics 2017). In addition, they serve as gateways and managers of vast areas of public lands. These vast public lands bring appreciation of open space and sense of place to communities which encourage them to focus on sustainable development rather than population growth (Power 1996). Figure 2 highlights how many counties in the Rocky Mountain are classified as level four, living 15 minutes or further from a population above 2,500 and 60 minutes or more to a population above 50,000, for remoteness.

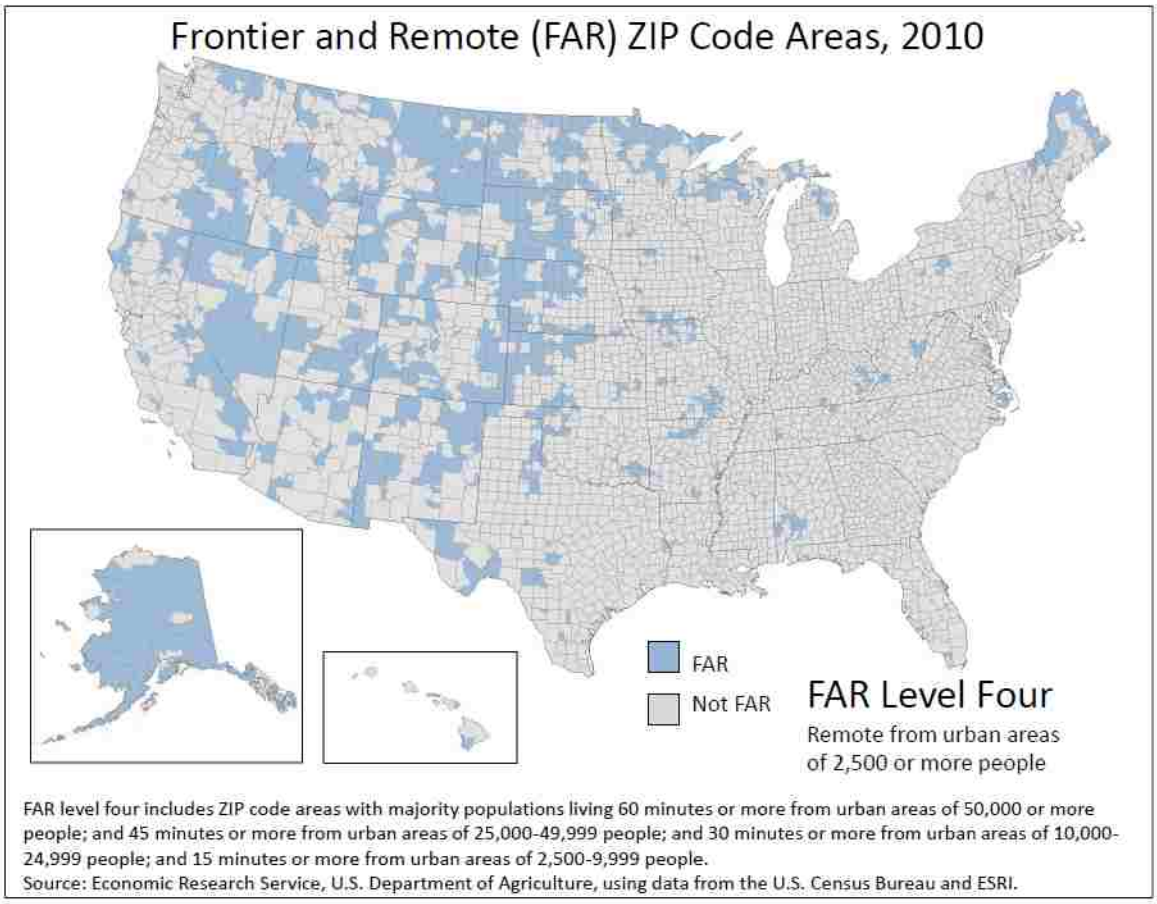


Figure 2: Remoteness level of counties in the United States

The impact of booms is part of a larger question on the role of resource abundance for growth and development. Economic studies of resource abundance tend to focus on the presence of resources and patterns of development. Booms provide an opportunity to study how rents from these resources flow through the economy. Others mostly study how the flow impacts current measures of welfare rather than development. To understand how resource abundance, and the extraction of those resources during booms, impact well-being in the future we need to examine how income increases are spent. This study builds upon other research by examining impacts of oil and gas booms on local government revenue and spending and the impact of spending choices on growth patterns in the bust and post-bust period.

Spending of additional incomes can be for current welfare or for future welfare (see Figure 3 for a description of measurements and indexes of current and future well-being). Consumption

and investment choices are made in the private and public sector. Public choices are compelling because they impact the desirability of a location and its' ability to attract and maintain residents. According to Keller (2000), the leading indicators of deep rural survival are the presence of quality education institutions, cluster activities in the local area, sustainable base populations of 5,000 or more, and a balance between retired and working populations. Public spending and investment choices can influence each of these indicators and therefore can influence outcomes during busts.

	Current welfare	**Current wealth (Capacity to generate future welfare)**
Economic Measures	Income Consumption Wages Employment	Physical capital Human Capital
Broader welfare Measures	Well-being Quality of life	Physical capital Human capital Environmental quality Social capital

Figure 3: Classification of terms

The goal of this study is to ask if, and how, local government choices during the peak boom improves outcomes during the bust period through capital investments in rural communities. More specifically, I ask the following two questions. First, did local government revenues and expenditures increase in boom counties, relative to non-boom counties, during the boom cycle? And, second, do increased investments into other forms of capital during the early and peak boom period improve a community's ability to sustain the pace of development after the boom ends?

The next chapter, Chapter 2, examines the how the economic literature of resource abundance and booms helps to answer impacts of resources on economic and welfare measures during different time periods and phases of the boom cycle, but has yet to extend studies to explore why particular impacts happen during the bust. Chapter 3 uses sustainable development and

community economic development theory and studies to provide a framework for analyzing how local government investments during a boom create new wealth to be used to improve outcomes during the bust. Chapter 4 looks at the data used to perform my analysis. Chapter 5 presents the two stages of the analysis. The first stage examines whether local government revenues and expenditures increase during the early and peak boom period in boom counties. The second stage analyzes how large increases in local government investment impact outcomes during the bust period. In Chapter 6 assumptions are tested, robustness is checked, and limitations are discussed. In the final chapter, contributions of the study and ideas for further research are presented.

Chapter 2: Resources in the economics literature

The starting point of most research on resource abundance and the impact of booms is the increased level of employment and income in the specific resource sector. From that point research branches into several theoretical, methodological, and geographical directions. Most research to date has focused on the level and duration of the income and employment increases, increases in employment and income in other sectors or geographic regions, and mechanisms causing changes in other sectors. The exploration of mechanisms causing changes to other sectors is based on theories that diversification of the economy will improve the opportunities for future well-being in the economy. However, a gap exists in studies that explore how the choice of spending for current consumption or investing for future potential consumption impact outcomes during the bust and post-bust periods. Filling this gap first requires examination of whether economies make different spending choices, between current well-being and future well-being, during the boom. And, then how these choices impact future well-being, that is, well-being during the bust and post-bust period. This is important because economies with higher level of investment of the additional income should be more capable of sustaining well-being levels after the boom.

There are competing theories regarding the impact of resource abundance on development. The positive role of resource abundance was first put forth by classical economic theory. Classical economists hypothesized that economies with abundance of natural resources have a comparative advantage in trade with others (Ricardo 1817) and increased opportunities for agglomeration (Smith 1776). Mechanisms through which agglomeration occur are sharing facilities, sharing suppliers, sharing the gains from individual specialization, sharing a labor pool, better matching, and learning (Puga 2010).

Evidence in support of this theory has not been observed empirically. A phenomena that has been noticed since World War II, is that countries abundant in natural resources have been slower to grow than countries with relatively low levels of natural resources. Several reasons have been put forth to explain this phenomena, both economic and institutional, and are well outlined by Venables (2016). The most commonly known explanation, labelled Dutch disease, is

that the high exports of natural resources cause an increase in the country's exchange rate. This results in contraction in the manufactured sector. This contraction then leads to the loss of learning-by-doing (if there are production externalities from manufacturing) and slows economic growth.

There are other theories that also explain slow growth in resource abundant countries. Sachs and Warner (1997) explain it is not necessary for production externalities from manufacturing to be present to slow growth in countries with large levels of natural resources. Growth can also be slowed by choices made by multiple generations in a resource abundant economy to opt out of additional education, higher economic rents leading to rent seeking behavior, and the volatility of the price level of the natural resources. Additional mechanisms are negative genuine savings by the economy in anticipation of better times in the future and unstainable policies (Van der Ploeg 2012). Unstable policies are the result of weak institutions and allow rent seeking behavior to occur.

Regional studies have been conducted to study within country resource abundance because this allows for controlling the institutional weaknesses plaguing country level studies. By controlling for country level institutions, researchers are able to focus on other mechanisms which improve or hinder growth in resource abundant economies. The results of within country studies are mixed in whether resource abundance hinders or improves growth. Fleming, Measham, and Paredes (2015) studied regions in Australia and found that in most instances abundant resources have proved beneficial to economic growth. Dube and Polese (2015) examined 135 urban areas in Canadian and found that resource abundance proved positive in about half the cases and negative in the other half.

Several studies have also been conducted in the United States. Michaels (2011) found a positive relationship between oil abundance and long-term economic growth within the Southern US from 1889-1990. In 1889 oil abundant counties were similar to all other counties because oil had not been discovered. In exploring the difference in growth patterns for oil abundant counties through 1990, Michaels finds they had higher population growth, higher per capita incomes, and better infrastructure. More specifically, he finds evidence of agglomeration for resource

abundant counties. An important difference is that the counties in the south are not hindered by the level of remoteness found in the Rocky Mountain States.

In the most comprehensive study in terms of length of time period, Clay and Partnykh (2016) analyze US states for the period from 1880-2012 and find the impact of natural resources on the growth of per capita income was dependent on the resource, the time period, whether there was an increase or decrease in the resource and the empirical model specification. Model specification includes the choice of dependent variable, measures of resources, estimation techniques and time frames.

In the absence of clear evidence for either a positive or negative impact of resource abundance on growth, others have studied how a resource boom impacts current welfare measures. Power (1996) summarizes it well by saying, "Because mining is relatively unstable owing to…fluctuating commodity prices…, it is a laboratory of sorts in which to study the impact of changes in one sector's employment and income on the rest of the economy." Within the United States, studies of the 1970s and more recent oil and gas booms have focused on the impact of the boom on employment and income in other sectors of the economy.

Weber (2014) and Brown (2014), studying shorter and more recent time periods find positive impacts to employment and income from increased oil and gas development from 2000 to 2010 (Weber 2014) and 2011 (Brown 2014). Weber studies counties in Oklahoma, Texas, Louisiana, and Arkansas, while Brown looks at impacts in these four states plus New Mexico, Colorado, and Wyoming. Brown finds that one rig added 171 jobs in the long run in the time period he studied, but argues that as technological advances continue employment will be less responsive to changes in drilling. This argument further advances reasons for focusing on how county governments can utilize rents from resource extraction to improve prospects for future growth. Weber (2012) also found positive impacts between oil and gas production and per capita income and employment in three Rocky Mountain States, Colorado, Wyoming, and Texas, from 2000-2008. These studies are interested in determining whether the employment and income effects predicted by input-output models were accurate. While they all find positive effects to income and employment, the effects are well below those estimated by input-output models.

Two other studies that focus on western states have also found short-term positive impacts in boom counties, but have found negative impacts during bust and post bust periods. Haggerty et al. (2014) examine the effects of specialization in oil and gas production from 1980 through 2011 and conclude as the length of time of specialization increases the effects to per capita income decrease and the county experiences significantly higher crime rates and lower percentages of population with a college degree. Jacobsen and Parker (2016) examine the effects of being in a boom county from 1969-1998, a clear oil and gas cycle. They find boom counties experience higher increases in per capita income, employment, and population growth. They are particularly interested in outcomes during the bust and post-bust period and find that on average boom counties began the cycle with high per capita incomes, but by the post-bust period on average had lower per capita incomes.

The three studies on western states use different time periods, geographic regions, specifications of what constitutes a boom, and empirical methods for analyzing impacts. Weber (2012) examines counties in Colorado, Texas, and Wyoming from 1998/99 – 2007/08 using a triple difference in differences empirical method and finds increases in oil production in a county increased employment and median household incomes. Weber divides the counties by calculating the change in gas production from the base year 1998/99 to 2007/08. Twenty five percent of the counties experienced an increase in oil and gas production, fifty percent experienced no change, and the last twenty five percent experienced decreases. The twenty five percent experiencing increases are labeled as boom counties. Counties that share a border with a boom county are excluded from the analysis to control for spill-overs.

Haggerty et al. (2104) take a different approach expanding both the time period, geographic region, and the scope of impacts. Their study covers six of the Rocky Mountain States from 1980-2011: Colorado, Montana, New Mexico, North Dakota, Utah, and Wyoming. Using the average percentage of per capita income from oil and gas production in the period from 1980-1982, the height of one oil peak, they find the length of the boom has statistically significant impacts on per capita income, the average violent and property crimes rate, and the percentage of adults with a college education. Their method controls for time invariant differences in counties by using control variables.

Jacobsen and Parker (2016) provide a time period and empirical approach for exploring how booms impact local government revenue and spending as well as how choices made during the early to peak boom period influence outcomes in the bust and post bust. They use the period from 1969-1998 and data from new drilling to examine how income and employment are impacted in boom counties during various phases of the boom. Their difference in differences approach and the use of a time period that covers an entire oil and gas boom cycle provides insights into how boom counties are affected throughout the cycle. The length of their time provides sufficient length to use six observations of five year government spending data. In addition, there is sufficient time to test how choices made earlier in the boom impact outcomes towards the end of the process. The model and time period of Jacobsen and Parker (2016) provide an opportunity to delve deeper and explore how choices made impact outcomes after.

According to current economic literature, there is not a consensus on whether resource abundance contributes to or hinders development or whether communities are better or worse after a boom. This leaves open the question of how choices made during the boom can improve outcomes after the boom. Sustainable development and community economic development provide theory and framework to help answer this question.

Chapter 3: Sustainable rural community development framework

Sustainable development emerged as an alternative objective to economic growth during the 1980s. In 1987 the United Nations published *Our Common Future*, also known as The Brundtland Report, and defined sustainable development as, "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." The ideas of sustainability had originally emerged out of ecological economics and the idea that humans (mainly in the developed world) are exceeding the carrying capacity of earth's resources and have a moral obligation to future generations to protect the natural resources for them. Given this context, sustainable development explores the interaction of economic, social and environmental goals.

Underlying sustainable development is the theory of sustainability. The theory of sustainability argues that it is the responsibility of the current generation to maintain the capital stocks of the world to ensure that future generations are provided the same potential for well-being as today's population. Theorists are divided on whether it is necessary to leave the same types of capital or if types of capital are interchangeable for ensuring future potential. Daly (1996) and others believe that human capital and natural capital are not interchangeable, a theory termed strong sustainability. Solow and Hartwick, on the other hand, argue that if the rents resulting from the extraction and production of natural capital, and in particular exhaustible natural capital, are invested in human capital sustainability is still possible (Hamilton 1995).

Many empirical frameworks for sustainable development emerged in the literature. In general, the frameworks list a set of development goals focusing on sources of wealth, indexes for measuring progress towards those goals, and models of how flows through the economy impact a source of wealth. Wealth in the context of sustainable development is more widely defined than economic wealth and in its' widest definition includes the following types of capital: natural, physical, financial, human, social, intellectual, cultural, and political (Pender et al. 2014). Another classification consists of natural, social, human, and built capital assets (Costanza et al. 2016).

Some of the frameworks are more focused on developing countries (Costanza et al 2016), while others examine urban sustainability (Prakash et al. 2016). A conceptual framework for rural sustainable development, specifically for the US, has been created by Pender, Weber, and Brown (2104).

The conceptual framework for US rural sustainable development devised by Pender, Weber, and Brown (2014) focuses on wealth creation through outcomes that are the result of decisions made by local actors within the economic, institutional, and policy context. Decisions include livelihood strategies, investments, production, and consumption. Local actors include individuals and households, businesses, civil society organizations, and local governments. The economic, institutional, policy context consists of markets and technology, laws and regulations, policies and programs, natural phenomena, and conflict or war. The context impacts the wealth of local actors, who constitutes local actors, and outcomes. At the same time, the context is impacted by decisions of local actors. The outcomes of the actors' decisions, which then impact community wealth, can be economic, environmental, or social.

Using this framework (depicted in Figure 4), I consider how decisions made by local government as local actors, between consumption and investments alter future outcomes. Theoretically, from the weak sustainability point of view if local governments invest in other types of capital this should improve a community's ability to sustain the pace of development after the boom. To test this theory, public welfare spending can be considered current consumption, while spending on education, highways, and health and hospitals can be considered investment into future welfare potential. Communities that spend more on future welfare should display higher outcomes during the bust period than communities that spend more on current welfare.

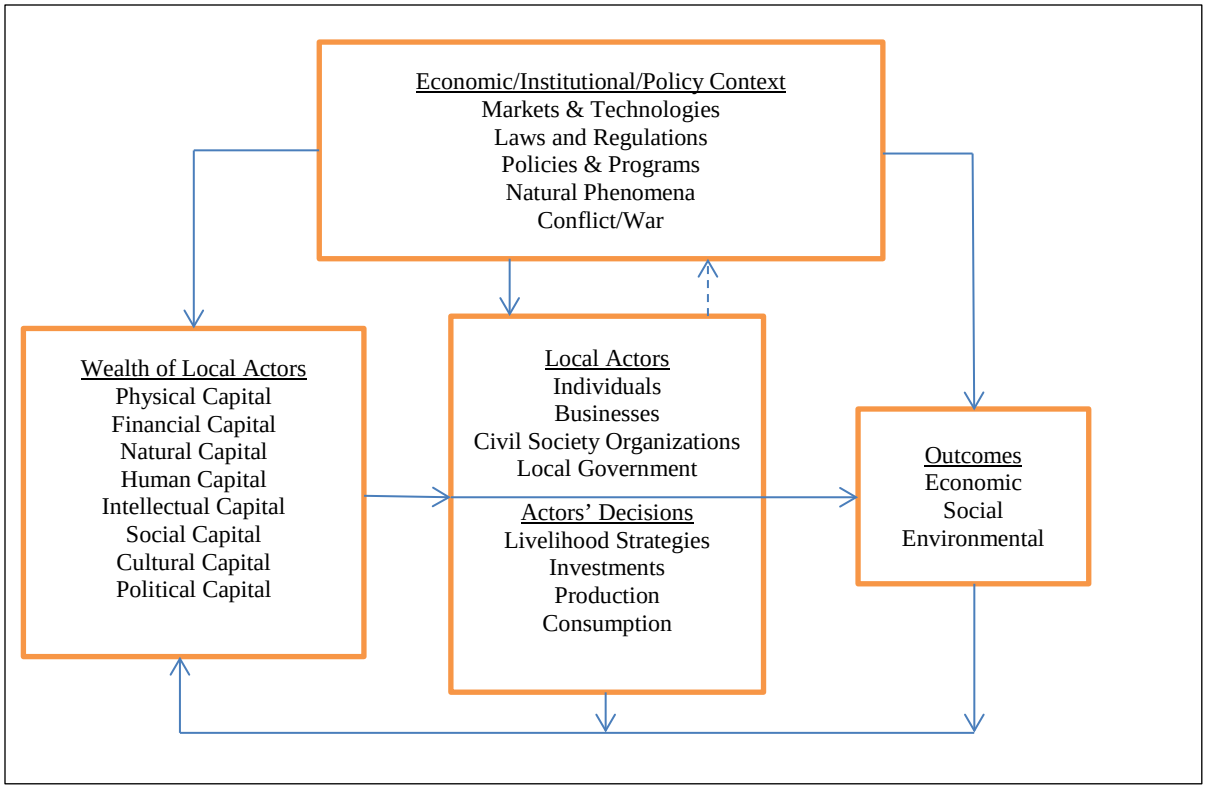


Figure 4: General wealth-decisions-outcomes framework (Pender et al. 2012)

Chapter 4: Data and descriptive statistics

The data for analysis are from two sources. Data on local government revenues and expenditures are from the Inter-university Consortium for Political and Social Research in *The Historical, Demographic, Economic, and Social Data: The United States, 1790-2002 (ICPSR 2896)* by Michael Haines. Data on boom counties and outcome variables are from a dataset created by Jacobsen and Parker (2016). The data they utilize includes variables for boom status derived from iHS[1] proprietary data and economic variables from the Bureau of Economic Analysis. Details of specific variables are described in the following sections based on their role in the analysis.

Time period and units of observation

The rise and fall of oil prices is one of the main causes of booms and they have been occurring in the US since the middle 1800s. El-Ramly (2014) describes the cyclical nature of the oil industry by defining cycles in the United States since 1859. Each of these periods as shown in Figure 5 represents periods when the price of oil increased followed by decreases of more than 30% in accumulated average price. These cycles provide opportunities for research before, during, and after an oil and gas boom. The period from 1974-1994 (the 5th period on the chart) was preceded by relatively stable prices, has a large increase in price for a relatively short period of time, and is followed by a brief period of stable prices before the next cycle began – making it ideal for studying the impact of a boom on the rural counties that were affected.

[1] You can visit the company website, iHS.com, for further information.

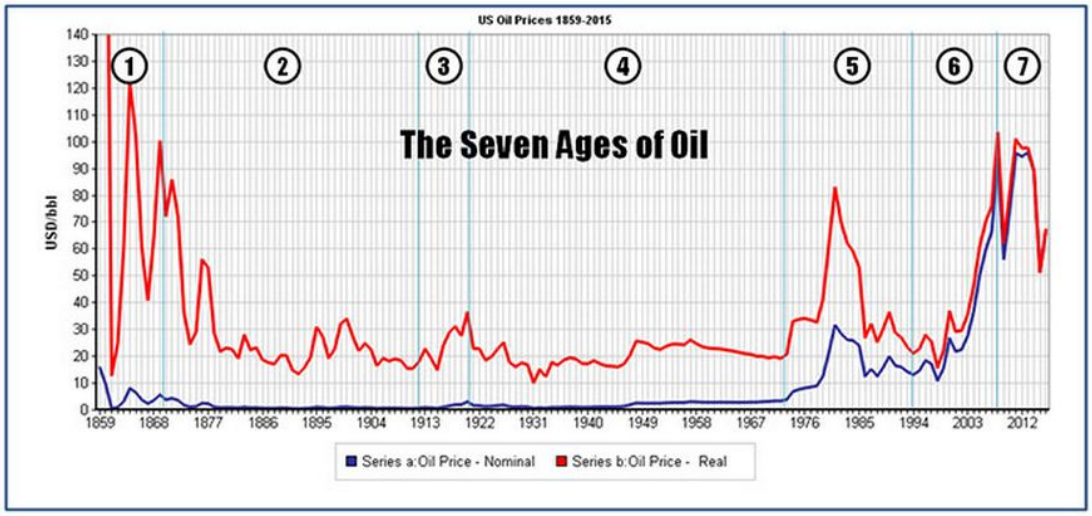


Figure 5: Oil and gas cycles, 1859-2012 (El-Ramly 2014)

The time period of this empirical study is 1967-1998, a thirty-two year period that includes the stable period before and after the 1974-1981 boom. This period provides a useful study period for two other reasons. First, there were no new large discoveries of oil and gas in the Rocky Mountains during this period. And second, data from the Bureau of Economic Analysis is based on industry classifications codes. These codes changed in 2001. The ability to confine the analysis to before this change means I do not have to worry about data inconsistencies.

For purposes of analysis the cycle is broken into the following periods:

- 1967-1974 (pre-boom)
- 1975-1979 (EB - early boom)
- 1980-1981 (PB - peak boom)
- 1982-1985 (LB - late boom)
- 1986-1998 (BUST – bust and post bust)

The periods are based on increases in both prices and drilling and are consistent with the periods utilized by Jacobsen and Parker (2016) to analyze the impact of phases of the boom on income and employment in the same region. They utilized propriety drilling data for the region and compared increases in prices to increases in drilling. During the early phases of the boom employment and population begins to increase. During the peak phase both prices and drilling

are at their highest point. The late-boom phase is defined by the slowing down of drilling and the beginning of the drop in prices. Finally the bust and pot-bust phase begins when prices reach their lowest price and begin to level out again.

The units of observation are 356, of 391, counties in the 10 Rocky Mountain States: Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, North Dakota, South Dakota, Utah, and Wyoming. In order to focus on rural sustainable development 35 counties that are classified as medium or large by the National Center for Health Statistics are excluded from the analysis. Also, two counties were formed during the analysis period, Lapaz, AZ in 1983 and Cibola, NM in 1981. These two counties and the counties whose borders they we formed within, Yuma, AZ and Valencia, NM are excluded from the analysis.

Boom data

Boom county data is from Jacobsen and Parker (2016). They use the number of wells drilled from iHS to identify counties in which 100, 200, and 300 extra wells per year were drilled during the boom period. Their process identifies oil and gas boom counties using a difference in differences approach, where they calculate the number of wells that would have been drilled had there not been a boom and then compare this to the number drilled.

The process used to determine if a county is a boom county is to first calculate the linear relationship without the boom between the number of wells drilled and time using the number of wells drilled each year during the period before and after the boom. Equation 1 is used to calculate δ, the parameter used to estimate additional wells drilled given one more year. The data from 1969-1974 is used for the pre-boom period and 1986-1998 is used for the post-boom era. The boom period from 1975-1985 is omitted from this equation, as the purpose is to determine the number of wells that would have been drilled had the boom not occurred.

(1) $$Wells\ Spudded_{it} = \alpha_i + \delta year_t + \varepsilon_{it}$$

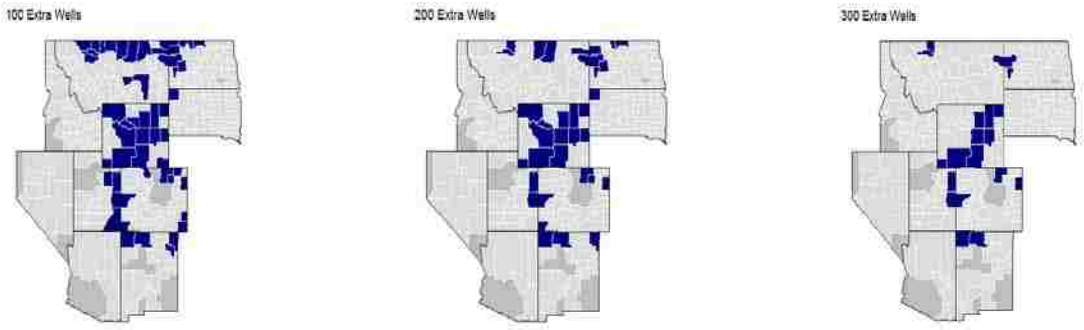
In this equation *i* indexes the county and *t* indexes the year. The parameter and the predicted wells in 1974 are then used in Equation 2 to calculate the estimated number of wells that would have been built were there not a boom, the counterfactual wells drilled.

(2) $Counterfactual\ Drilling_{it} = Predicted\ drilling\ in\ 1974_i \times (1+\delta)^{t-1974}$

This counterfactual number of wells is the subtracted from the number of actual new wells drilled from 1975 through 1991 to determine the extra wells drilled due to the boom created by the increase in oil and gas prices.

(3) $Extra\ Wells_{it} = Wells\ Spudded_{it} - Counterfactual\ Drilling_{it}$

Of the 356 counties in the analysis, 35 had 200 extra wells drilled during the boom period (for boom = 200, n = 35). These are the counties that are used as the boom counties in the main analysis. Of these 35, 20 had 300 extra wells drilled during the peak (for boom = 300, n = 20). There were 19 other counties that had 100 extra wells drilled, but did not meet the 200 well criteria (for boom = 100, n = 54).



Local government expenditures data

Local government finance data are obtained from three of Haines' 106 data sets (DS77, DS78, and DS83). Local government expenditure variables are available for 1967, 1972, 1977, 1982, 1987, 1992, and 1998 and include total revenue, total expenditures, education spending, highway spending, health and hospitals spending and public welfare spending. Total revenue, total expenditures and specific spending categories are used as outcome variables in the first part of the analysis to test if local governments in boom counties receive and spend more in both absolute and per capita during phases of the boom. Because the distributions are skewed toward zero for each of the categories, the log of each is used in the econometric model.

Summary statistics are shown in Table 1 for revenue, savings, and spending. All values are nominal values and are not deflated. The fixed effects methods accounts for changes in real terms that all counties experience equally. The mean revenue during the study period is $17.2 million dollars, with local government revenue ranging from $0 to over $288 million. Counties tend to spend the majority of the revenues with mean total expenditures equaling $16.7 million and approximately 50% of spending is for education. The means for public welfare and health and hospitals spending are the lowest.

Table 1: Summary statistics for revenue and spending, observations = 2,130 (all values in $1,000's)

Description	Mean	Std. dev	Min	Max
Local government revenue	17,204	31,027	0	288,072
Local government revenue per capita	1.17	1.03	0	17.50
Local government expenditures	16,748	30,170	200	313,590
Local government expenditures per capita	1.13	0.95	0.037	9.81
Local government savings	456	4,158	-48,893	78,770
Local government savings per capita	0.04	0.27	-1.705	7.66
Education spending	8,332	14,468	0	128,160
Education spending per capita	0.56	0.41	0	4.64
Public welfare spending	428	1,618	0	37,683
Public welfare spending per capita	0.03	0.06	0	0.90
Highway spending	1,343	2,091	0	39,441
Highway spending per capita	0.13	0.14	0	1.89
Health & hospital spending	1,099	3,503	0	65,566
Health & hospital spending per capita	0.07	0.15	0	1.67

In the second part of the analysis, significant changes in government spending in education and highways are used to represent investment. The change is calculated from 1967 (pre-boom) to 1982 (peak boom) as an absolute change, a change in per capita investment, and a percentage change. Table 1 shows the mean of each type of spending change. Education has the highest mean for absolute change at over $7 million. The mean absolute change for health and hospitals is approximately the same as for highways at $1.2 million. Health and hospitals has the highest mean for percentage of change at 34%, while each of the other categories is 4%. A dummy

variable is then created to classify counties as high investment counties, using the seventy-fifth percentile as the cutoff point. For each category on average 8 of the 35 boom counties and 20 of the 284 non-boom counties are classified as high investment.

Table 2: Summary statistics for spending changes from 1967-1982 and high investment dummy variables, observations = 356

Variable	Mean	Std. dev	Min	Max
Change in absolute spending from 1967-1982 ($1,000's)				
Change in absolute education spending	7,486	10,231	-286	58,831
Change in absolute highway spending	1,189	1,495	-241	14,342
Change in absolute health & hospital spending	1,158	3,301	-1,499	37,070
Change in absolute public welfare spending	282	1,161	-1,216	17,115
Dummy variable for high absolute spending change				
Education spending	0.08	0.27	0	1
Highway spending	0.05	0.22	0	1
Health & hospital spending	0.10	0.30	0	1
Public welfare spending	0.23	0.42	0	1
Per capita spending changes from 1967-1982 ($1,000's)				
Change in per capita education spending	0.45	0.21	-0.16	1.80
Change in per capita highway spending	0.10	0.11	-0.035	1.30
Change in per capita health & hospital spending	0.07	0.11	-0.049	0.58
Change in per capita public welfare spending	0.01	0.03	-0.061	0.23
Dummy variable for high per capita spending changes				
High per capita education spending change	0.08	0.27	0	1
High per capita highway spending change	0.12	0.33	0	1
High per capita health & hospital spending change	0.13	0.34	0	1
High per capita public welfare spending change	0.31	0.46	0	1
Outcome variable (observations = 10,680)				
Per capita income	9,023	2,194	2,492	28,458

Figure 6 shows the counties that are classified into each of the four types of counties based on change in per capita spending: boom and high per capita spending change, boom and low per capita spending change, non-boom and high per capita spending change, and non-boom and low per capita spending change. High per capita education spending change is concentrated in Wyoming, public welfare in North Dakota and Colorado, highway spending change is spread across Montana, North Dakota, South Dakota, and the northeast portion of Wyoming. High per

capita spending changes in health and hospitals is disbursed across Montana, Wyoming, and Colorado.

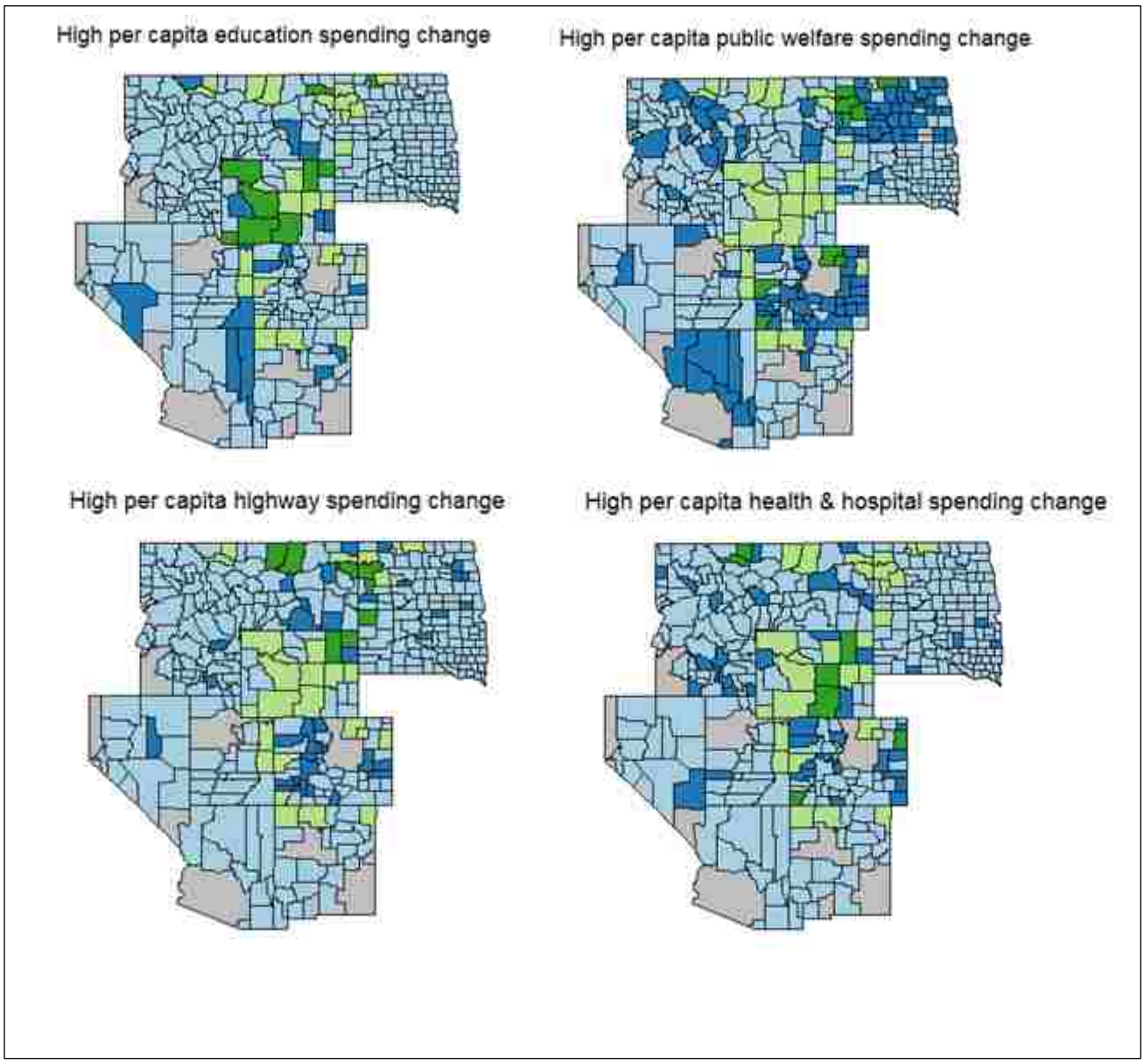


Figure 6: Classifications of counties as boom (green) or non-boom (blue) and high investment (dark) in per capita spending

Outcomes data for testing impact of high spending

Per capita income is used to test whether increased local government investment during the early period of the boom improves outcomes in the late boom and bust period.

Figure 7 shows the difference in per capita income for boom versus non-boom counties throughout the thirty year period. Both types of counties followed similar paths in the pre-boom period satisfying the assumption of the difference in differences method. The similar pattern includes an economy wide boom in the early 1970's when mean income per capita increased and then fell in both boom and non-boom counties. Jacobsen and Parker (2016) found a statistically and practically significant positive impact to per capita income in boom counties during the early, peak, and late boom periods. In addition, they found a slightly negative, but still significant, negative impact during the bust phase. It is this result that I am further analyzing to determine if local government investment early in the boom phase mitigates these negative impacts.

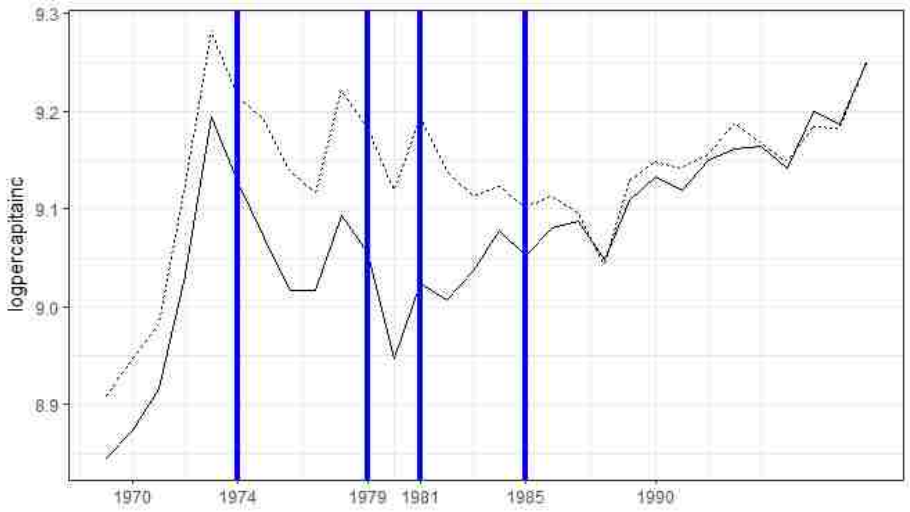


Figure 7: Comparison of means for ln(income per capita) for boom (dash) and non-boom (solid) counties. Blue lines depict phases of the boom, pre-boom(1969-1975), early boom (1975-1979), peak boom (1980-1981), late boom (1982-1985) and bust and post bust (1986-1998)

Chapter 5: Analytical and empirical model

The goal of the project is to gain a better understanding of the role local government's decisions can play in sustaining growth after a resource boom. Accomplishing this is a two-step process. First, I assess whether boom counties do in fact experience increases in revenues and expenditures relative to non-boom counties as a result of the boom. Second, I analyze how boom counties spend the additional revenues and the impact of those choices on outcomes during the bust and post-bust periods. Counties are classified as high spending in specific categories: education, highways, health and hospitals, or public welfare.

During an oil and gas boom employment and personal income increase early in the boom when drilling offers high paying jobs (Jacobsen and Parker 2916), but increases in local government revenues lag behind by a year or two (Haefele and Morton 2009). Local governments obtain additional revenues during booms primarily from taxes on production at the local, state, and federal level. At the local level, counties charge an ad valorem tax on production. States assess a severance tax on production and a portion of this is returned to the local area. Production on federal lands is assessed a Federal Mineral Revenue (FMR) tax, a portion of which is returned to the state which then distributes a portion back to the local area. Ad valorem and severance taxes generally lag a year behind production and FMR taxes lag two to three years behind production.

The early boom period was from 1975-1979, during this period drilling started to accelerate. Production is preceded by drilling and completion, further creating a lag between the booms effect on incomes and employments and the increase in local revenue. I would expect to see little to no change in the difference between boom and non-boom counties for 1972 and 1977 in comparison to 1967. I do expect to see an increase in government revenues beginning about the time of the peak boom in 1979-1981. The government finance year that corresponds most closely to this time period is 1982. Given the lag with taxes, the increase in comparison to non-boom counties should continue one or two years into the bust period, therefore the next local government reporting period in 1988 should also show a statistically significant positive difference in local government revenues between boom counties and non-boom counties relative

to the difference between them in the pre-boom period. This positive difference should diminish by the 1992 reporting period.

Local government can choose to spend the additional revenues received from oil and gas rents or save it. If they choose to spend it, they can either spend it on current well-being, through increasing public welfare spending, or they can invest in future well-being, through increased education, highway or health and hospital spending. Because the communities have experienced an influx of population and increased use of public services, I would expect to see expenditures increase when revenues increase.

Changes in local government spending between 1967 and 1982 represent the choices made by local governments on improving current well-being or potential future well-being. For purposes of analysis, increases in public welfare spending are viewed as a choice made by local governments to increase current levels of welfare and improve current equitable distribution. An increase in the portion of total revenue saved is viewed as investing for future welfare. Increases in spending in education, highways, and health and hospitals are also viewed as investing for future welfare.

According to theories of weak sustainability, if rents are reinvested into other forms of capital booms counties should be able to sustain development. The theory of weak sustainability argues that future potential will be maintained when nonrenewable natural resources are extracted is the rents received from extraction are reinvested in human, social, or other types of physical capital. Following this logic, communities with higher changes in investment from 1967 and 1982 should experience a less severe bust and should have improved outcomes post-bust. In contrast, those counties that increase public welfare spending during the same period will have a more severe bust and will have negative outcomes in the post-bust period in comparison. It is important to keep in mind that local governments are not the only decision-makers receiving rents from oil and gas extraction. Federal government, state government, individuals, and businesses are also receiving rents and making consumption and investment choices. Therefore, this current analysis studies whether reinvestment of a portion of the rents impacts outcomes during the bust and post-bust.

Counties are subset in two ways to analyze whether choices made early in the boom impact outcomes in the bust and post-bust periods. First, counties are subset by boom and non-boom and local government investment choices are analyzed. The boom subgroup consists of the thirty five counties with 200 extra wells drilled. The counties are further classified as high investment if there spending change is above the 75th percentile. There are 7 or 8 counties in this subgroup for each type of spending. When these counties are analyzed I expect to see that counties with higher investment, as measured by increases in spending, experience higher mean income per capita relative to lower spending counties.

Counties are also subset according to their investment levels. In this analysis boom and non-boom counties are included in the subgroups, and I analyze whether the phases of the boom impact outcomes differently in boom counties. For the high spending change in education, highways, and health and hospitals subgroups, I expect to see outcomes continually improve in both groups during periods after 1982. For the subgroup with high spending changes in public welfare, I expect to see little to no improvement to mean income per capita for the periods after 1982. This should also be the case for the subgroups with low spending changes in education, highways and health and hospitals. For the subgroup with low spending changes in public welfare spending, mean income per capita should remain relatively unchanged.

To test whether weak sustainability holds for counties during a boom and bust cycle, I first confirm whether boom counties receive a flow of rents from the extraction of oil and gas during the boom. I follow the fixed effects difference in differences methodology developed by Jacobsen and Parker (2016). Using county fixed effects allows me to control for time invariant characteristics of counties, such as the amount of land, percentage of public versus private land, the state, and the tax policies of the state and county. Including dummy variables for each year[2], further allow me to control for the events all counties experience during a specific year. The basic model is Equation 5.

(5) $\log(S_{it}) = \alpha_i + \gamma_t + \theta_t Boom\ Indicator_i \times Time\ Period_t + \epsilon_{it}$

[2] In each of the regressions every year is included as a dummy variable. The results for these dummy variables are not included in the tables.

In this equation the outcome variable, S_{it} is a vector of revenue or spending by county, *i,* for every fifth year, *t,* from 1967-1992. α_i is a vector of county-specific effects that account for time invariant differences across county, i. γ_t is a vector of yearly effects that controls for shocks that occur in all counties in year, *t*. ϵ_{it} is an idiosyncratic error term. The effect of the interaction of boom county status with the time period is indicated by the vector of coefficients, θ_t. This interaction term provides information on how the path of the type of county being tested differs from other counties during the specific year or time period in relation to pre-boom period. A key assumption of the difference in difference method is that the trend of the outcome variable for the two types of counties was similar before the boom.

Difference in differences allows the intercepts of the two groups to differ, but requires that the trends of the two are similar before the oil and gas boom occurs. Once the shock occurs, difference in differences analyzes how the difference between the two groups changes as a result of the boom. The difference between the means of the two groups prior to the boom is calculated as the average difference. Any change in this average difference during subsequent periods is measured by the interaction coefficient, θ_t.

That the trends of the group are similar prior to the boom is not the only assumption of the model. In addition, it is assumed that there are no other variables or characteristics that change within some counties, but not within others, that is also correlated with the increases in the outcome variables.

In the first part of the analysis, how the boom impacts local government revenues and expenditures, the time periods are every five years[3] for years corresponding to phases of the boom:

- 1967 – pre-boom
- 1972 - pre-boom
- 1977 – early boom (EB)
- 1982 – peak boom (PB)
- 1988 – bust (BUST)
- 1992 – post-bust (BUST)

[3] The Census of Governments is conducted every five years.

The first set of outcome variables are the log of per capita revenues, expenditures, and savings to confirm that boom counties receive additional revenues and do spend them. The second set of outcome variables explores spending in specific expenditure categories: education, highways, health and hospitals, and public welfare. The log of per capita spending is the focus of the main analysis, as it measures investment per person. The log of total absolute changes and percentage increases are included in Appendix D and discussed in the robustness section.

To determine how local government choices impact future outcomes dummy variables are created to classify counties as high investment in specific categories of education, public welfare, highways, and health and hospitals. The change in spending from 1967-1982 is calculated as a change in per capita spending. Additionally, counties are classified according to the percentage of total spending in 1982. Counties above the 75th percentile are classified as high spending change for the specific category. High absolute changes and high percentage changes are also calculated and are presented in Appendix A and discussed in the robustness section.

In the final portion of the analysis, counties are subset according to either boom and non-boom or high spending and low spending. These subgroups are then analyzed to determine the impact of local government choices on per capita income during the bust and post-bust period. First, counties are subset according to boom or non-boom. Then the basic equation is used to examine outcomes during phases of the boom in counties using Equation 6. Impact of high investment on per capita income is tested to determine if within boom counties the level of investment is statistically significant in determining outcomes. For comparison purposes, the same analysis is performed for non-boom counties.

(6) $\log(per\ capita\ income_{it}) = \alpha_i + \gamma_t + \theta_t High\ Invesment_i \times Phase\ of\ Boom_t + \epsilon_{it}$

The interaction coefficient, θ_t, provides information on the effect of high spending changes on mean income per capita during the bust and post-bust period, given that a county is a boom county. For example, if they are above the 75th percentile for change in education spending per capita, then during the bust and post-bust period the interaction term should be positive and statistically significant. This will indicate that the difference in mean per capita income between high and low spending boom counties has increased relative to the pre-boom period.

Counties are then subset by high and low investment in spending categories and the impact of being in a boom county is tested using Equation 7.

$$\textit{(7)} \quad \log(per\ capita\ income_{it}) = \alpha_i + \gamma_t + \theta_t Boom\ County_i \times Phase\ of\ Boom_t + \epsilon_{it}$$

Subgroups in this section include high spending change and low spending change. The interaction term, θ_t, provides details of the effect on mean income per capita of experiencing a boom, given that you are at the same spending level. By separating high and low spending, I am able to analyze if counties with high spending changes experience different outcomes, as compared to low spending change counties, during the bust and post-bust periods.

An annual model of Equation 7 is presented graphically. The annual model provides greater detail on how the difference in means between groups changes from year to year during the boom cycle. This path difference is relative to non-boom counties in the same spending change group.

A graphical representation of the mean per capita income from 1969-1998 is created for each of the four subgroups: boom with high investment change, boom with low investment change, non-boom with high investment change, and non-boom with low investment change. The graphs are useful, not only for group comparisons during the boom phases, but also for ensuring that counties were on similar trajectories prior to the boom. This is a necessary assumption for difference in difference analysis.

Chapter 6: Results

Results indicate there are increases in the difference of both local government revenue and expenditures in boom counties, in comparison to non-boom counties, during the peak and bust period. Specific spending categories also display statistically significant differences as a result of the boom. Whether those differences impact outcomes in the bust and post-bust is not as clear. There are indications of statistical significance with some types of spending; however it is difficult to conclusively state it is a result of the boom and the spending of the revenues from the boom.

Total revenue, expenditures and savings

Per capita revenues, expenditures and savings increase on a similar path in boom and non-boom counties during the pre-boom and early boom period, but appear to diverge during from one another during 1982 and 1988. Figure 8 shows that on average, before the boom period, boom counties have more revenue and expenditures per capita but save less. In the 1982 and 1988 periods mean per capita revenue and expenditures for boom counties appear to increase at a faster rate than the mean for non-boom counties. In the post-boom period of 1992 the difference between the means once returns to the pre-boom difference in means. Mean local government savings per capita appears to follow a different pattern. Local government savings in non-boom counties appear more volatile. The mean local government savings per capita in non-boom counties drops in 1978, but continue to increase in boom counties. The mean for both types of counties increases in 1982, but appears to increase more in boom counties. The mean drops for both in 1988. And then, in 1992 the mean increases for non-boom counties, but drops for boom counties. Finally, the mean for boom counties remains higher than for non-boom counties in 1992.

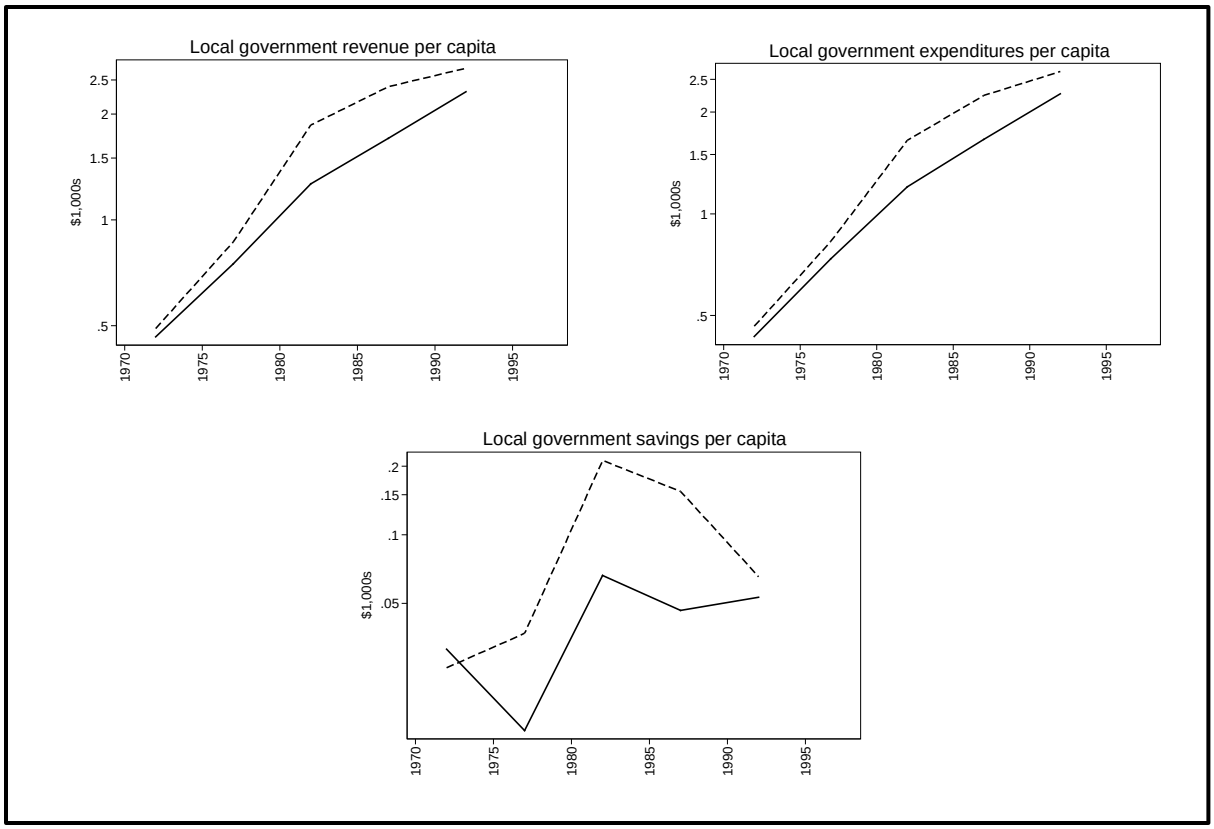


Figure 8: Mean of per capita revenue, expenditures, and savings for boom and non-boom counties from 1967-1992 in $1,000s (dash=boom)

Regression results show the difference between the mean of boom and non-boom counties for revenue, expenditures, and savings remains relatively constant during the pre- and early boom periods, diverges during the peak boom period, and then returns to pre-boom differences in 1992. The relatively stable differences between the two means in the pre- and early boom are shown by the non-significant coefficients for Boom * 1972 and Boom * 1982 in Table 3 and confirm the assumption that the two types of counties were on similar paths prior to the boom.

The two periods in which I expect to see statistical difference in boom and non-boom counties are 1982 and 1987. Figure 9 and Table 3 provide regression results showing statistically significant changes in the difference in means between boom and non-boom counties. The change in the difference of the two means just after the peak boom in 1982 is a 28% increase[4] in

[4] The coefficient in the model is .25 which is transformed to 28% for interpretation using the formula $(e^b-1)*100$ because the regression is a log-linear regression with dummy explanatory variables. This formula is used for transforming all of the coefficients from this point forward.

difference for local government revenue per capita, 23% increase for local government expenditures per capita, and 16% for local government savings per capita. The increase in the difference of the means for local government revenue per capita and local government expenditures per capita is significant at the 1% level and the increase in the difference for local government savings per capita is not statistically significant. In 1987, the change in difference in the means has increased further for revenue per capita (31%) and expenditures per capita (26%), but has diminished and is no longer statistically different from the pre-boom period for savings per capita (12%). These results imply that local governments do receive revenues from oil and gas extraction rents and they do spend them.

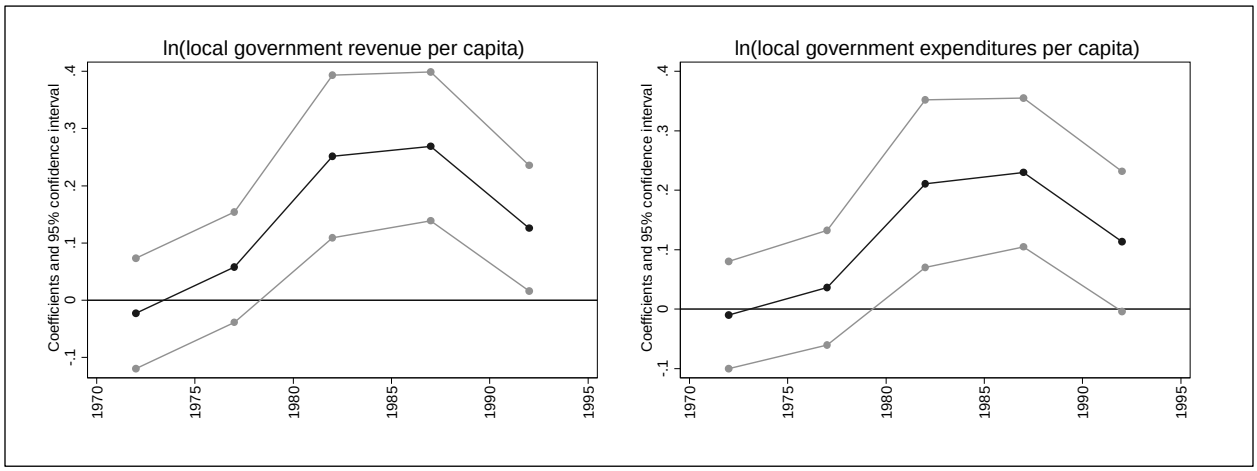


Figure 9: Comparison of regression results for impact of boom on local government revenues and expenditures. The coefficients represent the difference in means for boom and non-boom counties relative to the difference in 1967.

I expected local government revenues and expenditures to decrease a few years after the boom when revenues from the rents of oil and gas extraction diminish. While the difference in means is still statistically significant at the 10% level for revenue per capita in 1992, the change in difference is smaller at 14% for revenue per capita and 12% for expenditures per capita. These results could imply several different ideas. First, the delay of taxes may be longer than three years. Second, companies may continue production from wells that have already been drilled which would lengthen the period of time counties receive rents in the form of taxes. Lastly, the tax base may have increased during the boom.

Table 3: Regression results for the impact of the boom on local government revenues per capita, expenditures per capita and savings per capita, using year and county fixed effects with robust standard errors

	Revenues		Expenditures		Savings	
Dependent variable	ln(lg revenue)	ln(lg revenue per capita	ln(lg general expenditures)	ln(lg general expenditures per capita)	lg savings	lg savings per capita
Boom * 1972	-0.028	-0.023	-0.015	-0.010	192.857	-0.003
	(0.05)	(0.05)	(0.04)	(0.05)	(122.27)	(0.01)
Boom * 1977	0.092	0.058	0.070	0.036	548.324**	0.025
	(0.07)	(0.05)	(0.07)	(0.05)	(200.04)	(0.02)
Boom * 1982	0.396***	0.251***	0.356***	0.211**	2022.963	0.148
	(0.11)	(0.07)	(0.10)	(0.07)	(2108.64)	(0.09)
Boom * 1987	0.370***	0.269***	0.331***	0.230***	5065.677*	0.111
	(0.11)	(0.07)	(0.10)	(0.06)	(2335.98)	(0.06)
Boom * 1992	0.180	0.126*	0.168	0.114	1391.144	0.015
	(0.10)	(0.06)	(0.10)	(0.06)	(726.09)	(0.04)
_cons	7.738***	-1.192***	7.714***	-1.217***	-16.901	0.007
	(0.02)	(0.01)	(0.02)	(0.01)	(90.51)	(0.01)
R2 (within)	0.900	0.938	0.905	0.939	0.029	0.016
Observations	2129	2129	2130	2130	2130	2130
F	484.115	1203.688	512.654	1232.347	6.141	7.892

Notes: Coefficients are reported with robust standard errors in parenthesis. *, **, *** indicate significance at the 10%, 5%, and 1% significance level, respectively.

Where does the extra spending go?

Since results indicate that local governments do receive additional revenues as the result of the oil and gas boom, the next step is to determine if their spending choices impact outcomes during the bust. That is, does the theory of weak sustainability hold true. First, I examine whether booms impact local government spending in specific categories: education, public welfare, highways, and health and hospitals. Booms impact education spending per capita and highway

spending per capita, but not health and hospital spending per capita. The relationship between booms and public welfare spending is not as clear.

Figure 10 shows highway spending per capita has the clearest deviation for boom counties during the peak and late boom. Highway spending per capita is lower in boom counties prior to the boom and surpasses non-boom in 1982 and increases the difference in 1987. Boom counties spend slightly more on education per capita and health and hospitals per capita, and the boom appears to have a small effect of education per capita. The impact of the boom on health and hospitals is not clear in the graph. While it appears that boom counties spend less on public welfare after the boom, the two types of counties do not appear to be on similar paths prior to the boom, invalidating the difference in differences approach.

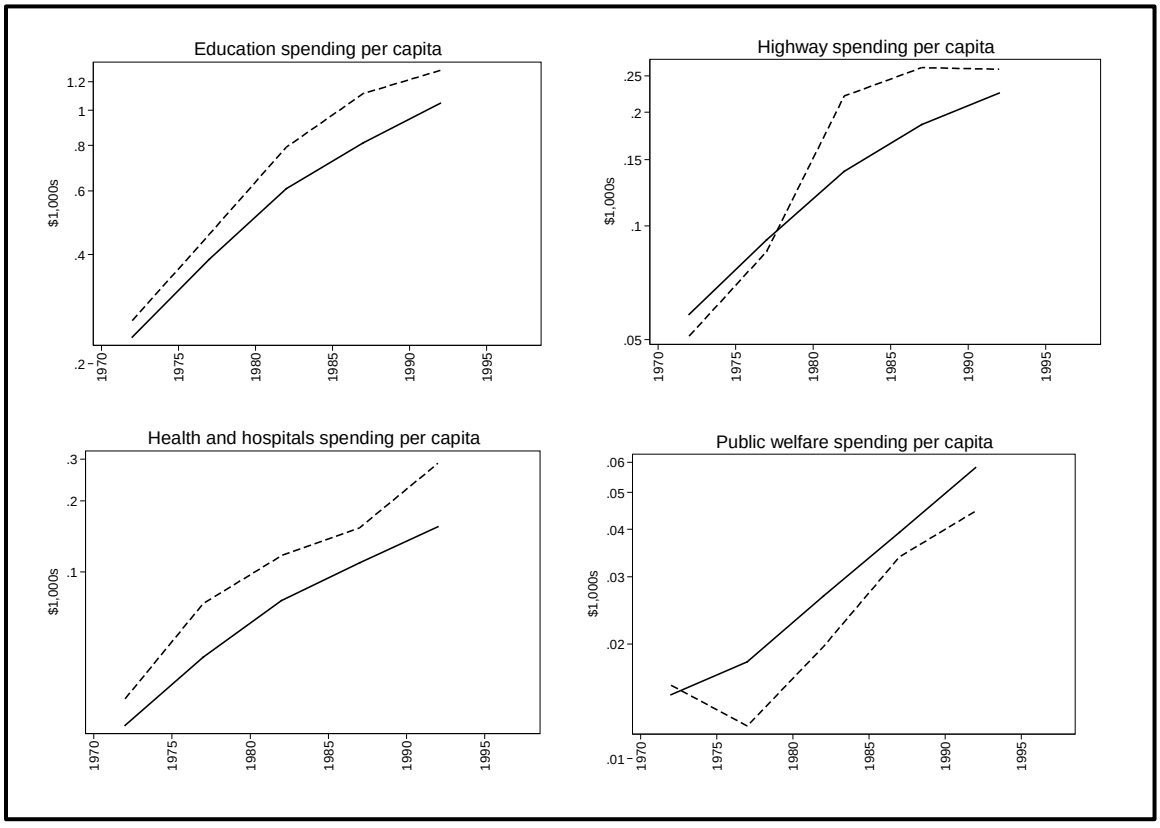


Figure 10: Comparison of per capita spending by category in boom and non-boom counties (dash=boom)

Regression results, depicted in Figure 11 and Table 4, show that mean highway spending per capita and mean education spending per capita both increase significantly for boom counties during in 1982 and 1987, while the difference in means between boom and non-boom counties for health and hospital spending per capita is relatively stable. The difference in means for highway spending per capita between boom and non-boom counties increases by 55% in 1982 and 41% in 1987 in relation to the pre-boom period in 1967. The difference in means in education spending per capita also increases - by 14% in 1982 and 21% in 1987. The difference in means for health and hospital spending per capita, on the other hand, diminishes, though not significantly. The lack of significance for health and hospital spending implies that on average across all boom counties, the additional revenue received from oil and gas rents by local governments is allocated to highways and education[5].

[5] Public welfare spending appears to decrease in boom counties; however, given the dissimilar paths of the two types of counties prior to the boom I cannot draw any conclusions from the regressions results.

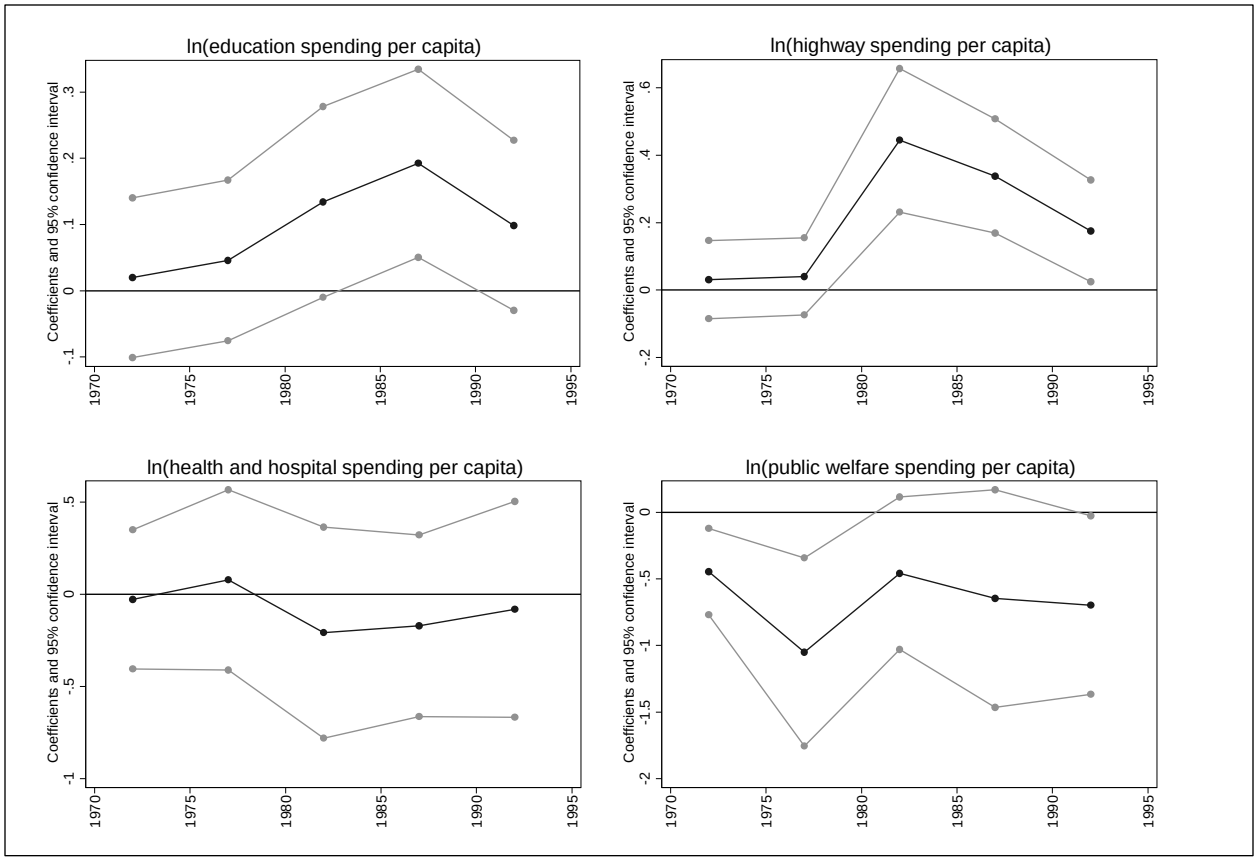


Figure 11: Comparison of regression results for impact of boom on specific spending of local governments. The coefficients represent the difference in means for boom and non-boom counties relative to the difference in 1967.

Table 4: Regression results for the impact of the boom on local government spending on education, public welfare, highways, and health and hospitals, 1967-1992, using year and countyfixed effects and robust standard errors

	Education	Public welfare	Highways	Health and hospitals
Dependent Variable	ln(education spending per capita	ln(public welfare spending per capita)	ln(highway spending per capita)	ln(hospital spending per capita)
Boom * 1972	0.020	-0.446**	0.031	-0.028
	(0.06)	(0.17)	(0.06)	(0.19)
Boom * 1977	0.046	-1.049**	0.040	0.079
	(0.06)	(0.36)	(0.06)	(0.25)
Boom * 1982	0.134	-0.457	0.444***	-0.209
	(0.07)	(0.29)	(0.11)	(0.29)
Boom * 1987	0.192**	-0.647	0.338***	-0.172
	(0.07)	(0.42)	(0.09)	(0.25)
Boom * 1992	0.099	-0.697*	0.176*	-0.081
	(0.07)	(0.34)	(0.08)	(0.30)
_cons	-1.812***	-5.156***	-3.334***	-5.578***
	(0.02)	(0.05)	(0.02)	(0.06)
R^2	0.884	0.326	0.811	0.459
Observations	2124	1939	2127	2008

Notes: Coefficients are reported with robust standard errors in parenthesis. *, **, *** indicate significance at the 10%, 5%, and 1% significance level, respectively.

Does reinvestment of rents improve outcomes in the bust and post-bust periods?

Results indicate that revenues and expenditures per capita increase in boom counties in comparison to non-boom counties during the peak and late boom, and on average for boom counties these increases are spent on education and highways. Does the extra spending in specific categories alter outcomes during the bust? And, if counties invest differently can they improve outcomes during the bust? The particular outcome tested in the analysis is per capita income. Jacobsen and Parker (2016) found that boom counties were worse off in the post bust period in comparison to non-boom counties. And that, while boom counties started with higher

per capita income than non-boom counties, in the post-bust period they had lower per capita incomes. By further examining how counties spend the extra money, is it possible to determine the choices that produce these negative outcomes?

To answer these questions I classify counties as high or low investment in education, highways, public welfare, and health and hospitals in two different ways using the 75th percentile for boom counties as the dividing point[6]. The first high and low division of counties is based on the change in per capita spending from 1967-1982 and the second is based on the percent of total spending in 1982 on a particular category. Counties are then subdivided in two ways. First, on whether they are a boom county to analyze the impact of high spending on outcomes given that you are a boom county. Second, on whether they are a high investment county in a particular category to analyze whether a boom impacts high spending counties differently.

Figure 12 compares the path of per capita income for each category of spending for each of the four types of counties: boom and high spend (orange dashed line), boom and low spend (black dashed line), non-boom and high spend (orange solid line), and non-boom and low spend (solid black line). Counties with higher changes in education spending per capita and health and hospital spending per capita appear to experience higher income per capita during the post bust period, while counties with higher highway spending per capita appear experience lower income per capita during the bust and post bust periods. Interestingly, boom counties with lower higher spending changes appear to experience the higher mean income per capita after the boom, relative to high highway spending per capita change boom counties.

The graphs also provide information on which subgroups were on the same paths prior to the pre-boom period in 1974 and the spending change in 1982, which is necessary for difference in differences analysis. For the education spending groups, the two boom counties (dashed lines) appear to follow similar paths just before the pre-boom period, diverge shortly after, and then appear to follow similar paths for a few years before 1982. The two non-boom counties (solid lines) appear to diverge prior to 1982 with mean income per capita dropping further for the low

[6] I analyze public welfare and health and hospitals even though there were not significant pattern differences in spending for boom and non-boom counties, because there may still be counties that spent more in these areas and that spending choice may make a significant difference on outcomes during the bust period.

spending change group. The two high spending change subgroups (orange lines) also appear to follow similar paths before each cut-off, as do the two low spending subgroups (black lines).

Within the highway spending groups, the boom subgroups (dashed lines) do not appear to be on similar paths prior to 1974 or 1982. The non-boom subgroups (solid lines) are also on dissimilar paths prior to the cut-off dates. The high spending change subgroups (orange lines) and the low spending change subgroups (black lines) each seem to be on similar paths within their group.

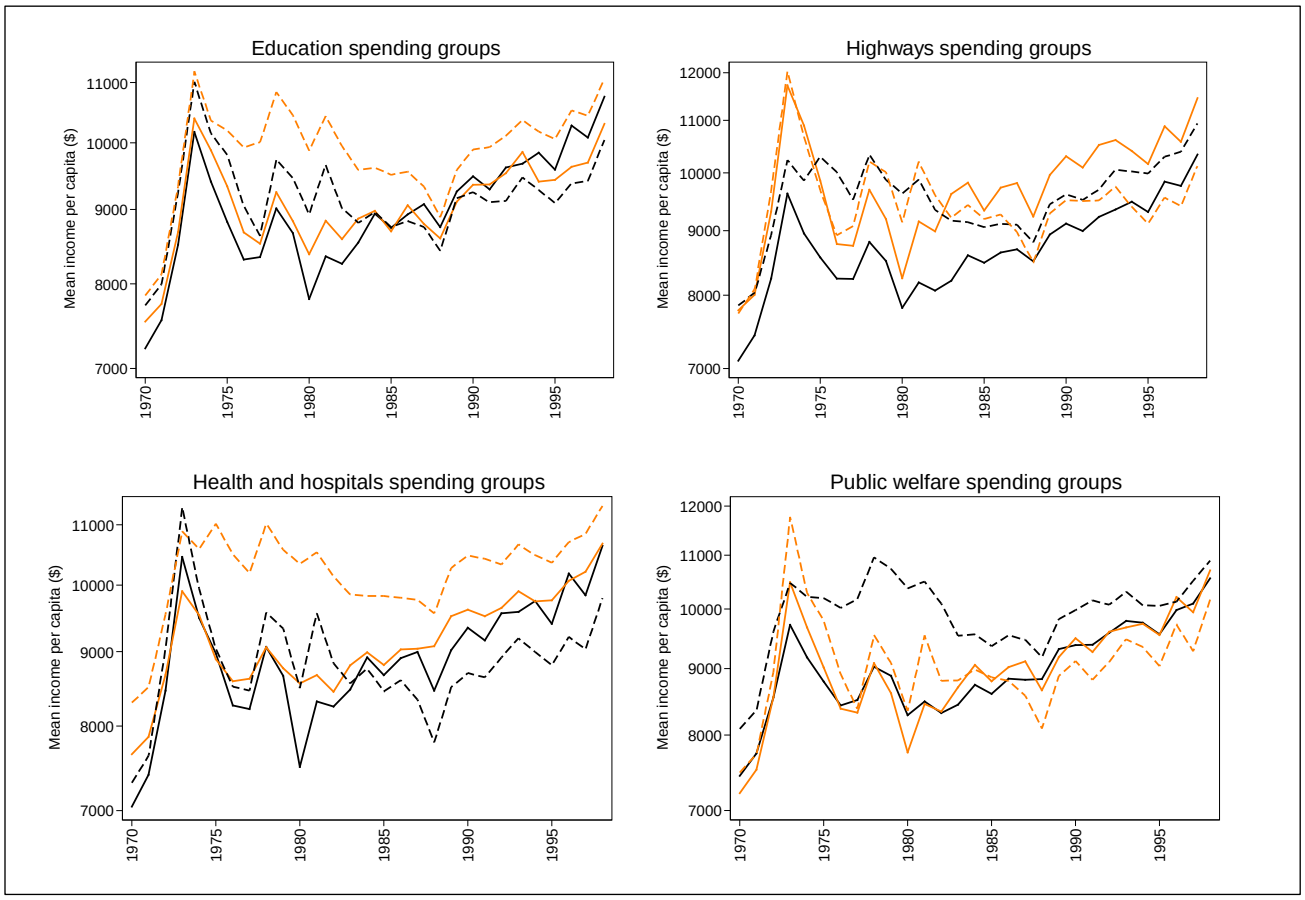


Figure 12: Comparison of paths of per capita income for boom (dashed lines) and high changes in per capita spending (orange lines)

For health and hospitals, boom counties (dashed lines) were not on similar paths prior to either cut-off and non-boom counties (solid lines) were also on dissimilar paths. The high spending subgroups (orange lines) do appear to follow similar paths in the years just before 1974 and 1982, while the low spending subgroups (black lines) also seem to follow similar paths in the years just before the cutoffs.

There is an important distinction between the education and highway spending groups and the public welfare and health and hospital groups of counties. High and low spending boom counties for education and highways appear to begin at the same initial per capita level, while high public welfare and health and hospital spending boom counties have higher initial levels of per capita income. This higher level of per capita income may be the cause of their ability to spend more on health and hospitals or the need to spend more on per capita income. See Chapter 7: Robustness and Limitations for a discussion of the impact of initial conditions.

Regression results indicate that given you are in a boom county, high and low per capita spending changes does not impact the difference in means for the bust and post-bust period (Table 5); however, given that you are a low per capita spending change county, the boom will negatively impact outcomes during the post-bust period (Table 6). This result for the boom county subgroups is contradictory to what I expected prior to the analysis. Theoretically, within a boom county if you invest in other types of capital by spending more on education, highways and health and hospitals outcomes during the post bust should be statistically more. The limited sample size may have hindered this portion of the analysis. This and other limitations are addressed in Chapter 7.

While almost all boom counties appear worse off after the boom, those that have lower spending changes experience more drastic declines. This may indicate that spending doesn't lead to positive outcomes for per capita income, but can help counties avoid very bad outcomes. The difference in means between boom and non-boom counties during the bust has fallen by about 8% for low education and low health and hospital spending counties.

Table 5: Impact of high per capita changes in spending (indicated by the interaction term) on ln(income per capita), using year and county fixed effects with robust standard errors

	Boom				Non-boom			
	High per capita spending change in				High per capita spending change in			
Interaction dummy variable	Education	Highways	Hospitals	Public Welfare	Education	Highways	Hospitals	Public Welfare
Dependent variable	ln(per capita income)				ln(per capita income)			
Interaction variable * EB	0.068	-0.066	0.090	-0.040	0.049*	-0.020	-0.032	0.012
	(0.06)	(0.06)	(0.07)	(0.04)	(0.02)	(0.03)	(0.02)	(0.01)
Interaction variable * PB	0.062	0.003	0.113	-0.025	0.128***	-0.004	0.031	-0.020
	(0.09)	(0.08)	(0.08)	(0.07)	(0.03)	(0.05)	(0.03)	(0.03)
Interaction variable * LB	0.083	-0.001	0.076	0.013	0.023	0.068	0.006	0.038*
	(0.05)	(0.06)	(0.07)	(0.05)	(0.04)	(0.04)	(0.02)	(0.02)
Interaction variable * BUST	0.052	-0.087	0.085	-0.053	-0.027	0.022	-0.002	-0.001
	(0.05)	(0.07)	(0.05)	(0.07)	(0.03)	(0.04)	(0.02)	(0.02)
_cons	8.908***	8.908***	8.908***	8.908***	8.844***	8.844***	8.844***	8.844***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)
R^2 (within)	0.341	0.349	0.346	0.340	0.405	0.403	0.402	0.402
Observations	1050	1050	1050	1050	9600	9600	9600	9600

Notes: Coefficients are reported with robust standard errors in parenthesis. *, **, *** indicate significance at the 10%, 5%, and 1% significance level, respectively.

Table 6: Regression results for the impact of the boom on boom counties within high and low spending changes per capita subgroups, using year and county fixed effects with robust standard errors

	Education		Highways		Health and hospitals		Public welfare	
Subgroup	High per capita change	Low per capita change	High per capita change	Low per capita change	High per capita change	Low per capita change	High per capita change	Low per capita change
Dependent variable	ln(income per capita)		ln(income per capita)		ln(income per capita)		ln(income per capita)	
Boom * EB	0.052	0.030	0.011	0.058**	0.144*	0.023	0.008	0.059*
	(0.06)	(0.02)	(0.07)	(0.02)	(0.07)	(0.02)	(0.03)	(0.03)
Boom * PB	0.027	0.089**	0.102	0.097**	0.161*	0.079*	0.093	0.098**
	(0.09)	(0.03)	(0.09)	(0.03)	(0.08)	(0.03)	(0.06)	(0.04)
Boom * LB	0.051	-0.010	-0.049	0.018	0.067	-0.004	-0.006	0.019
	(0.06)	(0.02)	(0.07)	(0.02)	(0.07)	(0.02)	(0.04)	(0.02)
Boom * BUST	-0.002	-0.080**	-0.150	-0.042*	0.005	-0.082**	-0.104	-0.051*
	(0.05)	(0.03)	(0.08)	(0.02)	(0.05)	(0.03)	(0.06)	(0.02)
_cons	8.889***	8.849***	8.929***	8.841***	8.945***	8.838***	8.828***	8.863***
	(0.02)	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)
R^2 (within)	0.341	0.405	0.280	0.440	0.366	0.403	0.403	0.408
Observations	840	9870	1350	9360	1440	9270	3300	7410

Notes: Coefficients are reported with robust standard errors in parenthesis. *, **, *** indicate significance at the 10%, 5%, and 1% significance level, respectively.

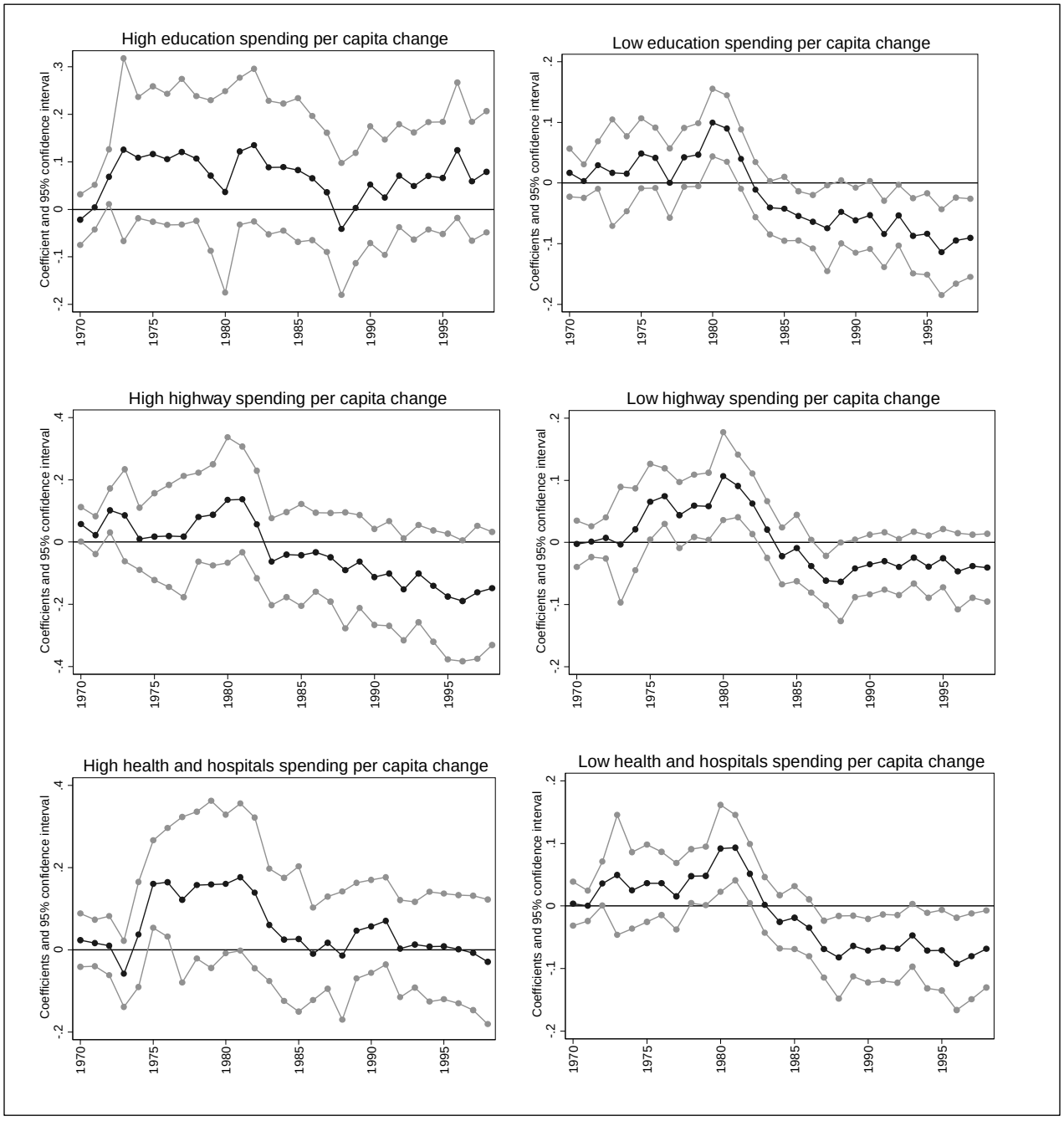


Figure 13: Coefficients for fixed effects annual regression with robust standard errors for high and low spending groups. Dependent variable is ln(income per capita) and the interdependent variables are boom status interacted with the year. Coefficients represent the mean difference between boom and non-boom counties relative to the difference in 1969.

Chapter 7: Robustness and limitations

Prior to establishing spending choices as a mechanism to improve outcomes in boom counties in the bust and post-bust period, a robustness check of the findings and discussion of limitations and other possible mechanisms is necessary. The robustness of findings is based on the classification of a county as a boom county, the choice of measurement for spending values, and the further classification of counties as high spending change. Experimenting with alternative definitions of each of these classifications will provide assurance that the results are not a product of the thresholds chosen. A discussion of other possible mechanisms and limitations of the model considers whether the type and level of spending is exogenous.

To determine robustness of the impact of the boom on local government revenues and spending I tested alternative definitions of a boom county and different measurements of the revenue and spending. For the definition of the boom, the main analysis classifies a county as a boom county if there are 200 or more extra wells drilled. I checked if the results were consistent if the boom was defined as 100 extra wells or as 300 extra wells. There are 35 counties classified as boom counties when the threshold is 200 extra wells. When the threshold is lowered to 100 extra wells there are 54 boom counties, and when it is increased to 300 extra wells there are only 20.

Results for total revenues and expenditures and for each category of spending are available in Appendix G and are statistically consistent with the results for 200 extra wells. The percentage of change in the means of the boom and non-boom counties increases as the threshold of extra wells increases. When the threshold is 300 extra wells the difference in means for revenue per capita between boom and non-boom increases by 43% in both 1982 and 1987, as opposed to the 23% and 26% increases when the threshold is 200 extra wells. This indicates that the number of extra wells in a county does impact local government revenue and expenditures.

The results for spending on specific categories indicates that on average counties experiencing higher level of booms spend more of the additional funds on highways and less on education, while the per capita spending change is insignificant in all cases for public welfare and health and hospitals. The results imply that the relationship between level of the boom and spending

choices, particularly for choices regarding education spending, are only somewhat consistent with the main model. Table 7 shows that percentage change in means for education spending per capita for 1982 is lowest at 14% when the boom level threshold is 200 extra wells and highest at 31% when the boom level threshold is only 100. These results indicate low-level boom counties increase both education and high spending equally, for some reason mid-level boom counties need to increase highway spending more, and high-level boom counties are able to increase education spending after a certain threshold of highway spending has been reached. Highway spending per capita, on the other hand, follows the pattern of revenues and total expenditures, with the increasing differences in means as the threshold of extra wells is raised. These results imply the relationship between the level of the boom and education spending per capita change is not a linear relationship, but should not impact the analysis of whether increases in education spending per capita effect outcomes during the bust.

Table 7: Comparison of coefficients for education and highways for all three levels of boom, 1982 and 1987

	Education			Highways		
Dependent variable	ln(education spending per capita)			ln(highway spending per capita)		
Boom level	100	200	300	100	200	300
Boom * 1982	0.271	0.134	0.184	0.289	0.444	0.584
Boom * 1987	0.296	0.192	0.234	0.250	0.338	0.425

The second set of robustness checks focus on the choice of per capita, versus absolute or percentage of total, spending when determining if booms impact spending. I used per capita measures in the main analysis because populations in boom counties increased during the boom period and fell in the post bust period, while populations in the non-boom counties remained relatively constant throughout (Jacobsen & Parker 2016). The influx of additional people requires additional expenditures per person for services such as education and also increases revenues from sources such as sales tax. The use of per capita measures helps to isolate additional revenue from oil and gas rents. Appendix D shows the percentage increase in mean in 1982 and 1987 for total revenues and expenditures is over 11% higher than the increase in mean for per capita revenue and expenditures. The same is true for education spending and highway spending. For the most part, the change in percentage is insignificant for education spending and highway spending. This is not surprising, since as revenues and expenditures increase, the percentage spent in each category will not necessarily change. The exception is public welfare

spending, while per capita and total public welfare spending is insignificant in 1982 and 1987, the coefficient for percentage spent is negative and significant with a 99% decrease in 1982 and a 141% decrease in 1987.

I analyze the choice of using change in per capita spending, rather than absolute or percentage changes, to determine high spending by using the graphical annual model. Maps in Appendix C show that using different measurements to classify high spending changes the counties included as high spending change are different. Graphs for each model are in Appendix E and show only small differences among measurement methods for non-boom counties, but insightful patterns for boom counties. The graphs for highway spending changes show that using the change in absolute spending to classify counties results in high spending counties have higher per capita income in the post-bust period, while the per capita change in spending model shows high spending boom counties with lower per capita income than any other counties.

The different results for per capita income when using absolute and per capita changes in spending imply that the counties classified into each group are much different. The group with high highway absolute spending changes may be those with large population changes, while those with high highway per capita spending changes are perhaps those with low population changes. Consequently, the groups of counties classified as high spending is substantially different and this alters the results of the analysis. The highway spending per capita changes in the main analysis are the most appropriate because per capita spending changes capture the impact of serving a larger population base. This is particularly important if the population has grown for reasons other than the oil and gas boom.

Lastly, I checked the robustness of the choice of 75^{th} percentile for determining high spending change. When using the 75^{th} percentile there are only 8 or 9 boom counties classified as high spending change. When the threshold is lowered to the 50^{th} percentile there are 17-19 counties classified as high spending change. Examination of the graphs for the annual model show the four groups following relatively similar paths using each threshold, but ending up closer together during the post bust period.

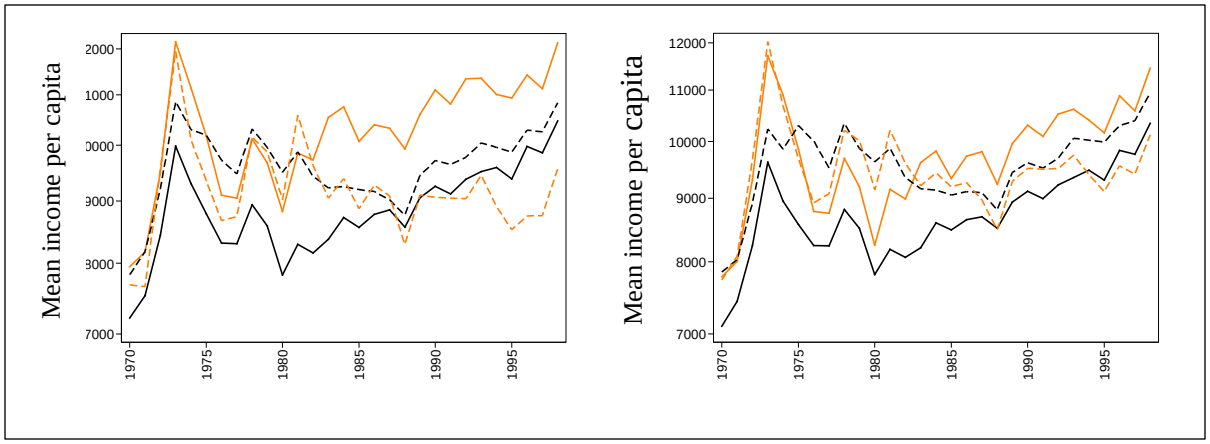


Figure 14: Comparison on 75th percentile (left) and 50th percentile (right) for high per capita change in highway spending on per capita income (dash=boom, orange=high spend change)

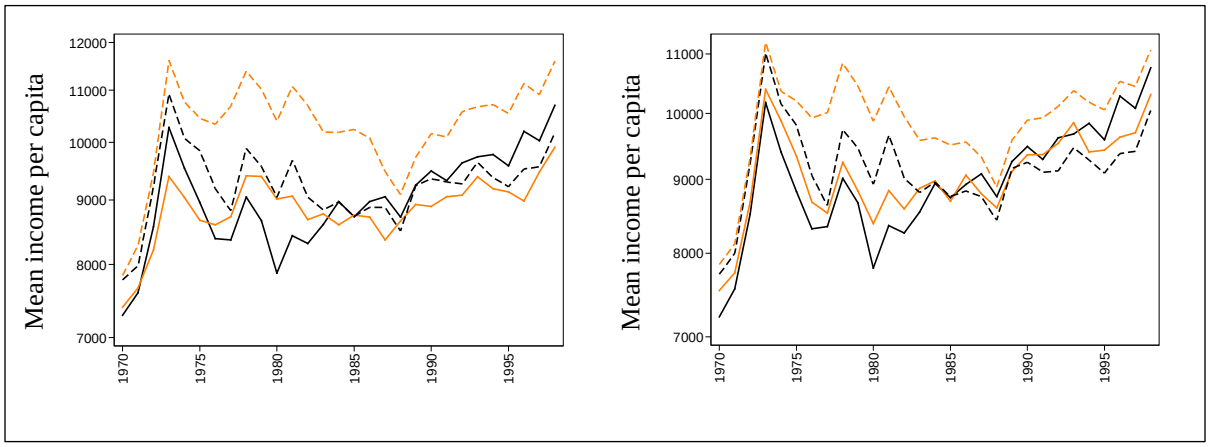


Figure 15: Comparison of 75th percentile (left) and 50th percentile (right) for high per capita education spending change on per capita income (dash=boom, orange=high spend change)

My analysis has shown that there are correlations between high spending in specific categories and per capita income outcomes in the bust; whether these local government choices are a mechanism for improving outcomes is not yet clear for several reasons. First, counties receive just a portion of the oil and gas extraction rents and it is usually less than 10%. For example, Wyoming has one of the largest effective tax rates (state severance and local property tax combined) on production at 11.7% (Headwaters Economics 2014) and only a portion of the state severance tax is returned to the local community. The other 90% or more of the rents are distributed amongst individuals, businesses, state governments, and the federal government. Each of these entities is also making choices between spending for current well-being and investing for future well-being. In almost all cases, these other entities are receiving rents earlier in the cycle than local counties. The mechanisms driving the change in per capita income for high versus low spending groups could be related to decisions in the private sector.

Another limitation of the findings is that alternative explanations exist. One alternative explanation for my findings is that the social and environmental effects of the boom may be dictating spending choices. Counties may be forced to spend more on highways to mitigate the damage done by the boom or simply to create roads for access to wells. So, rather than investing in improvements to increase future well-being, the spending is bringing communities back to the same level, or to a lower level, than before the boom. This implies high spending is sheltering counties for worse outcome, but not improving opportunities for potential future well-being.

Finally, there may be ways in which counties who chose to spend more are different from other counties and these differences may change over time. If this is the case, the model will suffer from omitted variable bias. Robustness checks already suggest correlation with the size of the boom and type of spending with outcomes. In each of the high spending groups the majority of the counties had 300 extra wells drilled. The higher level of the boom, rather than change in government spending, may be the cause of the change in means during the post bust.

There are likely other differences that change over time and are correlated. Industries may be changing within some counties, but not others. Some communities chose to focus their growth strategy on the retirement aged populations and grew their communities. Others became distributions centers. The overall recession in the economy, that occurred during the same time as the peak boom may have impacted communities differently. These omitted variables imply that the mean income per capita for subgroups is biased upwards is counties within the group experienced growth in other industries, or biased downwards if counties within the subgroups experienced the recession more deeply than others. If all groups are equally biased one direction or the other than the results of the analysis remain valid. If one particular subgroup experiences these biases then the interaction coefficient is biased in the same direction.

Differences in spending may also be a function of initial conditions and different state and local strategies that can change over time. Of the 9 boom counties that are classified as high education spending per capita change, 7 are located in Wyoming. In contrast, Wyoming does not have any boom counties classified as high public welfare spending per capita change. All of the boom counties classified as high public welfare spending per capita change are located in either Colorado or North Dakota. Of the 5 boom counties located in New Mexico and Utah, none are

classified as high spending per capita change in any category even though 4 of them have more than 300 extra wells. To completely isolate the impact of changes in local government spending on outcomes during the bust, it is necessary to understand and control for spending of state and federal funds during the same period. For example, state funding may provide funds for capital or highway projects in some counties, like Wyoming, allowing local government to concentrate additional funds on education. This would bias the estimator upwards, as the model is failing to capture the impact of the state funded projects.

Chapter 8: Conclusions

Oil and gas booms have been instrumental in shaping the communities in the Rocky Mountains for many decades. It is questionable whether these events provide more benefits than costs. Research on natural resources and boom cycles have focused on outcomes before, during, and after. Little to no research has focused on how decisions made during the early and peak boom impact outcomes in the bust and post bust period. My analysis finds local governments in boom counties do receive additional revenues as a result of the boom and they do spend these additional revenues in education and highways. Highway spending rises earlier in the cycle and education spending rises later. High additional spending in education appears to shield counties for declines in income per capita during the post-bust period. High additional highway spending is related to lower income per capita levels in the post-bust period. Research on how decisions impact and can improve outcomes in the bust can contribute to the academic literature and can help inform local government officials.

My research can help inform the academic literature by moving the debate beyond whether resource abundance accelerates or hinders growth, more to explorations of how utilization of rents from booms alters the growth process afterwards. Other studies have explored mechanisms which alter outcomes within other industries or geographic areas, but these studies have focused on market phenomena rather than individual choice. Does re-investment of rents into other forms of capital allow counties (or countries) to sustain growth after the boom? There is more to be gained by framing future research questions in this manner because results can be useful for natural resource economies.

Rural communities will be able to use this and subsequent research to create and pursue strategic develop plans. My research can be used by policymakers to argue for mitigation funds, from oil and gas companies, or higher levels of government spending, to be applied towards highway repair and maintenance. Subsequently, allowing them to use rents from oil and gas to invest in other types of capital that will improve future outcomes.

Using the theory of weak sustainability and a framework for community economic development for the rural United States, this study explores the role of local governments' reinvestment of rents from oil and gas as a method to improve future outcomes. Spending of additional revenues on education, highways, and health and hospitals are used as measures of reinvestment of rents. Spending on public welfare is considered current consumption. Before testing whether reinvestment of rents improves outcomes, it was necessary to test whether local government revenues and spending increased significantly more in boom, than in non-boom counties. Results indicate that boom counties do receive revenues as a result of the oil and gas boom and they do spend more as a result. The per capita revenue and expenditures increased most significantly, in comparison to the pre-boom period, in 1982. This finding shows that there is a lag between the time that individuals and businesses receive rents from the oil and gas extraction and the time that local governments do.

I find that once local governments receive additional revenues, savings increase as does spending in education and highways. Spending for education and highways increase the most in absolute and per capita terms; while, public welfare spending increases the most when measured as percentage of total spending. Spending in health and hospitals is not influenced by additional revenues. Useful insights are gleamed from the increases in spending in education and highways, but it is more difficult to attribute the oil and gas boom to changes in public welfare spending, because the pattern of public welfare spending for boom and non-boom counties were not on similar paths prior to the boom. This violates the assumption of the difference in differences method.

Large increases in per capita spending for education and highways have opposite effects. Boom counties that increase highway spending per capita more appear to experience lower levels of per capita income during the boom and post-boom period, while all other boom counties experience the highest mean in per capita income. In contrast, boom counties that increase education spending per capita more appear to fare better with higher per capita incomes during the bust and post-bust period. These results for high levels of highway spending may indicate that increases in drilling in the early and peak boom create such damage to highways that counties are forced to spend the extra funds making repairs rather than investing in future

welfare and once they reach the higher threshold of 300 extra wells they are able to divert funds to other purposes.

The main question of the study was whether local governments can reinvest rents from oil and gas extraction to sustain growth afterwards. If it is assumed that the extra revenues received in boom counties are reinvested in human capital (through education spending) and physical capital (through highways and health and education), then this study shows that reinvestment into human capital through education is more effective than reinvestment in physical capital. However, the difficulty of separating spending into investment and current operations makes the results inconclusive. Also, isolation of the impact of local government spending on per capita income levels is difficult. There may still be characteristics of counties with high spending levels that influence per capita income outcomes that were not controlled for in the model. Additional research is needed to overcome these limitations.

Ideas for future studies include a more in depth examination of types of spending, exploration of initial conditions in boom counties, and methods of exploring the impact of early and peak boom investment and consumption choices made by individuals and businesses. A more in-depth examination of types of spending would further classify increased spending by capital projects, maintenance, and current services. For example, spending in education may be for building new facilities, maintaining current facilities in the face of additional pressures, or hiring additional teachers and administrators. New facilities and additional or more highly qualified teachers would be considered investments to increase potential future well-being, while maintaining current facilities and hiring additional administration to deal with the influx of students would be considered consumption or increases in current well-being.

With thirty five boom counties in the region case studies exploring cultural and environmental capital before, during, and after the boom would provide more information on choices and sustainable development. Many rural communities in the west have distinct cultures based on the resources that were an impetus to growth. Some counties have experienced previous boom and bust cycles and there may be a learning curve. Also, some counties may have more detailed and focused strategic growth plans in place prior to the boom. Information on each of these elements would improve the level of insights gained from my own analysis.

Lastly, additional empirical analysis on how the reinvestment of all rents would further the theoretical knowledge about weak sustainability and would provide more insights for local policy makers. Local governments receive only a portion of the rents from the extraction of oil and gas. The federal government, state governments, businesses, and individuals also receive rents. Each of these entities also makes choices about spending for current consumption or investing for potential future consumption. Without analyzing decisions of all to determine how much is reinvested for future potential, it is difficult to fully test the concept of weak sustainability. None the less, studying local government revenues in the Rocky Mountain provides valuable information on the extent to which their decisions can impact outcomes. Rural county governments provide education, recreational, and hospital facilities that make an area attractive to live and work.

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Appendix A: Classification of counties as high investment

Table 8: Classification of counties based on 75th percentile of boom counties

		Boom		Non-boom	
Variable	75^{th} percentile	# High	# Other	# High	# Other
Per capita changes					
Education spending	0.751	9	26	18	302
Highway spending	0.169	8	27	36	284
Health and hospital spending	0.190	8	27	4	280
Public welfare	0.014	9	26	100	220
Percentage of 1982 spending					
Education spending	0.553	9	26	127	193
Highway spending	0.159	9	26	65	255
Health and hospital spending	0.115	8	27	75	245
Public welfare	0.016	9	26	107	213
Absolute changes					
Education spending	23,099	8	27	20	300
Highway spending	3,930	8	27	10	310
Health and hospital spending	2,879	8	27	27	293
Public welfare	203	9	26	73	247
Percentage change in spending					
Education spending	0.049	8	27	58	262
Highway spending	0.104	9	26	13	307
Health and hospital spending	0.149	8	27	97	223
Public welfare	0.019	10	25	136	184

Table 9: Classification of counties based on 50th percentile

		Boom		Non-boom	
Variable	50^{th} percentile	# High	# Other	# High	# Other
Per capita changes					
Education spending	0.5481	17	18	71	249
Highway spending	0.1060	18	17	92	228
Health and hospital spending	0.0163	18	18	133	187
Public welfare	0.0001	17	18	211	109
Percentage of 1982 spending					
Education spending	0.488	18	17	201	119
Highway spending	0.103	17	18	170	150
Health and hospital spending	0.107	17	18	135	185
Public welfare	0.003	18	17	226	84
Absolute changes					
Education spending	6,300	17	18	91	229
Highway spending	1,573	17	18	57	263
Health and hospital spending	222	17	18	130	190
Public welfare	4	17	18	206	114
Percentage change in spending					
Education spending	0.0425	18	17	73	247
Highway spending	0.0520	18	17	53	267
Health and hospital spending	0.0521	18	17	185	135
Public welfare	-0.0010	19	16	243	77

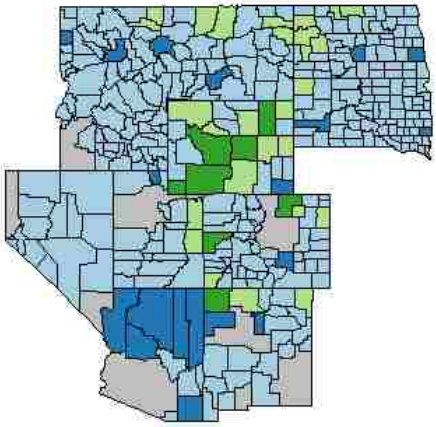
Appendix B: Additional summary statistics

Table 10: Summary statistics for outcome and high investment variables, observations = 356

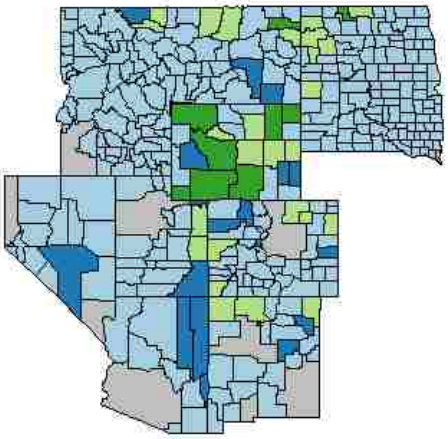
Variable	Mean	Std. dev	Min	Max
Change in absolute spending from 1967-1982				
Change in absolute education spending	7,486	10,231	-286	58,831
Change in absolute highway spending	1,189	1,495	-241	14,342
Change in absolute health & hospital spending	1,158	3,301	-1,499	37,070
Change in absolute public welfare spending	282	1,161	-1,216	17,115
Dummy variable for high absolute spending change				
Education spending	0.08	0.27	0	1
Highway spending	0.05	0.22	0	1
Health & hospital spending	0.10	0.30	0	1
Public welfare spending	0.23	0.42	0	1
Percentage change in spending from 1967-1982				
Change in percentage education spending	0.04	0.08	-0.0100	1.50
Change in percentage highway spending	0.04	0.05	-0.0039	0.52
Change in percentage health & hospital spending	0.34	1.38	-0.0100	16.80
Change in percentage public welfare spending	0.04	0.17	-0.0100	2.15
Dummy variable for high percentage spending change				
High percentage education spending change	0.19	0.39	0	1
High percentage highway spending change	0.06	0.24	0	1
High percentage health & hospital spending change	0.30	0.46	0	1
High percentage public welfare spending change	0.41	0.49	0	1
Dummy variable for high percent of total spending in 1982				
Education spending	0.38	0.49	0	1
Highway spending	0.21	0.41	0	1
Health & hospital spending	0.23	0.42	0	1
Public welfare spending	0.33	0.47	0	1

Appendix C: Maps showing how counties are classified (green=boom, dark=classified as high spending)

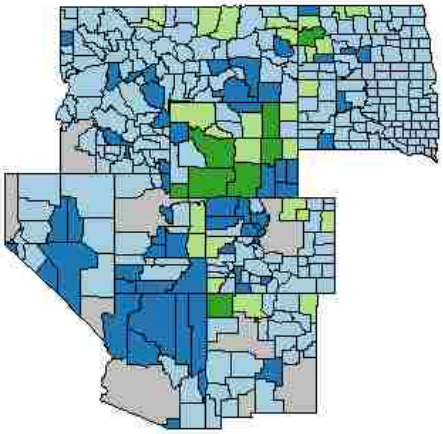
High education spending change



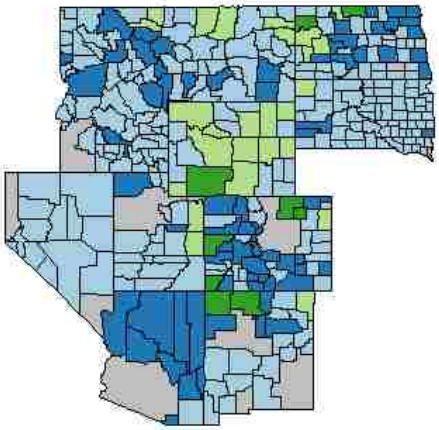
High per capita education spending change



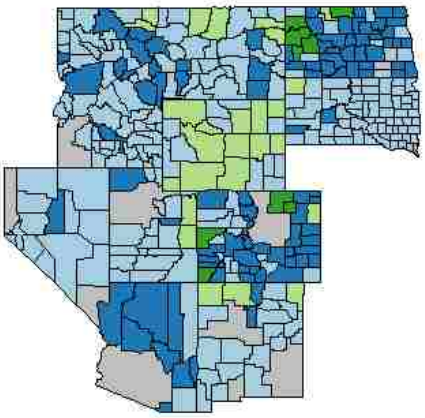
High percentage education spending change



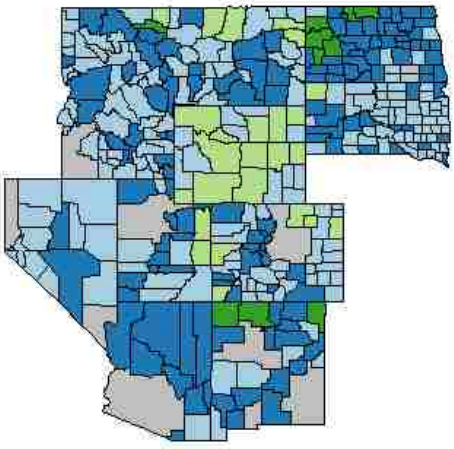
High public welfare spending change



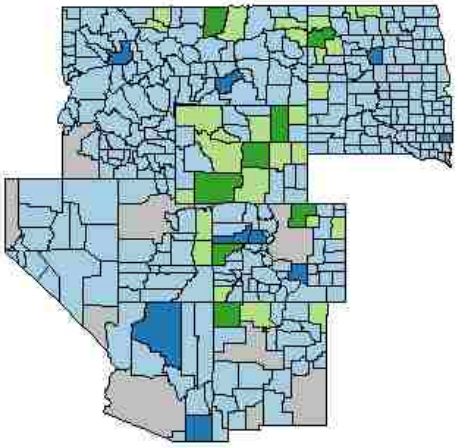
High per capita public welfare spending change



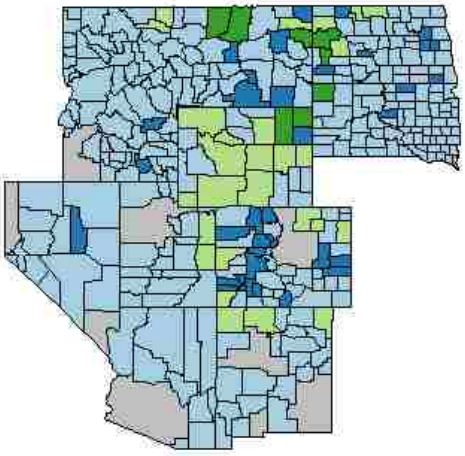
High percentage public welfare spending change



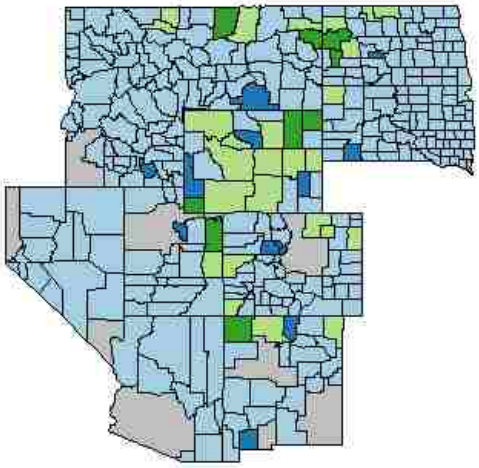
High highway spending change



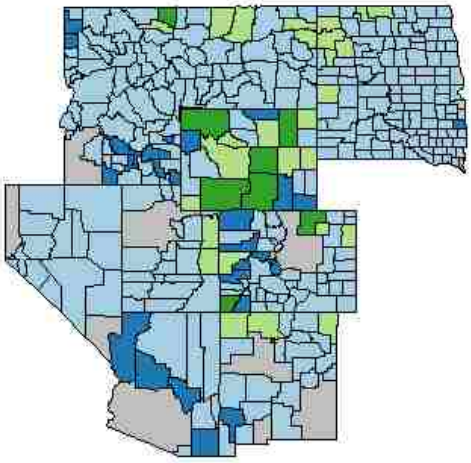
High per capita highway spending change



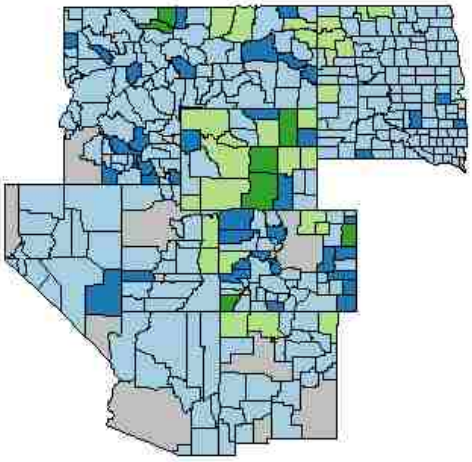
High percentage highway spending change



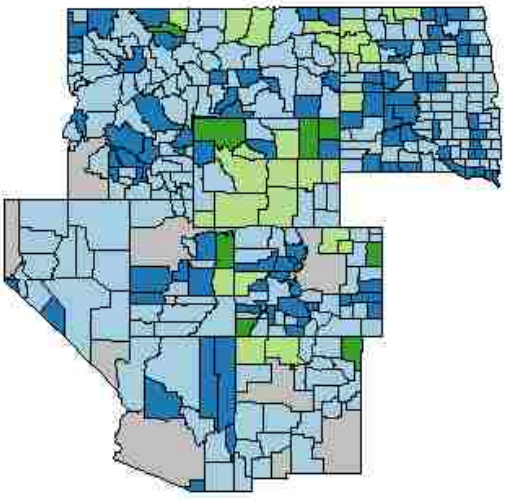
High health & hospital spending change



High per capita health & hospital spending change



High percentage health & hospital spending change



Appendix D: Tables of regression results used for robustness testing (Part 1)

Table 11: Regression results for impact of boom on local government revenues, expenditures and savings, using year and county fixed effects with robust standard errors

	Local government revenues		Local government expenditures		Local government savings	
Dependent variable	ln(revenue)	ln(revenue per capita)	ln(general expenditures)	ln(general expenditures per capita)	Savings	Savings per capita
Boom * 1972	-0.028	-0.023	-0.015	-0.010	192.857	-0.003
	(0.05)	(0.05)	(0.04)	(0.05)	(122.27)	(0.01)
Boom * 1977	0.092	0.058	0.070	0.036	548.324**	0.025
	(0.07)	(0.05)	(0.07)	(0.05)	(200.04)	(0.02)
Boom * 1982	0.396***	0.251***	0.356***	0.211**	2022.963	0.148
	(0.11)	(0.07)	(0.10)	(0.07)	(2108.64)	(0.09)
Boom * 1987	0.370***	0.269***	0.331***	0.230***	5065.677*	0.111
	(0.11)	(0.07)	(0.10)	(0.06)	(2335.98)	(0.06)
Boom * 1992	0.180	0.126*	0.168	0.114	1391.144	0.015
	(0.10)	(0.06)	(0.10)	(0.06)	(726.09)	(0.04)
_cons	7.738***	-1.192***	7.714***	-1.217***	-16.901	0.007
	(0.02)	(0.01)	(0.02)	(0.01)	(90.51)	(0.01)
R2 (within)	0.900	0.938	0.905	0.939	0.029	0.016
Observations	2129	2129	2130	2130	2130	2130
F	484.115	1203.688	512.654	1232.347	6.141	7.892

Notes: Coefficients are reported with robust standard errors in parenthesis. *, **, *** indicate significance at the 10%, 5%, and 1% significance level, respectively.

Table 12: Regression results for impact of boom on local government spending in specific categories, using year and county fixed effects with robust standard errors

	Education			Public welfare			Highways			Health and hospitals		
Dependent variable	ln(educ spending)	ln(educ spending per capita)	ln(percent educ spending)	ln(pw spending)	ln(pw spending per capita)	ln(percent pw spending)	ln(hwy spending)	ln(hwy spending per capita)	ln(percent hwy spending)	ln(hh spending)	ln(hh spending per capita)	ln(percent hh spending)
Boom * 1972	0.016	0.020	0.028	-0.446**	-0.446**	-0.442*	0.026	0.031	0.037	-0.037	-0.028	-0.036
	(0.06)	(0.06)	(0.03)	(0.16)	(0.17)	(0.17)	(0.06)	(0.06)	(0.04)	(0.19)	(0.19)	(0.18)
Boom * 1977	0.081	0.046	0.013	-1.011**	-1.049**	-1.102**	0.075	0.040	0.001	0.111	0.079	0.055
	(0.07)	(0.06)	(0.03)	(0.35)	(0.36)	(0.37)	(0.06)	(0.06)	(0.06)	(0.26)	(0.25)	(0.25)
Boom * 1982	0.280**	0.134	-0.073	-0.335	-0.457	-0.691*	0.590***	0.444***	0.230**	-0.068	-0.209	-0.414
	(0.10)	(0.07)	(0.04)	(0.29)	(0.29)	(0.31)	(0.13)	(0.11)	(0.07)	(0.30)	(0.29)	(0.29)
Boom * 1987	0.294**	0.192**	-0.034	-0.546	-0.647	-0.877*	0.440***	0.338***	0.104	-0.075	-0.172	-0.398
	(0.10)	(0.07)	(0.04)	(0.42)	(0.42)	(0.42)	(0.11)	(0.09)	(0.07)	(0.26)	(0.25)	(0.24)
Boom * 1992	0.154	0.099	-0.010	-0.623	-0.697*	-0.828*	0.230*	0.176*	0.059	-0.033	-0.081	-0.190
	(0.09)	(0.07)	(0.04)	(0.34)	(0.34)	(0.36)	(0.10)	(0.08)	(0.07)	(0.31)	(0.30)	(0.29)
_cons	7.124***	-1.812***	-0.598***	3.802***	-5.156***	-3.941***	5.597***	-3.334***	-2.122***	3.383***	-5.578***	-4.370***
	(0.02)	(0.02)	(0.01)	(0.05)	(0.05)	(0.05)	(0.02)	(0.02)	(0.02)	(0.07)	(0.06)	(0.06)
R^2 (within)	0.868	0.884	0.049	0.356	0.326	0.117	0.795	0.811	0.129	0.483	0.459	0.046
Observations	2124	2124	2124	1939	1939	1939	2127	2127	2127	2008	2008	2008
F	570.622	1226.865	7.888	53.674	47.958	14.208	309.774	454.683	15.999	84.282	79.495	4.978

Notes: Coefficients are reported with robust standard errors in parenthesis. *, **, *** indicate significance at the 10%, 5%, and 1% significance level, respectively.

Appendix E: Comparison of means for income per capita by spending levels

Per capita income and high change in education spending

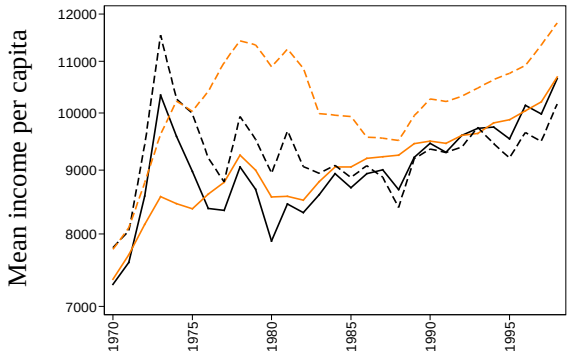


Figure 12: Per capita income and high education spend change (dash=boom, orange=high spend)

Figure 11: Per capita income and high education per capita spend change (dash=boom, orange=high spend)

Figure 16: per capita income and high percentage education spend change (dash=boom, orange=high spend)

Per capita income and high highway spending change

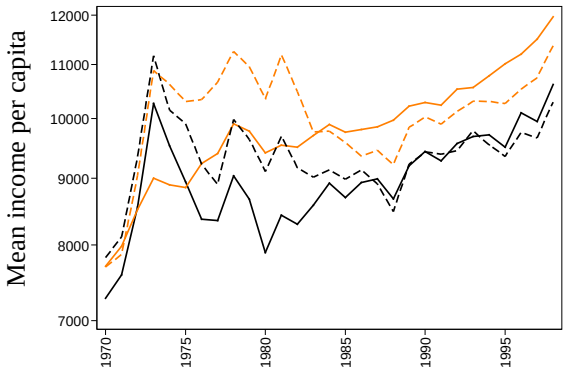


Figure 17: Per capita income and high absolute highway spend change (dash=boom, orange=high spend)

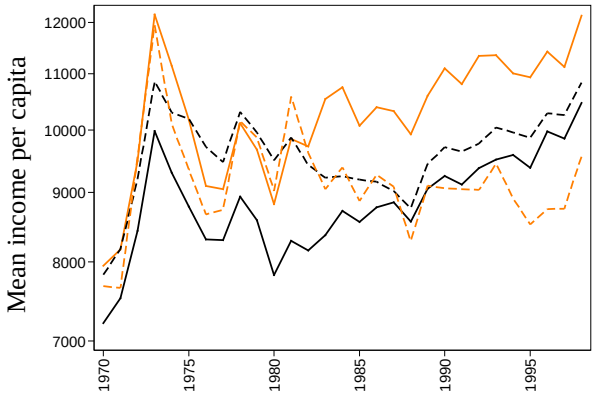


Figure 18: Per capita income and high per capita highway spending change (dash=boom, orange=high spend)

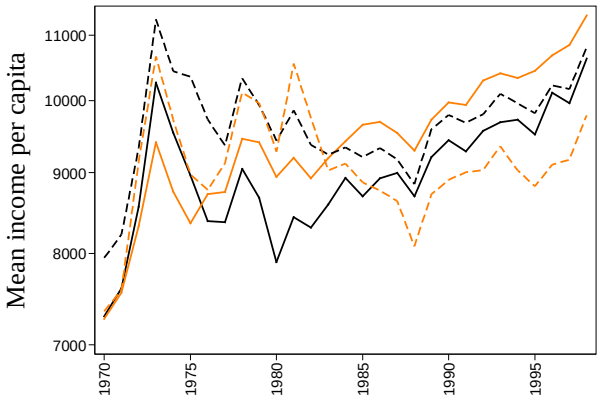


Figure 19: Per capita income and high percentage highway spending change (dash=boom, orange=high spend)

Per capita income and high health and hospital spending change

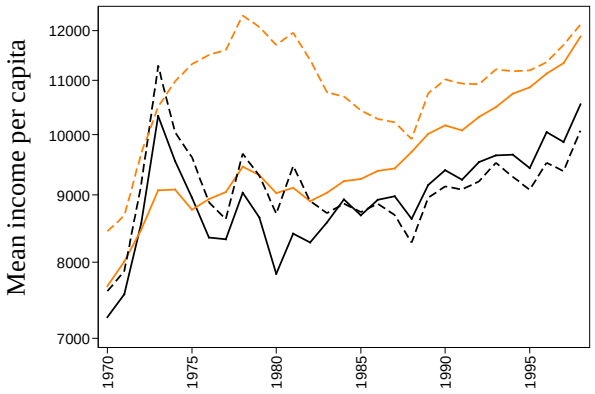


Figure 20: Per capita income and high absolute health and hospital spending change (dash=boom, orange=high spend change)

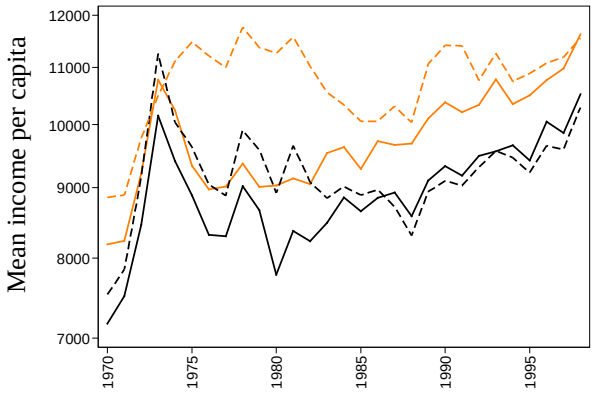


Figure 21: Per capita income and high per capita health and hospital spending change (dash=boom, orange=high spend change)

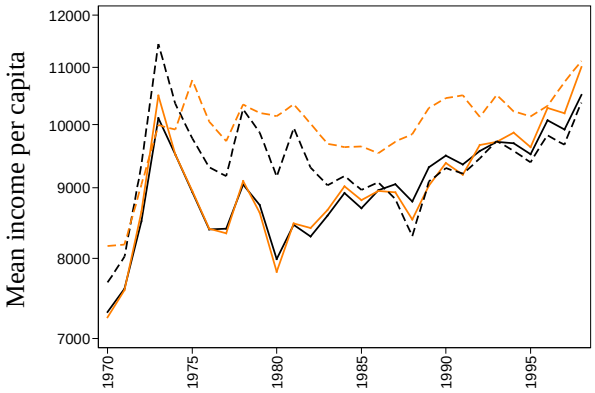


Figure 22: Per capita income and high percentage health and hospital spending change (dash=boom, orange=high spend change)

Per capita income and high public welfare spending

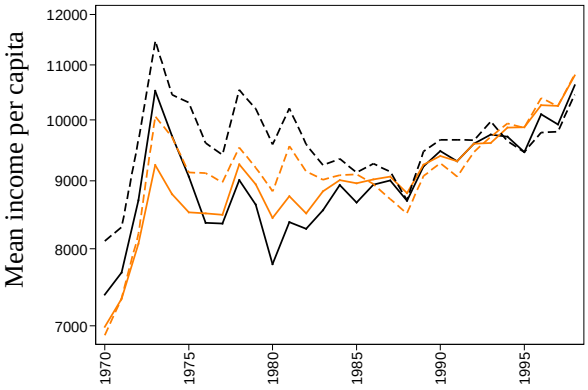


Figure 23: Per capita income and high change in absolute public welfare spending (dash=boom, orange=high spend)

Figure 24: Per capita income and high per capita change in public welfare spending (dash=boom, orange=high spend)

Figure 25: Per capita income and high percentage public welfare spending (dash=boom, orange=high spend)

Appendix F: Tables of regression results used for robustness testing (Part 2)

Table 13: Regression results for impact of high absolute changes in spending on log per capita income for boom and non-boom counties, using year and county fixed effects with robust standard errors

	Boom				Non-boom			
Interaction term	High absolute change in				High absolute change in			
	Education	Highways	Hospitals	Public welfare	Education	Highways	Hospitals	Public welfare
Dependent variable	ln(income per capita)				ln(income per capita)			
Interaction term * EB	0.143*	0.109	0.158**	0.037	0.049**	0.059**	0.041**	0.065***
	(0.05)	(0.06)	(0.04)	(0.04)	(0.02)	(0.02)	(0.01)	(0.01)
Interaction term * PB	0.186**	0.122	0.179**	0.046	0.087***	0.126***	0.101***	0.127***
	(0.06)	(0.07)	(0.06)	(0.07)	(0.02)	(0.04)	(0.02)	(0.02)
Interaction term * LB	0.137**	0.083	0.132*	0.087*	0.053**	0.095**	0.035	0.082***
	(0.05)	(0.06)	(0.05)	(0.04)	(0.02)	(0.03)	(0.02)	(0.02)
Interaction term * BUST	0.129**	0.072	0.110*	0.123**	0.048*	0.083*	0.061*	0.069***
	(0.04)	(0.05)	(0.04)	(0.04)	(0.02)	(0.03)	(0.02)	(0.02)
_cons	8.908***	8.908***	8.908***	8.908***	8.844***	8.844***	8.844***	8.844***
	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)
R^2 (within)	0.367	0.349	0.366	0.360	0.402	0.403	0.403	0.411
Observations	1050	1050	1050	1050	9600	9600	9600	9600

Notes: Coefficients are reported with robust standard errors in parenthesis. *, **, *** indicate significance at the 10%, 5%, and 1% significance level, respectively.

Table 14: Regression results for impact of high percentage changes in spending on log per capita income for boom and non-boom counties, using year and county fixed effects with robust standard errors

	Boom				Non-boom			
Interaction term	High percentage change in				High percentage change in			
	Education	Highways	Hospitals	Public welfare	Education	Highways	Hospitals	Public welfare
Dependent variable	ln(income per capita)				ln(income per capita)			
Interaction term * EB	0.110	-0.004	0.058	-0.042	0.051***	0.045*	-0.011	0.032**
	(0.06)	(0.06)	(0.06)	(0.04)	(0.01)	(0.02)	(0.01)	(0.01)
Interaction term * PB	0.169*	0.082	0.081	-0.102	0.128***	0.117**	-0.030	0.005
	(0.06)	(0.07)	(0.07)	(0.07)	(0.02)	(0.04)	(0.02)	(0.02)
Interaction term * LB	0.064	0.048	0.066	-0.052	0.047*	0.069	-0.004	0.022
	(0.06)	(0.05)	(0.07)	(0.05)	(0.02)	(0.04)	(0.01)	(0.01)
Interaction term * BUST	0.032	-0.040	0.102*	-0.084	0.028	0.070	-0.019	0.000
	(0.05)	(0.06)	(0.05)	(0.06)	(0.02)	(0.05)	(0.02)	(0.02)
_cons	8.908***	8.908***	8.908***	8.908***	8.844***	8.844***	8.844***	8.844***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)
R^2 (within)	0.355	0.347	0.349	0.347	0.407	0.403	0.401	0.402
Observations	1050	1050	1050	1050	9600	9600	9600	9600

Notes: Coefficients are reported with robust standard errors in parenthesis. *, **, *** indicate significance at the 10%, 5%, and 1% significance level, respectively.

Table 15: Regression results for impact of high percentage spending on category in 1982 on per capita income for boom and non-boom counties, using year and countyfixed effects with robust standard errors

	Boom				Non-boom			
Interaction term	High percentage of spending in 1982				High percentage of spending in 1982			
	Education	Highways	Hospitals	Public welfare	Education	Highways	Hospitals	Public welfare
Dependent variable	ln(per capita income)				ln(per capita income)			
Interaction term * EB	-0.039	-0.061	0.028	-0.050	-0.007	-0.051**	-0.029*	0.006
	(0.04)	(0.06)	(0.05)	(0.04)	(0.01)	(0.02)	(0.01)	(0.01)
Interaction term * PB	-0.136	-0.008	0.024	-0.050	-0.067**	-0.163***	0.012	-0.018
	(0.07)	(0.07)	(0.06)	(0.07)	(0.02)	(0.03)	(0.02)	(0.02)
Interaction term * LB	-0.051	-0.012	0.024	-0.002	-0.025	-0.031	-0.021	0.028
	(0.04)	(0.06)	(0.04)	(0.05)	(0.01)	(0.02)	(0.02)	(0.02)
Interaction term * BUST	0.002	-0.120	0.075	-0.003	-0.023	-0.023	-0.016	-0.011
	(0.06)	(0.07)	(0.04)	(0.06)	(0.02)	(0.02)	(0.02)	(0.02)
_cons	8.908***	8.908***	8.908***	8.908***	8.844***	8.844***	8.844***	8.844***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)
R^2 (within)	0.348	0.362	0.343	0.338	0.404	0.412	0.402	0.402
Observations	1050	1050	1050	1050	9600	9600	9600	9600

Notes: Coefficients are reported with robust standard errors in parenthesis. *, **, *** indicate significance at the 10%, 5%, and 1% significance level, respectively.

Table 16: Regression results for impact of high spending change on log per capita income, using year and county fixed effects with robust standard errors (subgroups based on investment and independent variables are periods of the boom)

	Education		Highways		Hospitals		Public welfare	
Subgroup	High absolute change	Low absolute change	High absolute change	Low absolute change	High absolute change	Low absolute change	High absolute change	Low absolute change
Dependent variable	ln(income per capita)		ln(income per capita)		ln(income per capita)		ln(income per capita)	
Boom * EB	0.110*	0.016	0.075	0.022	0.130**	0.013	0.023	0.050
	(0.05)	(0.02)	(0.06)	(0.02)	(0.04)	(0.02)	(0.03)	(0.03)
Boom * PB	0.161**	0.061	0.076	0.074*	0.146*	0.065*	0.035	0.115**
	(0.06)	(0.03)	(0.08)	(0.03)	(0.06)	(0.03)	(0.06)	(0.03)
Boom * LB	0.068	-0.018	-0.009	-0.006	0.081	-0.017	0.012	0.007
	(0.05)	(0.02)	(0.06)	(0.02)	(0.05)	(0.02)	(0.03)	(0.02)
Boom * BUST	-0.008	-0.091***	-0.083	-0.079**	-0.034	-0.085**	-0.026	-0.081**
	(0.03)	(0.03)	(0.06)	(0.03)	(0.04)	(0.03)	(0.03)	(0.03)
_cons	8.888***	8.849***	8.931***	8.848***	8.921***	8.845***	8.808***	8.866***
	(0.02)	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)
R^2 (within)	0.713	0.390	0.613	0.390	0.610	0.389	0.554	0.377
Observations	870	9840	570	10140	1080	9630	2490	8220

Notes: Coefficients are reported with robust standard errors in parenthesis. *, **, *** indicate significance at the 10%, 5%, and 1% significance level, respectively.

Table 17: Regression results for impact of high percentage spending change on log per capita income, using year and county fixed effects with robust standard errors (subgroups based on investment and independent variables are periods of the boom)

	Education		Highways		Hospitals		Public welfare	
Subgroup	High percentage change	Low percentage change	High percentage change	Low percentage change	High percentage change	Low percentage change	High percentage change	Low percentage change
Dependent variable	ln(income per capita)		ln(income per capita)		ln(income per capita)		ln(income per capita)	
Boom * EB	0.088	0.029	0.001	0.048*	0.097	0.029	-0.003	0.071**
	(0.05)	(0.02)	(0.06)	(0.02)	(0.06)	(0.02)	(0.03)	(0.03)
Boom * PB	0.124*	0.082*	0.050	0.082*	0.181**	0.070*	0.022	0.129***
	(0.06)	(0.03)	(0.07)	(0.03)	(0.07)	(0.03)	(0.07)	(0.03)
Boom * LB	0.022	0.004	-0.015	0.001	0.064	-0.006	-0.039	0.034
	(0.06)	(0.02)	(0.07)	(0.02)	(0.06)	(0.02)	(0.04)	(0.03)
Boom *BUST	-0.062	-0.067*	-0.158	-0.052*	0.027	-0.094***	-0.125*	-0.040
	(0.05)	(0.03)	(0.08)	(0.02)	(0.04)	(0.03)	(0.05)	(0.03)
_cons	8.881***	8.846***	8.860***	8.852***	8.851***	8.853***	8.820***	8.875***
	(0.02)	(0.01)	(0.03)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
R^2 (within)	0.420	0.407	0.411	0.398	0.377	0.407	0.407	0.397
Observations	2010	8700	690	10020	3180	7530	4410	6300

Notes: Coefficients are reported with robust standard errors in parenthesis. *, **, *** indicate significance at the 10%, 5%, and 1% significance level, respectively.

Table 18: Regression results for impact of high percentage of 1982 spending on log per capita income, using year and countyfixed effects with robust standard errors (subgroups based on investment and independent variables are periods of the boom)

	Education		Highways		Hospitals		Public welfare	
Subgroup	High % spending in 1982	Low % spending change in 1982	High % spending in 1982	Low % spending change in 1982	High % spending in 1982	Low % spending change in 1982	High % spending in 1982	Low % spending change in 1982
Dependent variable	ln(income per capita)		ln(income per capita)		ln(income per capita)		ln(income per capita)	
Boom * EB	0.021	0.052	0.040	0.050*	0.088*	0.032	0.004	0.060*
	(0.03)	(0.03)	(0.06)	(0.02)	(0.04)	(0.02)	(0.04)	(0.03)
Boom * PB	0.036	0.106***	0.219**	0.067*	0.106*	0.095*	0.072	0.105**
	(0.07)	(0.03)	(0.07)	(0.03)	(0.05)	(0.04)	(0.06)	(0.04)
Boom * LB	-0.013	0.014	0.026	0.007	0.045	-0.000	-0.009	0.020
	(0.04)	(0.03)	(0.06)	(0.02)	(0.04)	(0.03)	(0.04)	(0.02)
Boom * BUST	-0.049	-0.074**	-0.136*	-0.038	0.005	-0.085**	-0.060	-0.067*
	(0.05)	(0.03)	(0.07)	(0.02)	(0.03)	(0.03)	(0.05)	(0.03)
_cons	8.801***	8.884***	8.871***	8.847***	8.908***	8.835***	8.840***	8.858***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
R^2 (within)	0.425	0.386	0.420	0.430	0.380	0.406	0.394	0.409
Observations	4110	6600	2250	8460	2520	8190	3510	7200

Notes: Coefficients are reported with robust standard errors in parenthesis. *, **, *** indicate significance at the 10%, 5%, and 1% significance level, respectively.

Appendix G: Tables of regression results used for robustness testing of boom level specification

Table 19: Regression results for impact of boom on local government revenues, spending and savings when boom level = 100 extra wells, using year and county fixed effects with robust standard errors

	Local government revenue		Local government expenditures		Local government savings	
Dependent variable	ln(revenue)	ln(revenue per capita)	ln(expenditures)	ln(expenditures per capita)	Savings	Savings per capita
Boom * 1972	-0.018	-0.013	0.009	0.014	153.611	-0.008
	(0.04)	(0.04)	(0.04)	(0.04)	(99.76)	(0.01)
Boom * 1977	0.081	0.071	0.098	0.088*	432.774	-0.009
	(0.06)	(0.04)	(0.05)	(0.04)	(235.12)	(0.03)
Boom * 1982	0.285***	0.218***	0.274***	0.207***	1694.557	0.100
	(0.09)	(0.05)	(0.08)	(0.05)	(1420.57)	(0.06)
Boom * 1987	0.292**	0.265***	0.268**	0.242***	4164.709*	0.146**
	(0.09)	(0.06)	(0.08)	(0.05)	(1615.33)	(0.06)
Boom * 1992	0.135	0.162**	0.133	0.161**	2285.648	0.166
	(0.09)	(0.06)	(0.08)	(0.06)	(1233.15)	(0.14)
_cons	7.738***	-1.192***	7.714***	-1.217***	-16.901	0.007
	(0.02)	(0.01)	(0.02)	(0.01)	(89.51)	(0.01)
R2 (within)	0.899	0.939	0.905	0.940	0.030	0.023
Observations	2129	2129	2130	2130	2130	2130

Notes: Coefficients are reported with robust standard errors in parenthesis. *, **, *** indicate significance at the 10%, 5%, and 1% significance level, respectively.

Table 20: Regression results for impact of boom on local government revenues, spending and savings when boom level = 300 extra wells, using year and county fixed effects with robust standard errors

	Local government revenue		Local government expenditures		Local government savings	
Dependent variable	ln(revenue)	ln(revenue per capita)	ln(expenditures)	ln(expenditures per capita)	Savings	Savings per capita
Boom * 1972	0.017	0.012	0.070	0.064	144.104	-0.017
	(0.07)	(0.08)	(0.06)	(0.07)	(168.58)	(0.02)
Boom * 1977	0.203	0.090	0.222*	0.109	375.369	0.004
	(0.10)	(0.08)	(0.09)	(0.07)	(231.46)	(0.02)
Boom * 1982	0.640***	0.357**	0.611***	0.327***	2973.592	0.221
	(0.16)	(0.11)	(0.14)	(0.10)	(3583.50)	(0.13)
Boom * 1987	0.594***	0.364***	0.570***	0.340***	8226.494*	0.153
	(0.16)	(0.10)	(0.14)	(0.09)	(3878.76)	(0.09)
Boom * 1992	0.402**	0.197*	0.405**	0.201*	2284.198*	0.031
	(0.13)	(0.08)	(0.13)	(0.08)	(1072.06)	(0.04)
_cons	7.738***	-1.192***	7.714***	-1.217***	-16.901	0.007
	(0.02)	(0.01)	(0.02)	(0.01)	(89.25)	(0.01)
R^2 (within)	0.901	0.938	0.907	0.940	0.041	0.019
Observations	2129	2129	2130	2130	2130	2130

Notes: Coefficients are reported with robust standard errors in parenthesis. *, **, *** indicate significance at the 10%, 5%, and 1% significance level, respectively.

Table 21: Regression results for local government spending in specific categories when boom level = 100 extra wells, using year and county fixed effects with robust standard errors

	Education			Public welfare			Highways			Health & hospitals		
Dependent variable ln(spending)	Total	Per capita	Percent	Total	Per capita	Percent	Total	Per capita	Percent	Total	Per capita	Percent
Boom * 1972	0.167	0.171	0.043*	-0.420**	-0.412**	-0.438**	-0.084	-0.079	-0.097	-0.002	0.003	-0.024
	(0.10)	(0.10)	(0.02)	(0.15)	(0.15)	(0.15)	(0.05)	(0.05)	(0.05)	(0.17)	(0.17)	(0.17)
Boom * 1977	0.193*	0.181*	0.029	-0.840**	-0.855**	-0.956***	-0.004	-0.015	-0.106	0.276	0.267	0.184
	(0.09)	(0.09)	(0.02)	(0.26)	(0.27)	(0.27)	(0.06)	(0.05)	(0.06)	(0.24)	(0.23)	(0.23)
Boom * 1982	0.339***	0.271**	0.010	-0.407	-0.461	-0.677*	0.356**	0.289**	0.078	0.153	0.088	-0.117
	(0.10)	(0.09)	(0.02)	(0.25)	(0.25)	(0.26)	(0.11)	(0.09)	(0.07)	(0.25)	(0.24)	(0.24)
Boom * 1987	0.323***	0.296***	0.002	-0.362	-0.385	-0.627*	0.277**	0.250**	0.004	0.265	0.237	0.002
	(0.10)	(0.09)	(0.02)	(0.32)	(0.32)	(0.32)	(0.10)	(0.08)	(0.07)	(0.25)	(0.24)	(0.24)
Boom * 1992	0.191*	0.217*	0.007	-0.476	-0.466	-0.651*	0.053	0.080	-0.084	0.092	0.130	-0.028
	(0.09)	(0.09)	(0.02)	(0.26)	(0.26)	(0.27)	(0.10)	(0.07)	(0.07)	(0.27)	(0.26)	(0.25)
_cons	7.124***	-1.812***	0.563***	3.801***	-5.157***	-3.942***	5.597***	-3.334***	-2.122***	3.385***	-5.576***	-4.369***
	(0.02)	(0.02)	(0.00)	(0.05)	(0.05)	(0.05)	(0.02)	(0.02)	(0.02)	(0.07)	(0.06)	(0.06)
R^2 (within)	0.869	0.886	0.106	0.356	0.325	0.117	0.793	0.811	0.129	0.483	0.460	0.044
Observations	2124	2124	2130	1939	1939	1939	2127	2127	2127	2008	2008	2008

Notes: Coefficients are reported with robust standard errors in parenthesis. *, **, *** indicate significance at the 10%, 5%, and 1% significance level, respectively.

Table 22: Regression results for local government spending in specific categories when boom level = 300 extra wells, using year and county fixed effects with robust standard errors

	Education			Public welfare			Highways			Health & hospitals		
Dependent variable ln(spending)	Total	Per capita	Percent	Total	Per capita	Percent	Total	Per capita	Percent	Total	Per capita	Percent
Boom * 1972	0.099	0.092	0.002	-0.537*	-0.552*	-0.623**	0.075	0.069	0.002	0.343	0.332	0.251
	(0.08)	(0.08)	(0.01)	(0.22)	(0.22)	(0.24)	(0.07)	(0.08)	(0.05)	(0.20)	(0.21)	(0.20)
Boom * 1977	0.196	0.082	-0.014	-1.074*	-1.189*	-1.298*	0.198*	0.084	-0.028	0.431	0.318	0.214
	(0.11)	(0.09)	(0.02)	(0.49)	(0.51)	(0.52)	(0.08)	(0.08)	(0.09)	(0.31)	(0.30)	(0.31)
Boom * 1982	0.469**	0.184	-0.070***	-0.200	-0.445	-0.805	0.868***	0.584***	0.253*	0.434	0.155	-0.168
	(0.15)	(0.11)	(0.02)	(0.42)	(0.42)	(0.42)	(0.15)	(0.13)	(0.10)	(0.36)	(0.36)	(0.36)
Boom * 1987	0.465***	0.234*	-0.055*	-0.024	-0.240	-0.599	0.656***	0.425***	0.082	0.278	0.052	-0.284
	(0.14)	(0.10)	(0.02)	(0.50)	(0.49)	(0.48)	(0.15)	(0.13)	(0.10)	(0.29)	(0.29)	(0.28)
Boom * 1992	0.326**	0.120	-0.047*	-0.559	-0.788	-1.012*	0.534***	0.329***	0.126	0.282	0.082	-0.114
	(0.13)	(0.09)	(0.02)	(0.49)	(0.48)	(0.50)	(0.11)	(0.09)	(0.10)	(0.36)	(0.37)	(0.35)
_cons	7.124***	-1.812***	0.563***	3.803***	-5.156***	-3.940***	5.597***	-3.334***	-2.122***	3.384***	-5.577***	-4.369***
	(0.02)	(0.02)	(0.00)	(0.05)	(0.05)	(0.05)	(0.02)	(0.02)	(0.02)	(0.07)	(0.06)	(0.06)
R^2 (within)	0.869	0.884	0.107	0.355	0.325	0.114	0.797	0.810	0.128	0.483	0.459	0.045
Observations	2124	2124	2130	1939	1939	1939	2127	2127	2127	2008	2008	2008

Notes: Coefficients are reported with robust standard errors in parenthesis. *, **, *** indicate significance at the 10%, 5%, and 1% significance level, respectively.

Appendix H: Comparison of means for spending groups using 50th percentile to test robustness

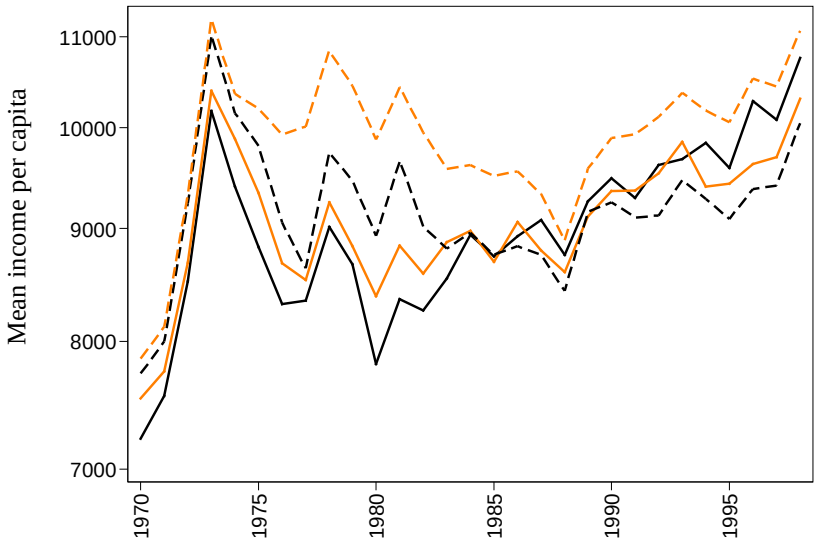


Figure 26: Per capita income and high per capita education change using 50th percentile (dash=boom, orange=high spend change)

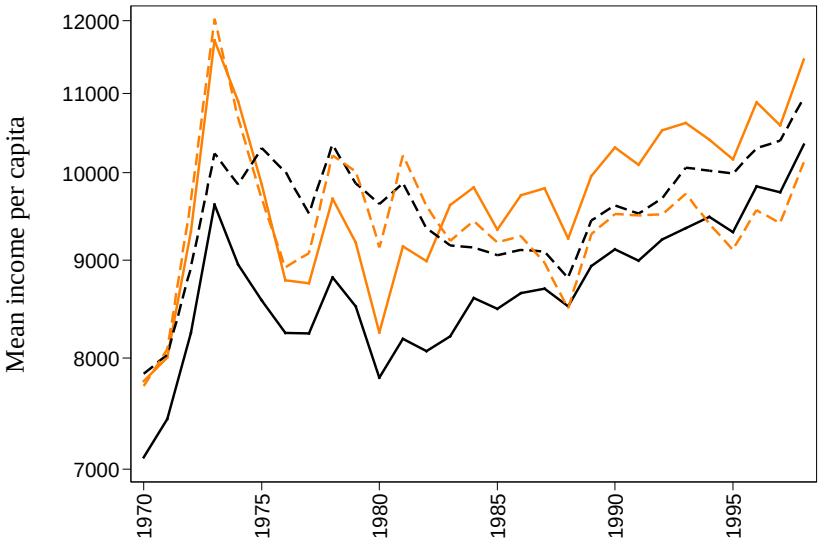


Figure 27: Per capita income and high per capita highway change using 50th percentile (dash=boom, orange=high spend change)

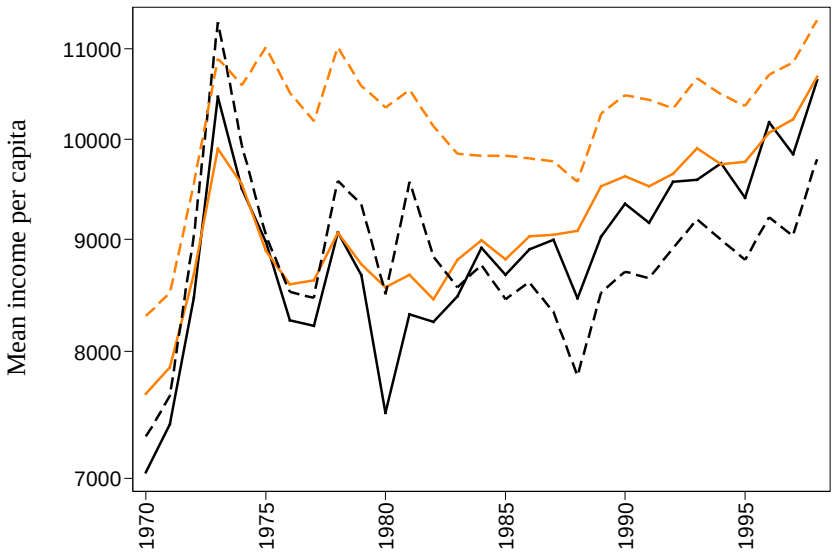


Figure 28: Per capita income and high per capita health and hospital change using 50th percentile (dash=boom, orange=high spend change)

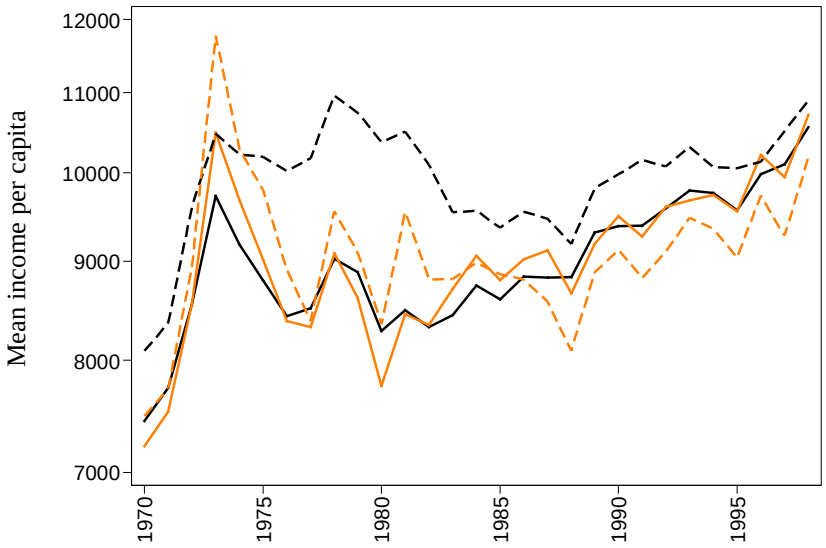


Figure 29: Per capita income and high per capita public welfare change using 50th percentile (dash=boom, orange=high spend change)