Title: Resource Booms and Crime: Evidence from Oil and Gas Production in Colorado

Author: Patrick Gourley Greg Madonia

PII: S0928-7655(17)30200-2
DOI: https://doi.org/doi:10.1016/j.reseneeco.2018.07.001
Reference: RESEN 1075

To appear in: *Resource and Energy Economics*

Received date: 30-6-2017
Revised date: 12-2-2018
Accepted date: 2-7-2018

Please cite this article as: Patrick Gourley, Greg Madonia, Resource Booms and Crime: Evidence from Oil and Gas Production in Colorado, <*![CDATA[Resource and Energy Economics]]*> (2018), https://doi.org/10.1016/j.reseneeco.2018.07.001

“Resource Booms and Crime: Evidence from Oil and Gas Production in Colorado” by Patrick Gourley and Greg Madonia highlights.

- A simple model shows a resource boom could increase or decrease crime.
- The recent Colorado resource boom caused an increase in violent crime rates.
- The recent Colorado resource boom caused an increase in property crime rates.
- The results are robust to numerous specifications.

Resource Booms and Crime: Evidence from Oil and Gas Production in Colorado

Patrick Gourley[1] and Greg Madonia[2]

[1]Department of Economics, University of New Haven
[2]Department of Economics, California State University, Chico

July 31, 2018

Abstract

The 21st century oil and gas boom is drastically changing life in the American West. While previous literature has examined how resource booms affect household income and infant health, the effects of resource booms on crime remain largely unstudied. We develop a simple model that demonstrates an oil and gas boom could increase or decrease crime as employment opportunities, inequality, and other aspects of the local economy change. Combining well data provided by drillinginfo.com and FBI incident-level crime data, we examine intra-county changes in both property and violent crime in Colorado as wells open and shut down. We find a positive relationship between the well density of a county and both violent and property crimes. This suggests that while counties in resource intense areas may receive a financial windfall from a rapidly expanding industry base, increased public safety spending may be needed to counteract increases in crime.

JEL Codes: Q33, K14, J61

The authors would like to thank Dan Kaffine, Brian Cadena, Nick Flores, Jonathan Hughes, Alex James, Austin Smith, as well as participants at the University of Colorado Boulder Environmental Economics Brown Bag, University of Colorado Boulder FrackingSENSE luncheon, and SEA 2016 Meetings for their help and suggestions throughout the editing process. All remaining errors are our own.

1 Introduction

Over one million oil and gas well are currently active in the United States, thousands of which have been drilled in the last decade (Kelso 2015). Economists have scrutinized the economic impacts of these wells, but less attention has been paid to the impact of these resource booms on local crime outcomes.[1] The hydraulic fracture (fracking) revolution combined with record commodity prices and other new technologies have the potential to change household incomes, wealth, employment opportunities, housing prices, and even family size. (Black *et. al.*, 2003; Jacobsen and Parker, 2014; Kearney and Wilson, 2017; Maniloff and Mastromonaco, 2017).[2,3] Large scale oil or gas development could also affect such disparate outcomes as housing prices and infant health (Muehlenbachs *et. al.*, 2015; Hill, 2012). Previous research has shown that changes in economic outcomes may lead to changes in both violent crimes and property crimes (Chand and Levantis, 2000; Kowalski and Zajac, 2012). Given the prevalence of oil and gas wells in the United States, any relationship between drilling activity and crime is an important dynamic to understand. Do resource booms increase the crime rates committed in a county, and what type of crime is most affected? Using a panel data set that contains information on both well activity and crime in the state of Colorado, we exploit changes in county-level oil and gas production activity to examine the impact of resource booms on local crime incidences. Our findings suggest that increased drilling activity leads to a significant increase in property and violent crime.

Whether or not a change in oil or gas extraction leads to any change in crime is an open empirical and theoretical question as several forces can influence behavior in opposing directions. First, suppose that an expansion in extraction activity along either the extensive or intensive margin leads to an uptick in wealth by increasing the property value of land where oil and gas production is taking place. An increase in household wealth or income can lead to a decrease in crime due to a higher opportunity cost of incarceration.

[1] One exception is James and Smith (2016). Couttenier *et. al.* (2014) examines how 19th century American mineral booms affected murder rates.

[2] See Kinnaman (2011) for a survey of economic effects relating to resource extraction.

[3] While the resource boom in this paper will necessarily focus on short term outcomes, the long term outcomes of an oil and gas boom could be much different (Haggery *et. al.* 2014)

However, an increase in wealth or income could lead to more domestic violence (Tauchen *et. al.*, 1991; Farmer and Tiefenthaler, 1997; Makowitz, 2000). Alternatively, a change in income or wealth could lead to more property crime as the benefit of theft increases. Stories in the popular press tell of top-of-the-line mountain bikes and luxury cars suddenly arriving in boom towns (Holeywell, 2011). These new high-value goods could prove overly tempting for both locals and migrant workers who may not benefit as much from the resource boom as those who own the property where the resource extraction is occurring. Second, in addition to changing the wealth and income of households, a sudden demand for natural resource extraction laborers could also lead to a change in the demographics of a county. As shown by Albrecht (1978), crime can increase when a formerly homogeneous group becomes diluted by a different demographic. We develop a simple theoretical framework and show that while crime could increase or decrease during a resource boom, the competing mechanisms indicate an increase in crime is more likely.

Although Colorado is not undergoing an oil and gas boom on the same scale as the often studied Bakken shale region of North Dakota, Figure 1 shows that hundreds of new well permits were issued in 2014 alone.[4] Historically, many of Colorado's oil and gas wells were not financially viable because of high extraction costs. With Brent Crude prices exceeding $100 in the mid-2000s, however, these areas became more appealing.[5] For the first time, many of these fields were financially viable and companies began to extract resources.

As seen in Table 1, there is significant variance in both the number of wells and well density in any given county-month. Weld County, which runs along the Wyoming Border (see Figure 2), has upwards of 20,000 wells. Compare that with nearby Larimer County, which has around 200 active wells during the sample period. This heterogeneity presents a unique opportunity for study. Thousands of additional wells could substantially improve economic performance (Weber, 2012), but could put local institutions such as road infrastructure under severe strain. Hundreds of wells could present a different set of

[4]During our study period, natural gas production increased by 22 percent and oil production increased by 66 percent.

[5]Natural gas prices were also above their long term average at this time, but the increase was not as drastic as oil.

challenges to counties, especially if they are located far away from the county seat in an area that usually receives little government attention.

Additionally, Colorado itself exhibits a great deal of variety outside of the resource sector (see Table 2). Within the state there is a major metropolitan area (Denver), nearly uninhabitable mountain areas, and large open plains that occupy the eastern third of the state.[6] This diversity suggests that our conclusions about Colorado may be more generalizable than in a state like North Dakota, where the unprecedented fracking revolution above the Bakken shale play occurred almost solely in rural areas with homogeneous populations.

Using a detailed data set containing county-level information of the number of oil and gas wells in Colorado from 2008 through 2012, this paper examines the impact of oil and gas well activity on count-level crime incidences. Data for our outcome variable, violent and property crime rates, were obtained from the National Incident-Based Reporting System (NIBRS). The NIBRS data set includes all incidences of crimes (including those were no arrests are made) for all participating police agencies in the United States.[7] Given the detail of the crime data, we separate crime into two major categories: crimes against people (violent crime) and crimes against property (property crime). Since the mechanisms that drive these two broad divisions of crime may be different, we examine these outcomes separately.

The results indicate that increases in the density of gas and oil wells cause an increase in both property and violent crime rates. Using a fixed effects estimation technique that controls for county-level time invariant characteristics, as well as month $\times$ year fixed effects that allow for non-parametric time trends, we find that a one unit increase in well density is associated with a 0.6 percent increase in violent crime and a 1.1 percent increase in property crime.[8,9] These results are robust to numerous sample selections. We also

[6]Contrast Colorado with North Dakota, which has no metropolitan areas that are in the national top 200 by size, and has a largely uniform topography.

[7]Although the NIBRS data is not comprehensive in Colorado, more than 95 percent of the population is serviced by participating agencies. Additionally, for this lack of completeness to affect our results, there would have to be some systemic relationship between lack of agency participation and both the level of crime and the level of oil and gas extraction in a given county, which we believe is unlikely.

[8]Well density is defined as wells per hundred people

[9]It should be noted that there is a single county, Weld, which has many more wells than any other

investigate heterogeneous effects, and find evidence that lower population counties, low income counties, and counties with lower levels of inequality see larger changes in crime. Our results suggest that a potential increase in crime rate must be acknowledged when assessing the external costs of expanding resource extraction operations in a county.

This paper provides direct insight into the link between resource booms and crime. This insight contributes to the literature of examining how an employment shift can affect crime, whether that shift is caused by a resource boom or the opening of a new casino (Grinols and Mustard, 2006). To our knowledge, this is the first time that detailed oil and gas production data at the county-month level has been linked with lawlessness. While some counties have a constant increase in the number of wells, others see both decreases and increases as wells are capped or come on-line, strengthening the empirics. Our results show that a natural resource boom can have a significant increase on property and violent crime.

The remainder of the paper is organized as follows. Section 2 briefly discusses the theoretical work analyzing crime and resource booms and then develops a simple theoretical framework. Section 3 describes the two data sources used in the analysis. Section 4 explains the methodology. Section 5 discusses the main results, robustness tests, and examines possible heterogeneous effects. Section 6 concludes.

2 Theoretical Motivation

Since Becker's (1968) seminal work, economists have examined crime as a potentially rational action in which individuals will choose whether or not to participate.[10] While career criminals may have a high discount factor of long term utility versus short term, they may still make a rational decision based on their preferences and examine the benefits and costs of committing a crime. It is not immediately clear whether a resource boom in a local area would increase or decrease the net benefits to committing an offense. Resource booms have the potential to generate wealth, which would decrease crime, but

county in the sample. In a robustness check, we omit Weld County.

[10] Also see Erhlich (1973).

also increase inequality, which will increase crime (Kelly, 2000). In this section we will detail the effects that a resource boom has on the local area and describe the various channels that could influence crime either positively or negatively. Although the direct implications of the model cannot be tested due to data constraints, it is instructive to determine what mechanisms may cause a change in crime. As we show, crime could theoretically increase or decrease as a result of a resource boom, so it is important to establish how either could occur.

A separate strand of literature has formalized the idea of "Dutch Disease" (Corden and Neary, 1982; Krugman, 1987). In short, an economy consists of three sectors: a non-tradable sector that includes services, a tradable boom sector (the oil and gas industry), and a tradable lag sector (agriculture and manufacturing). During a resource boom, labor and capital will move away from the tradable lag sector and to the boom sector. With most resource booms this effect can be relatively small, given the capital intensive nature of exploiting natural resources. In Colorado, the population of some areas may be low enough that if migration is sticky, this form of direct deindustrialization may be large. The more significant channel of Dutch Disease is usually through increased spending in the non-tradable sector caused by the large revenues from the boom sector. Prices in the non-tradable sector rise, sometimes exponentially. Prices in the lag sector are set nationally, however, and so remain fixed. Workers who remain in the lag sector may see sharp decreases in their real wealth as prices rise but wages stagnate.[11] The takeaway is that some workers will benefit and others will suffer during a resource boom.

2.1 Extensive and Intensive Marginal Changes

A resource boom could change the crime rate in an area along the extensive and intensive margin of the population.[12] Changes in the extensive margin result from population shifts caused by both incoming and outgoing migrants and changes in the number of people

[11] There is some discussion whether Dutch Disease reduces social welfare or is just movement to a new optimal allocation but that is beyond the scope of this paper.

[12] The extensive margin refers to new workers migrating to an area and committing crimes, while the intensive margin refers to existing people committing more crimes.

likely or unlikely to commit a crime.[13] We expect the majority of extensive marginal change occurs from inbound migrants, although natives that cannot reap any windfall from the boom may emigrate from the area. Those who live in an area both before and after the resource boom drive changes along the intensive margin, as they will update their optimal number of offenses as the economy grows.[14]

Migrants immigrating into an area is the main mechanism for change along the extensive margin, as they will most likely dwarf natives emigrating (Bachman, 2014). A resource boom can attract a large number of workers, both those who will work directly in the boom sector and those seeking the inflated wages in other industries that are competing with the boom sector employers. While the obvious job placement for a newcomer is in the oil and gas sector, a large number of migrants may seek work in the non-tradable sector, which will have to raise wages to compete with the boom sector. Stories of McDonald's paying $15 an hour in North Dakota are common as existing native workers move into the boom sector (Shactman, 2011). Levi Strauss, for example, made his fortune not by panning for gold during the California Gold Rush, but by selling his new pants to miners. Land in particular can become quite valuable, even if that land is not situated immediately above a shale play. Migrants that are looking for work either in the boom or non-tradable sector may not successfully assimilate into the area, or could come into conflict with natives.

It is also likely that the types of workers that migrate to work in the boom sector are not randomly drawn from the US working population. Young men have a comparative advantage in many of the jobs generated during a resource boom, and young men are the most likely demographic to commit a crime. American men in their twenties, for instance, committed 35 percent of crimes in 2011 despite making up only 14 percent of the population. Violent crime is the most skewed towards men, who make up 90 percent of all offenders (FBI, 2011). There is also evidence that sexual offenders disproportionately locate to resource boom areas, possibly because the lack of employable workers diminishes the stigma surrounding their previous offenses (Berger and Beckman

[13]For a detailed analysis of how population increases affect crime, see Freudenberg and Jones (1991).
[14]Both natives in the lag sector and those in the non-tradable sector will update their priors.

2010; James and Smith 2016). Further exacerbating the situation is that there is often a lack of single women present. This leads to a windfall for female sex workers and exotic dancers (Sheerin, 2014), but can also increase tensions among men. On the other hand, boom workers are often making large amounts of money for the first time, raising the opportunity costs of committing any crime.

Along the intensive margin, native workers can move from the lag sector to the boom sector or non-tradable sector, and native workers that are part of the non-tradable sector may move to the boom sector. Often there is a shortage of labor in the boom and non-tradable sector, so even natives without skills will be competitive for jobs. In fact, employers may find native workers to be better employees because of their ties to the local community. Some native workers, however, will stay in the lag sector. Their real wages may decrease dramatically in the wake of a resource boom. As the model below illustrates, the benefits of committing a crime will increase for all workers, while the costs of committing a crime could increase or decrease depending on worker type.

2.2 The Model

The following model is based off Becker (1968), Kaffine (2009), and Borjas *et. al.* (2010). Given three different types of jobs (boom, non-tradable, and lag) and two different types of workers (migrants and natives), who is likely to commit more crimes and who is likely to commit less crimes during a resource boom than they would otherwise? Consider the simple framework below:

$$V = U_{ij}[\theta_{ij}, X_{ij}(b), O_{ij}(b)] - C_{ij}[O_{ij}(b)] \tag{1}$$

Where the value function, V, for a worker of type i working in job type j is determined by a number of factors, including the number of offenses, O_{ij}, that the worker chooses to commit. Those workers also face a cost associated with committing an offense, C_{ij}. There are utility generating mechanisms, θ_{ij}, that are not influenced by a resource boom, b; the local climate, for instance, as well as factors that do depend on whether a resource boom is occurring, X_{ij}.

Separate literatures have identified factors determined by resource booms and factors that determine utility. While a resource boom has the potential to affect many aspects of a worker's utility, we will focus on several of the most salient. One of the most notable impacts of a resource boom is a rise in inequality (Gylfason and Zoega, 2003; Goderis and Malone, 2011; Ploeg 2011). Inequality has also been shown to decrease welfare (Alesina *et. al.*, 2004; Graham and Felton, 2004). A resource boom will also increase the wage level for employees in the boom or non-tradable sector, which will increase welfare. The price level will rise for all workers, decreasing utility. These mechanisms show how a resource boom's effects on utility will vary in both magnitude and direction across workers.

There are two cost dimensions to committing an offense. The first is the cost of jail time, fines, probation, or other legal penalties. The second is the cost imposed by society on known criminals. It is important to recognize that there is some uncertainty on behalf of a worker on the chances of those costs being realized. Cities cannot immediately adapt to the increased population and wealth that accompanies a resource boom. Even if they are receiving increased revenue into municipal coffers,[15] it will take time to hire and train new public safety officers to increase conviction rates (Di Tella, Schargrodsky, 2004). In the time between migration and increased spending on public safety, the odds of being apprehended for an offense decrease.[16]

Second, if a worker commits an offense and is not legally apprehended, knowledge of his behavior may or may not become known. If the illegal behavior does become known, the worker will likely be shunned. Whether or not an offender is "caught" by society and how much society deplores that action depends on the level of social disorganization (Kubrin and Weitzer, 2003). Social Disorganization Theory arises from Strain Theory (Merton, 1938), which predicts that an agent's social structure can influence their behavior. In short, when society is well organized there are large societal pressures to obey the law. This influence has the potential to outweigh any individual predilections towards committing an offense. In a boom town the social cost borne by natives and migrants

[15]There is some doubt as to how much additional revenue stays in the local area. Feyrer *et. al.* (2017) estimates about a third of all revenues stay within the regional economy.

[16]Archbold (2014) gives a detailed analysis of how a resource boom can affect policing.

could differ by a wide margin. Natives will have existing social structures and possibly long term ties to the community, while migrants are often total outsiders.

Because the benefits of crime are known and the costs of crime are uncertain to the offender Equation 1 becomes:

$$E(V) = U_{ij}[\theta_{ij}, X_{ij}(b), O_{ij}(b)] - E[C_{ij}[O_{ij}(b)]] \tag{2}$$

Where the factors generating positive utility including the benefits of committing an offense are known with certainty, but the costs are uncertain.

2.3 Analytical Form

To illustrate a potential scenario let Equation 2 take the functional form below:

$$max_O \quad V = \quad \theta_{ij} - I(b) + w_{ij}^L(b) + I(b)w_{ij}^I(b)O_{ij}(b) - \frac{E[J_{ij}(b)]w_{ij}^L(b)O_{ij}^2(b)}{E[S_{ij}(b)]} \tag{3}$$

The first term of Equation 3, θ_{ij}, comprises any utility generating factors that do not interact with number of offenses or depend on a resource boom. The second term, $I(b)$, refers to the disutility individuals get from income inequality holding all else equal. The level of inequality in society is tautologically the same for all members of a society and does not vary across individuals. The third term, $w_{ij}^L(b)$, refers to the real legitimate wage a worker can earn. The fourth term shows the benefits of committing a criminal offense; the utility from an offense is increased with inequality and the real illegitimate wage, $w_{ij}^I(b)$, gained from the offense. Inequality is positively related to the number of violent offenses (Kelly, 2000; Fajnzlber, 2002), so $I(b)$ is a component of the benefits of an offense. An increase in the real illegitimate wage is equivalent to having more high value goods in the area which would also increase the benefits to committing offenses. $5,000 mountain bikes, nice cars, and other goods that would increase the benefit to theft often accompany an intense resource boom.

The fifth and final term describes the cost from committing an offense. Given three-

strike laws and the general attitudes towards repeat offenders of the American legal system, it is assumed that the expected costs of committing offenses is convex. A higher expectation of conviction or harsher punishment upon conviction, $E[J_{ij}(b)]$, will result in a higher cost. The expectation of being convicted and the severity of the punishment is not constant across individuals; that is, certain individuals are more likely to be convicted and punishments will differ across classes of worker (Walker *et. al.*, 2011). A higher real wage from legitimate work, $w_{ij}^L(b)$, that will be lost from being incarcerated will also result in an increased cost.

An increase in expected social disorganization, $E[S_{ij}(b)]$, will decrease the social punishment of committing a crime, and will result in a lower cost of crime. Social disorganization can be thought of as the breakdown of social structures, that when functioning properly, will exert control over individual behavior. In most cases having a high level of social organization will result in mostly law abiding activity. When social disorganization increases, society will no longer be able to place the correct pressures on individuals to obey the law.

The relationship between these various factors and the existence or intensity of a resource boom are mostly straightforward. Inequality will increase in the presence of a boom ($\frac{\partial I}{\partial b} > 0$) as a (possibly small) segment of the population realizes a financial windfall.[17] The sign on the real legitimate wage will be worker dependent, ($\frac{\partial w_{ij}^L}{\partial b} \lessgtr 0$). This is because wages for workers in the boom and non-tradable sector will rise, but the spending effect will cause the price level to increase as well (Aragon and Rud, 2013), resulting in a possible decrease of real legitimate wage for natives in the lag sector (Corden, 1984). The real illegitimate wage increases with the boom ($\frac{\partial w_{ij}^I}{\partial b} > 0$) as there will be more items worth stealing. The expected punishment of committing a crime will decrease with the intensity of the resource boom ($\frac{\partial E[J_{ij}]}{\partial b} < 0$) as the local government will take time to properly increase public safety spending. Finally, the level of social disorganization will increase with the resource boom as society becomes more fragmented ($\frac{\partial E[S_{ij}]}{\partial b} > 0$).

[17] Resource booms are often capital intensive, meaning that even large booms can result in a small change in employment.

Maximizing Equation 3 and solving for $O_{ij}(b)$ yields the following:

$$O^*_{ij}(b) = \frac{I(b)w^I_{ij}(b)E[S_{ij}(b)]}{2w^L_{ij}(b)E[J_{ij}(b)]} \tag{4}$$

2.4 Worker Types

As Equation 4 shows, theoretically it is unclear how a resource boom will affect the optimal number of offenses. A large increase in legitimate wage due to a resource boom could decrease the optimal number of offenses an individual commits because of the high opportunity cost of being incarcerated or otherwise unemployable. Of course, different worker-job types will produce different results. As with any economic shock, some workers will benefit and some will suffer. Often the latter are more salient, especially in the media and from a public policy perspective, but both deserve equal economic consideration. In the following subsections we will examine all of the various worker job types.

Inequality increases equally for all members of society, so that alone would increase the optimal number of crimes (Kelly, 2000).[18] Exactly why inequality increases crime is unclear, but there is evidence that people measure their quality of life by making contemporary comparisons to those around them (Easterlin, 1974).[19] Inequality excepted, other factors will have different magnitudes of change based on the type of worker and sector of employment. We will now cover these in detail.

2.4.1 Native Lag Worker

Native workers that are employed in the lag sector are likely to suffer the most during a resource boom, although they may not be the most likely to commit more offenses. During a resource boom a lag worker will see the ratio $\frac{w^I_{ij}(b)}{w^L_{ij}(b)}$ increase; an increase in price level would affect the real illegitimate wage and real legitimate wage equally, but nominal legitimate wage for a lag worker stays level by definition, while the nominal illegitimate wage will increase. This mechanism acting alone would lead a native lag worker to commit

[18] For a worker in the boom sector, a rise in inequality would be nullified by a rise in real legitimate wage.

[19] Stevenson and Wolfers (2008) have challenged this view, but the economic literature has still not agreed on the relative importance between absolute and relative income in determining happiness.

more crime. Social disorganization probably increases slightly for natives; without a large amount of emigration, native social structures should stay relatively intact. The expected risk of being convicted and severity of sentence would arguably decrease more for a native than a migrant; migrants are more likely to be viewed suspiciously and with less leniency by local authorities. Overall the benefits to committing a crime increase, while the costs decrease. Therefore, $\frac{\partial Oij}{\partial b} > 0$.

2.4.2 Native Boom Worker

Native workers that are employed in what will become the lag sector can either move into the boom sector or non-tradable sector; for the purposes of this section, working in the boom or non-tradable sector will be viewed as equivalent. Natives in the non-tradable sector could be stationary or move into the boom sector.[20] There also may be a small number of natives employed in the boom sector before the boom begins. It is unclear how the ratio between illegitimate and legitimate wage, $\frac{w_{ij}^I(b)}{w_{ij}^L(b)}$, will change for a native boom worker as both types of nominal wage will increase. It is likely that given $\frac{\partial^2 O_{ij}}{\partial^2 w_{ij}^I} < 0$, the change in wage ratio alone will result in a decrease in the number of offenses.[21] The changes to the legal and societal costs of committing an offense during a resource boom will be the same for native boom and native lag workers. In sum, the benefits to committing a crime increase, but a large change in legitimate wage may drastically increase the costs of being imprisoned. Therefore, $\frac{\partial Oij}{\partial b} \gtrless 0$.

2.4.3 Migrant Boom Worker

Migrant workers differ from natives in several ways. First, the level of social disorganization may be very high for them. Moving to a new area, and being amongst total strangers, many of whom are also in a high offense committing demographic, means the societal pressures to stay on the straight and narrow are small. On the other hand, mi-

[20] It is assumed that no native workers or migrant workers will move into the lag sector.

[21] Assuming $\frac{\partial^2 O_{ij}}{\partial^2 w_{ij}^I} < 0$ is based on the idea that every additional crime increases the probability of apprehension at a constant or increasing rate, but additional utility from more crime diminishes.

grants will not be given the benefit of the doubt by the legal system. They are more likely to receive the full brunt of the law should they be convicted; although how their odds of being convicted compare to a native are difficult to determine. The wage ratio will mirror the native boom worker, increasing the opportunity cost of being incarcerated. Also, a migrant worker may be more likely to lose their job after committing an offense compared to a native worker who has ties to the community. Overall it is difficult to say how likely migrant boom workers will be to commit a crime. The selection issues and high level of social disorganization lead us to believe they could be the main drivers of an increased crime rate, but high legitimate may dissuade workers from committing crimes. Once again, $\frac{\partial O_{ij}}{\partial b} \gtrless 0$.

2.5 Theoretical Conclusions

Although the effects of crime could theoretically be either positive or negative, our prior is that crime will increase. While the model predicts that some locals and even migrants will commit less crime because of the increased opportunity cost of incarceration, migration from a high crime demographic can quickly overwhelm local security services. Also, the increase in inequality will make crime more attractive to all residents. This shift may not be permanent as public services are able to better respond to changing conditions in the long run and migrants develop more ties with the area, but this could take years to develop.

3 Data

Data for this paper come from several sources. Well data was provided by www.drillinginfo.com, which contains data on every well drilled, dates that those wells produced, and the amount of production at each well. Exact well location is often given, but in order for well data to be linked with the crime data we aggregate to the county level.

Population data is provided by the US Census Bureau. Each year, county popula-

tions are estimated by the Census Bureau based on the previous decennial census. We constructed a linear spline between each annual estimate to approximate each county-month's population. Although we are concerned how accurately migrant workers can be captured, as many move around frequently, population data allows us to determine changes in the crime rate, which is a more useful benchmark than the number of crimes. The increases in crime rates also provide evidence that those moving into an area are more predisposed towards committing crimes than native workers. Other socioeconomic data is from the year 2000.

Crime data comes from the FBI's Uniform Crime Reports (UCR) National Incident-Based Reported System (NIBRS). NIBRS captures more detailed information than the older Summary Reporting System (SRS). While over 6,000 law enforcement agencies submitted data in 2012, participation in the NIBRS program is voluntary.[22] The NIBRS data includes information on incidents, offenses, and victims. Incidents include both occurrences where arrests are made and occurrences where no arrest is made. Crucially, the date and county of each incident are reported. Each incident contains a wealth of additional information. Any weapons or drugs involved in the incident are included. The type of location, *e.g.* home or work, of the incident is present. Any possible discrimination or bias by the offender is also recorded.

Given the highly detailed nature of the crime data, we separate crime into two major categories: crimes against people and crimes against property. Per the FBI, crimes against people are crimes where the "victim is always a person" (NIBRS User Manual). Crimes that fit into this category are murder, manslaughter, assault, aggravated assault, and intimidation. Crimes against property are such that the goal of the crime is to "obtain money, property, or some other benefit" (*Ibid.*) Some examples of crimes that are included in the category of against property include burglary, vandalism, arson, and extortion.[23] Since the mechanisms that drive these two broad divisions of crime may be

[22]Of the 64 counties in Colorado, 53 counties have crime data for all years while 60 counties have crime data for a majority of the years.

[23]In addition to those listed in the main text, crimes against property include: bribery, counterfeiting, embezzlement, running confidence games, credit card/ATM fraud, impersonation, welfare fraud, and wire fraud.

completely different, we examine these outcomes separately.

With all data sources there is some concern about completeness. As stated above, not every law enforcement agency reports to NIBRS.[24] Another potential problem is different rates of enforcement within a county. Some counties probably have more or less strict enforcement regimes, but as long as these stay constant the county level fixed effect will capture the effect. A more salient concern is that enforcement changes over time within a county. As more migrants move into an area, police officers might be less likely to let people off with warnings. At the same time, police may become more likely to let a native go with a warning as migrants become a bigger concern. If this occurs at different rates in different counties, this could potentially create a large omitted variable bias of unknown direction. As a result, all of our results should be considered net of an endogenous public safety response.

Although there is always some concern about enforcement levels not being consistent from one time period to the next, we find it unlikely that the crimes listed in both crimes against people and crimes against property would fall prone to this complaint. It is hard to imagine that crimes like murder, arson, assault, and burglary would be a function of either police enforcement levels or the number of police present in a given county. Once again, the data is for every incident, not every arrest or conviction. Although the NIBRS data does contain information about drug related crimes and other "crimes against society", the enforcement rate of those could change substantially, especially if there are changes in violent crime that require immediate police attention. Finally, since the NIBRS is an incident level database, there only needs to be a report made of a potential crime, which further mitigates the change-in-enforcement concern.

Data from drillinginfo.com is also difficult to verify. Drillinginfo uses FracFocus.org and other websites to assemble data. The website does claim to have complete coverage throughout Colorado for this time period of study. This claim appears to be fairly accurate. Popular press articles from counties that have zero wells (according to Drilling-

[24]As a robustness check, the county-months with the highest change in number of crimes reported compared to the previous month were dropped. The results, found in Appendix C, are not substantively different than the results found using the full sample.

info) confirm that while exploration may be taking place, there is no current production. Drillinginfo also provides exact location on well data, and currently producing wells do align with satellite imagery.

Table 1 shows summary statistics for both wells and crime. Some counties experienced zero instances of particular types of crime in a month, while others saw many. It is important to note that to ease the interpretation of later results, both well density and crime rate are calculated as observations per 100 people. This will result in small crime rates, as the usual way of measuring crime rates is per 100 people. The density of wells also varies widely. This illustrates the heterogeneity of the boom; some counties have tens of thousands of operating wells while others have only a couple hundred. The sample used in the empirical specifications found in the following sections consists of 38 counties. These counties fulfilled the criteria of having crime, well, and population data for at least one month during the time period examined.

4 Methodology

The specification below estimates the relationship between wells and crime:

$$Crime_{cmy} = \alpha + \beta(Well\ Density)_{cmy} + \delta_{my} + \theta_c + \epsilon_{cmy} \tag{5}$$

Where $Crime_{cmy}$ is one of several variables of crime rates in county c in month m year y. θ_c is a vector of county fixed effects, δ_{my} is a vector of month-year fixed effects, and ϵ_{cmy} is a random error term.[25] The county-level fixed effects control for time invariant county-level unobserved characteristics, while the month-year fixed effects allow for a flexible, non-parametric time trend in average crime levels across counties. Well density is measured as the number of wells per hundred people living in county c during month m in year y.[26] The coefficient of interest is β. As the well density of a county increases, we believe there will be a positive change in the numbers of crimes ($\beta > 0$). As seen in

[25] See the appendix for results when all data is aggregated to year, instead of month, level

[26] An older version of the paper used the number of wells as opposed to well density. See the appendix for the results.

the theoretical motivation, however, a resource boom could potentially decrease crime.

While it could be beneficial to include socioeconomic characteristics in Equation 5, due to the monthly measure of the data and doubts about month-to-month accuracy of these characteristics we cannot use them as controls. Although it would be possible to aggregate to the year level, this would lower our panel from 60 time periods to five.[27] While omission of socioeconomic variables is almost always a concern in an empirical setting, those concerns are mitigated for two reasons. First, our sample consists only of counties where well production occurred. Therefore, a change in a potential socioeconomic characteristic that is related to the crime rate would also have to be related to the number of active wells. This does not seem likely as the amount of well production is determined by the physical characteristics of that well and prices for the type of fuel being extracted – which are not set locally. Second, for changes in a potential socioeconomic characteristic to bias the results they would have to be related to both the crime rate and to the amount of well production at the *monthly level*, as our county and year fixed effects structure reduces other concerns. Finally, socioeconomic outcomes could be endogenous to a resource boom, and an inclusion of these variables would capture the effect we are trying to measure.

It is not obvious whether level or log specifications are preferred. The standard deviation of the property crimes in a county for one month is 1,150. 10 percent of the county-months have less than five property crimes. This means there could be a large increase in crime from a percentage perspective even if the number of crimes only went up by one or two. An increase in the number of crimes this small may not have anything to do with the well density. Therefore, in the results for the main specification, we present both the level and log specifications.

A well is assigned to a county if it is active and producing. This is in contrast to Jacobson and Parker (2014) where the drill or "spud" date is used. The rationale for using the drill date is that the highest number of workers are needed during the drilling process. However, the drill date itself may not be that notable in terms of workers. Work

[27] We explore this level of aggregation in Appendix A.

begins on a site months before the drill date, and the rig that will do the drilling must be readied. Years before the drill date surveying had to take place. Then after the drill date, the number of workers could fluctuate widely. With well production, however, the number of workers involved will stay relatively constant from day to day. A large portion of the workers are truck drivers (Holeywell, 2011), running regular trips to and from the wells. Long-term workers whose job site does not change every month are the workers that are likely to relocate to an area instead of commuting.

4.1 Novelty of Approach

This paper both compares to and contrasts with James and Smith (2016), who examine how the fracking revolution affected crime rates across the country. While the question is similar, our approach is quite different. James and Smith focus on the extensive margin, that is, does a county lie over a shale play or does it not. All counties are assigned to either being part of a treatment or control group based on this designation. The effect is then quantified using a difference-in-difference approach. In other words, James and Smith find an intent-to-treat effect. This may result in an underestimation of the true treatment-on-treated, but also provides an unquestionably exogenous explanatory variable. This paper should be viewed as a complement to James and Smith as we focus on treatment-on-the-treated, and identify changes in crime based on the intensive margin. In other words, the focus of this paper is on how the amount of resource extraction effects crime, as opposed to how the existence of resource extraction effects crime. This is done by looking at the density of actively producing wells in every county-month, and using that number as the explanatory variable.

Our approach utilizes an accurate method regarding the intensity of the boom. Some counties in the sample see large increases in the density of wells over the sixty month time period, while others actually see a decrease in density, and we can observe how the number of crimes in a county-month vary as that occurs. Second, most of Colorado is not over a shale play but still experienced a resource boom as conventional drilling became more financially viable. Fracking requires unique technologies and possibly a

different worker profile than conventional drilling, so analyzing both is important. One disadvantage to our approach is that due to the monthly nature of the data, there are often not enough of any specific type of violent or property crime to accurately track monthly changes.

There is also the question of how population changes affect the crime rate. It is not clear that higher populations alone increase the crime rate in a community, especially in rural areas. Also, it is important to keep in mind that a resource boom will change both the population quantities, and crucially, the population demographics of an area in a unique way. In other words, if a population substantially changes because of a resource boom, societal differences that result from the new population only happen because the resource boom occurred in the first place. However, as the model shows, any change of crime will likely be through several mechanisms. Increased illegitimate wage, increased inequality, and a decrease is social cohesion will all contribute to the effect that a resource boom has on crime.

5 Results

Table 3 shows the results of Equation 5 where the dependent variable is the violent crime rate[28] and the independent variable of interest is wells per hundred people. Both are observed at the county-month level. All standard errors are clustered by county. While our parameter of interest is identified when only considering counties where there is well activity, we also include counties where there has been neither oil nor gas extraction during the time frame of our sample. This allows us to include potentially important information about how crime rates have changed over time for counties where no well activity has occurred, but could be similar to well-active counties on other dimensions. By including all counties in the state, the estimates can be interpreted as the average treatment effect. However, there may be endogeneity concerns because counties do not randomly have active wells. Thus, the restricted sample of only counties that engage

[28] All crime rates are the number of crimes committed in a county-month divided by the population and multiplied by 100.

in oil or gas production are included to mitigate these concerns. In both cases, the coefficients stay quantitatively similar and are highly statistically significant. Panel A in the following two tables uses the full sample, while Panel B uses the restricted sample. Column 1 of Table 3 shows that in the absence of county or month-year fixed effects, the correlation between well density and the log of violent crime rate is negative, but without fixed effects this could be caused by a myriad of omitted variables. Column 2 includes county fixed effects only, and the coefficient indicates that the violent crime rate increases by 0.4 percent for every unit increase in well density.

Column 3 of Table 3 uses both county and time fixed effects, and the coefficient indicates that a one unit increase in well density results in a 0.6 increase in the violent crime rate. At the median county population in our sample of 15,460 people, this implies that an additional 155 wells will cause the violent crime rate to increase by 0.6 percent. Also the average county saw a change of 2.32 wells per hundred people, which corresponds to a 1.4 percent change in violent crime rate.

A direct comparison to James and Smith is difficult, due to the different treatment assignments, units, and time horizon. To help give a sense of scale, however, they find that counties that are undergoing a boom have a roughly 7.1 percent increase in the violent crime rate compared to counties that are not undergoing a boom. This is roughly equivalent to a 12 unit change in our measure of well density, something seen in only Rio Blanco and Yuma counties in our sample.[29]

Column 4 uses the county-month crime rate instead of the log of crime rate, and the coefficient indicates that a unit increase in well density corresponds to an additional 0.0001 crimes per hundred people and is not statistically significant. It is important to remember that as most of our counties are rural, the number of crimes per 100 people in any county month is going to be small, so the coefficients will be small as well. Column 5 uses the log of the number of violent crimes in a county month as the dependent variable. Here a unit increase in well density is associated with a 0.57 percent increase in the number of crimes and this is statistically significant at the one percent level.

[29]Several other counties do see changes in well density that approaches this amount

Panel B of Table 3 is the same specification as Panel A but only counties with active oil or gas wells are included. The results are almost identical to those that only include counties with well activity and all coefficients maintain statistical significance.

Table 4 repeats the specifications from Table 3 but uses the property crime rate as the dependent variable. Given the large increase in the illegitimate wage from committing burglary or theft during a resource boom, we expect there to be a large increase in property crimes. As already mentioned, boom towns often see a large increase in luxury goods. Those in the lag sector may not be tempted to commit a violent crime like assault, which would not see an increase in illegitimate wage, but as wealthy outsiders occupy the area property crime could look more appealing.

Column 3 of Table 4 shows that higher well density results in a 1.1 percent increase in the property crime rate. Also, the property crime rate increases by .0004 and the number of property crimes increases by 1.1 percent. All of these results are statistically significant at the one percent level and remain unchanged when the sample is restricted to counties with active wells. For the median county, this implied that an additional 155 wells would increase the property crime rate by 1.1 percent. An average county would see a 2.6 percent change in property crime rate over the time horizon of this study.

5.1 Robustness Tests

Although many Colorado counties vary substantially from one another, two counties in particular are outliers and could have disproportionate impacts on the results. The first is Weld County, which, as mentioned previously, has far more wells than any other.[30] Strong results when Weld County is excluded would indicate that even counties with less intense resource booms will see an increase in crime. Secondly, Denver County, which comprises only the City of Denver, also has roughly 400 wells throughout the study period. Given Denver County's large population and overall urban nature, it is unlikely that we are estimating any causal relationship between wells and crime.

The results from omitting Weld County and Denver County are shown in Table 5.

[30]Weld County has upwards of 20,000 wells. Nearby Garfield County peaks at circa 11,300 wells.

In both columns and across both panels, the results remain statistically significant and the magnitudes stay similar to the main results. In general, these results provide further evidence that the results are not being driven by these two outlier counties.

A related concern is the geographic boundaries of other counties in the Denver Area. Looking at Figure 2, it is easy to see that several counties such as Adams and Arapahoe are mostly rural by geographic area, but their western borders stretch well into the Denver Metro and even border the City and County of Denver. Most of the population in these counties live in suburban areas, and are probably not affected by changes in the well density. This leads to concerns that any relationship between crime and wells may not be causally related. To address this concern Columns 3 and 5 of Table 5 omit urban counties. Column 3 omits the Denver Metro, while Column 4 omits the entire front range. All coefficients maintain statistical significance at the one percent level and have similar magnitudes to those in the main specification.

Thus far, we have seen that the Colorado oil and gas boom during the 2000s appears to have increased crime rates against both property and people. While both are meaningful, the effect on property crime is roughly twice the size as the effect on violent crime. This is sensible based on the theory developed earlier in the paper; the net benefits for committing property crime would substantially increase with inequality, while the change in net benefits for violent crime is less clear. We now further examine what type of county is driving these effects. Do wealthy counties see a greater increase in crime than poor counties? How much does the intensity of the resource boom or population matter?

5.1.1 Population Effects

To provide evidence on whether the increase in crime is being driven by high or low population counties, we split the data in half between high and low population counties.[31] The results are displayed in Columns 5 and 6 of Table 5. There is weak evidence that low population counties (Column 6) are driving the results found in the main results. Low population counties have statistically significant results when considering both violent

[31]The median county-month population according to the 2000 Census is 14,523. Counties with more than 14,523 people are assigned to the high population group.

and property crime.

Columns 7 and 8 of Table 5 split the counties by population density. Counties with more than 50 people per square kilometer, where a clear structural break occurs, are labeled high density counties (see Figure 3).[32] Interestingly, sparsely populated counties seem to be driving the results, with ranges of magnitudes that are only slightly smaller than their full sample counterparts. This could be for several reasons. Denser counties could have a more effective police force; after all, officers will have to cover less ground. Conversely, sparsely populated counties may not have the resources to adequately patrol an area or investigate crimes. Also, rents may be higher in a dense county leading to wealthier migrants moving into those areas.

5.2 Heterogeneous Effects

Characteristics regarding county population could influence the amount of impact a resource boom has on crime.[33] If counties have to pay large fixed costs to implement successful public safety standards, then counties with large populations may see lower crime because of higher tax revenues. The population density and the relative intensity of a resource boom may also be important. There could be an optimal population density; a dispersed population makes effective policing difficult, while a densely populated area can lead to higher tensions in urban areas. Finally, a county with a high population and many wells will not strain a county's resources as much as a county with a low population and many wells.

Socioeconomic characteristics may also play an important role in how a resource boom affects crime. As already stated, inequality may cause both property and violent crime. Wealthier counties may be better able to deal with incoming migrants than poorer counties. At the same time, there may be more goods in wealthier counties for people to steal. Other aspects such as poverty rate may also affect how a community responds to

[32]The results are similar if dense counties are assigned to any county with more than 20 people per square kilometer, another structural break in the data.

[33]Population, wealth, poverty, and racial statistics are from the US Census. Income inequality information is provided by the American Community Survey. Unemployment data comes from the Bureau of Labor Statistics.

a resource boom.

To examine both heterogeneity in population and socioeconomic characteristics, we perform a series of regressions where counties are bisected along the median. One exception to this is population density, where high density counties are assigned to an area with more than 50 people per square kilometer.[34] All of the following specifications are also performed with Denver County omitted.

5.2.1 Socioeconomic Characteristics

Wealthier counties should, all else equal, be able to better manage a resource boom than poorer counties. To investigate this issue, we compare counties across two dimensions of wealth: income per capita and poverty rate.[35,36] Once again, both the benefits and costs of committing an offense change along these dimensions. A county with a high income per capita will have more resources to spend on public safety but natives will have more luxury goods worth stealing. Counties with high poverty rates may qualify for more state and federal assistance, reducing crime, but higher poverty rates are correlated with a lower educated populace, and lower educated citizens are more likely to commit violent crimes (Lochner and Moretti, 2004).

Columns 1 and 2 of Table 6 show the counties divided by per capita income. Low income per capita counties appear to be driving the results, especially for property crime. Columns 3 and 4 show counties divided by poverty rate. Once again, poorer counties are driving the results, with high poverty rate counties showing statistical significance for both violent crime and property crime. Places with low incomes and high levels of poverty will have residents with a lower opportunity cost of committing crimes than those with high numbers wealthy individuals. In other words, it is worth investigating whether inequality plays a role in how people respond to resource booms.

Columns 5 and 6 of Table 6 divide counties between those with high and low levels of

[34] See Figure 3.

[35] Wealthy counties are those with more than the median $23,764 income per capita.

[36] Counties assigned to the high poverty group are those above the median of 11.7 percent of people living below the poverty line.

inequality.[37] Interestingly, the results do not agree with conventional economic theory and previous empirical research. Both violent and property crime have statistically significant coefficients only in the counties with low levels of inequality. The reasons behind this are unclear. Future research could examine this issue further.

6 Conclusion

The recent oil and gas boom occurring across much of Western America is unprecedented. With this boom comes a windfall for some. Natural resource extraction firms record high profits. Previously middle class land owners are earning upwards of $100,000 per month in passive incomes. Migrant workers can make six figures a year working in the boom sector, or make relatively high wages by working in industries that service the boom. These benefits do come with costs, however. Quiet towns can be transformed into bustling hubs. Hour long traffic jams can form outside of towns that used to number less than 10,000 people. All of this can stress local infrastructure and increase tensions. Some may turn to a life of crime as a result.

We show that the oil and gas boom that occurred in the 2000s in Colorado led to both higher number of violent crimes and property crimes. An increase in well density led to a 0.6 percent increase in the violent crime rate and a 1.2 percent increase in the property crime rate. These results are confirmed by assuming a different distribution of the data and numerous sample selections. There is also some evidence that both increases in population as well as shifts in the working class contribute to these results. Existing inequality before the boom began also appears to be involved in the relationship between crime and resource extraction.

There are several mechanisms that could lead to the increase in crime rates. First, growing inequality caused by non-uniform wealth increases has been shown to increase crime in other settings. Second, native workers could be frustrated with their communities undergoing rapid changes, especially if their wages stagnate, leading them to commit more crimes. Third, migrant workers who do not have ties to their new communities bear a low

[37] Counties with a Gini coefficient above the median of 0.43 are assigned to the high inequality group.

social cost of committing crime, and they could be the driving force. As more workers move into an area the increased population density can also contribute to crime. Whether resource boom workers themselves are ultimately responsible for the increase in crime rate or natives are, local governments should be prepared.

While we believe that the conclusions of this paper are applicable to a moderate sized oil or gas boom anywhere, the results may not extend to other types of booms such as mineral extraction in Australia. Oil and gas booms require a unique mix of educated and skilled workers alongside low skilled employees, and that ratio could be vastly different in different industries. Further research could examine how different types of booms affect crime rates.

For public policy makers, this is an important external cost to consider during the beginning stages of a resource boom. During the period of discovery, surveying, and planning occur before a well is drilled, let alone starts producing, local government should plan accordingly. Once the resource boom begins, things may pick up quickly, leading to pop-up tent cities and inflated rents. However, in the interregnum there is some time to make adequate preparations. Most importantly, financial windfalls rarely last forever, and municipal leaders should be prepared for an eventual bust. Given proper awareness and anticipation, policy makers should be able to mitigate any possible increases in crime.

References

Albrecht, Stan L. 1978. "Socio cultural factors and energy resource development in rural areas in the West." *Journal of Environmental Management* .

Alesina, Alberto, Rafael Di Tella, and Robert MacCulloch. 2004. "Inequality and happiness: Are Europeans and Americans different?" *Journal of Public Economics* 88 (9):2009–2042.

Aragon, Fernando M and Juan Pablo Rud. 2013. "Natural resources and local communities: Evidence from a Peruvian gold mine." *American Economic Journal: Economic Policy* 5 (2):1–25.

Archbold, Carol A, Thorvald Dahle, and Rachel Jordan. 2014. "Policing The Patch: Police Response to Rapid Population Growth in Oil Boomtowns in Western North Dakota." *Police Quarterly* :1098611114549629.

Bachman, Justin. 2014. "Fracking and Retirees Drive U.S. Population Growth." *Bloomberg Business* .

Becker, Gary S. 1968. "Crime and Punishment: An Economic Approach." *The Journal of Political Economy* :169–217.

Berger, Joel and Jon P Beckmann. 2010. "Sexual predators, energy development, and conservation in greater Yellowstone." *Conservation Biology* 24 (3):891–896.

Black, Dan A, Terra G McKinnish, and Seth G Sanders. 2003. "Does the availability of high-wage jobs for low-skilled men affect welfare expenditures? Evidence from shocks to the steel and coal industries." *Journal of Public Economics* 87 (9):1921–1942.

Borjas, George J, Jeffrey Grogger, and Gordon H Hanson. 2010. "Immigration and the Economic Status of African-American Men." *Economica* 77 (306):255–282.

Bureau, United States Census. 2000. "2000 Census." URL `http://www.census.gov/main/www/cen2000.html`.

Chand, Satish and Theodore Levantis. 2000. "Dutch Disease and the crime epidemic: An investigation of the mineral boom in Papua New Guinea." *Australian Journal of Agricultural and Resource Economics* 44 (1):129–146.

Corden, W Max. 1984. "Booming Sector and Dutch Disease Economics: Survey and Consolidation." *Oxford Economic Papers* 36 (3):359–380.

Corden, W Max and J Peter Neary. 1982. "Booming sector and de-industrialisation in a small open economy." *The Economic Journal* 92 (368):825–848.

Couttenier, Mathieu, Pauline Grosjean, and Marc Sangnier. 2014. "The Wild West is Wild: The Homicide Resource Curse." *UNSW Australian School of Business Research Paper* (2014-12).

Di Tella, Rafael and Ernesto Schargrodsky. 2004. "Do police reduce crime? Estimates using the allocation of police forces after a terrorist attack." *The American Economic Review* 94 (1):115–133.

Easterlin, Richard A. 1974. "Does economic growth improve the human lot? Some empirical evidence." *Nations and Households in Economic Growth* 89:89–125.

Ehrlich, Isaac. 1973. "Participation in illegitimate activities: A theoretical and empirical investigation." *The Journal of Political Economy* :521–565.

Fajnzlber, Pablo, Daniel Lederman, and Norman Loayza. 2002. "Inequality and violent crime." *Journal of Law & Economics* 45:1.

Farmer, Amy and Jill Tiefenthaler. 1997. "An economic analysis of domestic violence." *Review of Social Economy* 55 (3):337–358.

FBI. 2011. "Uniform Crime Report." URL `https://www.fbi.gov/about-us/cjis/ucr/nibrs/2014`.

Feyrer, James, Erin T Mansur, and Bruce Sacerdote. 2017. "Geographic Dispersion of Economic Shocks: Evidence from the Fracking Revolution." *American Economic Review* .

Freudenburg, William R and Robert Emmett Jones. 1991. "Criminal Behavior and Rapid Community Growth: Examining the Evidence." *Rural Sociology* 56 (4):619–645.

Goderis, Benedikt and Samuel W Malone. 2011. "Natural Resource Booms and Inequality: Theory and Evidence*." *The Scandinavian Journal of Economics* 113 (2):388–417.

Graham, Carol and Andrew Felton. 2006. "Inequality and happiness: Insights from Latin America." *The Journal of Economic Inequality* 4 (1):107–122.

Grinols, Earl L and David B Mustard. 2006. "Casinos, crime, and community costs." *Review of Economics and Statistics* 88 (1):28–45.

Gylfason, Thorvaldur and Gylfi Zoega. 2003. "Inequality and Economic Growth: Do Natural Resources Matter?" *Inequality and Growth: Theory and Policy Implications* 1:255.

Haggerty, Julia, Patricia H Gude, Mark Delorey, and Ray Rasker. 2014. "Long-term effects of income specialization in oil and gas extraction: The US West, 1980–2011." *Energy Economics* 45:186–195.

Hill, Elaine L. 2012. "Unconventional natural gas development and infant health: Evidence from Pennsylvania." *Working Paper* 12.

Holeywell, Ryan. 2011. "North Dakota's Oil Boom is a Blessing and a Curse." *Governing* .

Jacobsen, Grant D and Dominic P Parker. 2014. "The economic aftermath of resource booms: evidence from boomtowns in the American West." *The Economic Journal* .

James, Alexander and Brock Smith. 2016. "There will be blood: crime rates in shale-rich US counties." *Journal of Environmental Economics and Management* .

Kaffine, Daniel T. 2009. "Quality and the commons: The surf gangs of California." *Journal of Law and Economics* 52 (4):727–743.

Kearney, Melissa S and Riley Wilson. 2017. "Male Earnings, Marriageable Men, and Nonmarital Fertility: Evidence from the Fracking Boom." Tech. rep., National Bureau of Economic Research.

Kelly, Morgan. 2000. "Inequality and crime." *Review of Economics and Statistics* 82 (4):530–539.

Kelso, Matt. 2015. "1.7 Million Wells in the U.S. – A 2015 Update." .

Kinnaman, Thomas C. 2011. "The economic impact of shale gas extraction: A review of existing studies." *Ecological Economics* 70 (7):1243–1249.

Kowalski, Lindsay and Gary Zajac. 2012. "A preliminary examination of Marcellus shale drilling activity and crime trends in Pennsylvania." *Justice Center for Research, Pennsylvania State University, University Park* .

Krugman, Paul. 1987. "The narrow moving band, the Dutch disease, and the competitive consequences of Mrs. Thatcher: Notes on trade in the presence of dynamic scale economies." *Journal of Development Economics* 27 (1-2):41–55.

Kubrin, Charis E and Ronald Weitzer. 2003. "New directions in social disorganization theory." *Journal of Research in Crime and Delinquency* 40 (4):374–402.

Lochner, Lance and Enrico Moretti. 2004. "The Effect of Education on Crime: Evidence from Prison Inmates, Arrests, and Self-Reports." *The American Economic Review* .

Maniloff, Peter and Ralph Mastromonaco. 2017. "The local employment impacts of fracking: A national study." *Resource and Energy Economics* 49:62–85.

Markowitz, Sara. 2000. "The price of alcohol, wife abuse, and husband abuse." *Southern Economic Journal* :279–303.

Merton, Robert K. 1938. "Social structure and anomie." *American Sociological Review* 3 (5):672–682.

Muehlenbachs, Lucija, Elisheba Spiller, and Christopher Timmins. 2012. "Shale gas development and property values: Differences across drinking water sources." *NBER Working Paper* .

Ploeg, Frederick Van der. 2011. "Natural resources: Curse or blessing?" *Journal of Economic Literature* :366–420.

Shactman, Brian. 2011. "Unemployed? Go to North Dakota." *USA Today* .

Sheerin, Jude and Anna Bressanin. 2014. "North Dakota oil boom: American Dream on ice." *BBC* .

Stevenson, Betsey and Justin Wolfers. 2008. "Economic Growth and Subjective Well-Being: Reassessing the Easterlin Paradox." *Brookings Papers on Economic Activity* .

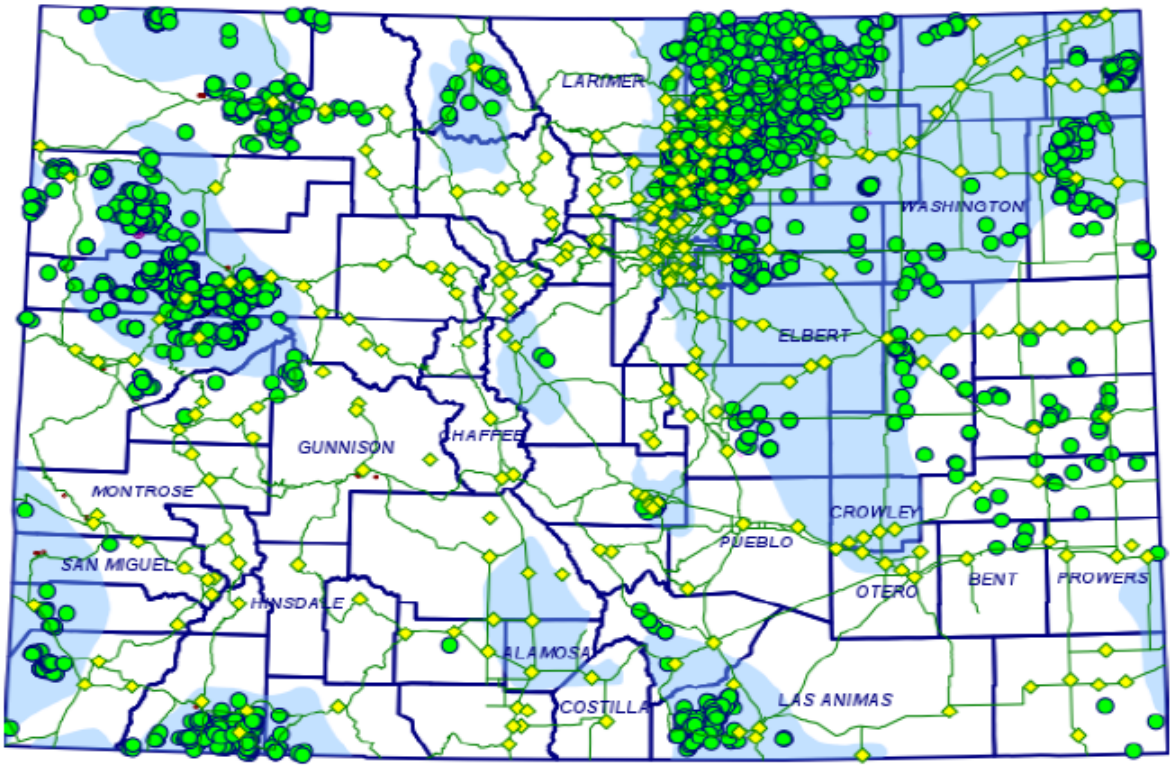
Tauchen, Helen V, Ann Dryden Witte, and Sharon K Long. 1991. "Domestic violence: A nonrandom affair." *International Economic Review* :491–511.

Walker, Samuel, Cassia Spohn, and Miriam DeLone. 2011. *The color of justice: Race, ethnicity, and crime in America*. Cengage Learning.

Weber, Jeremy G. 2012. "The effects of a natural gas boom on employment and income in Colorado, Texas, and Wyoming." *Energy Economics* 34 (5):1580–1588.

Figures and Tables

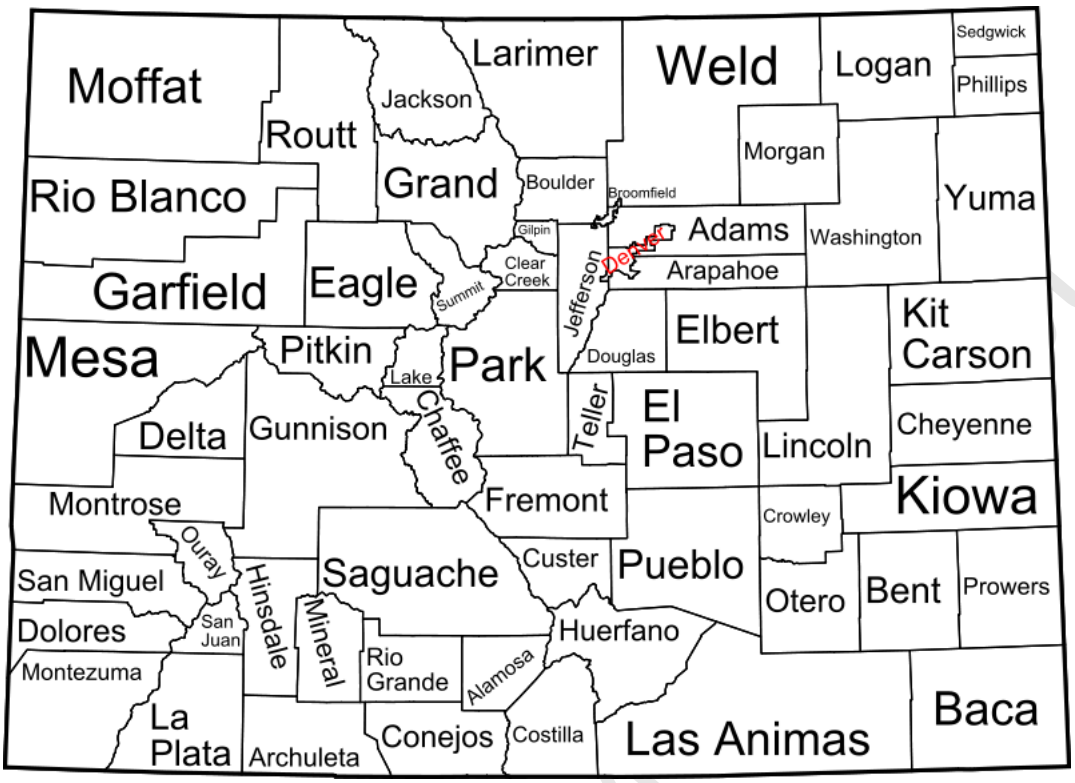
Figure 1: Wells in Colorado



Circles are 2014 well permits. Diamonds are incorporated towns.

Source: Colorado Oil and Gas Conservation Commission

Figure 2: Colorado County Map



Map created by David Benbennick.

Figure 3: County Population Density

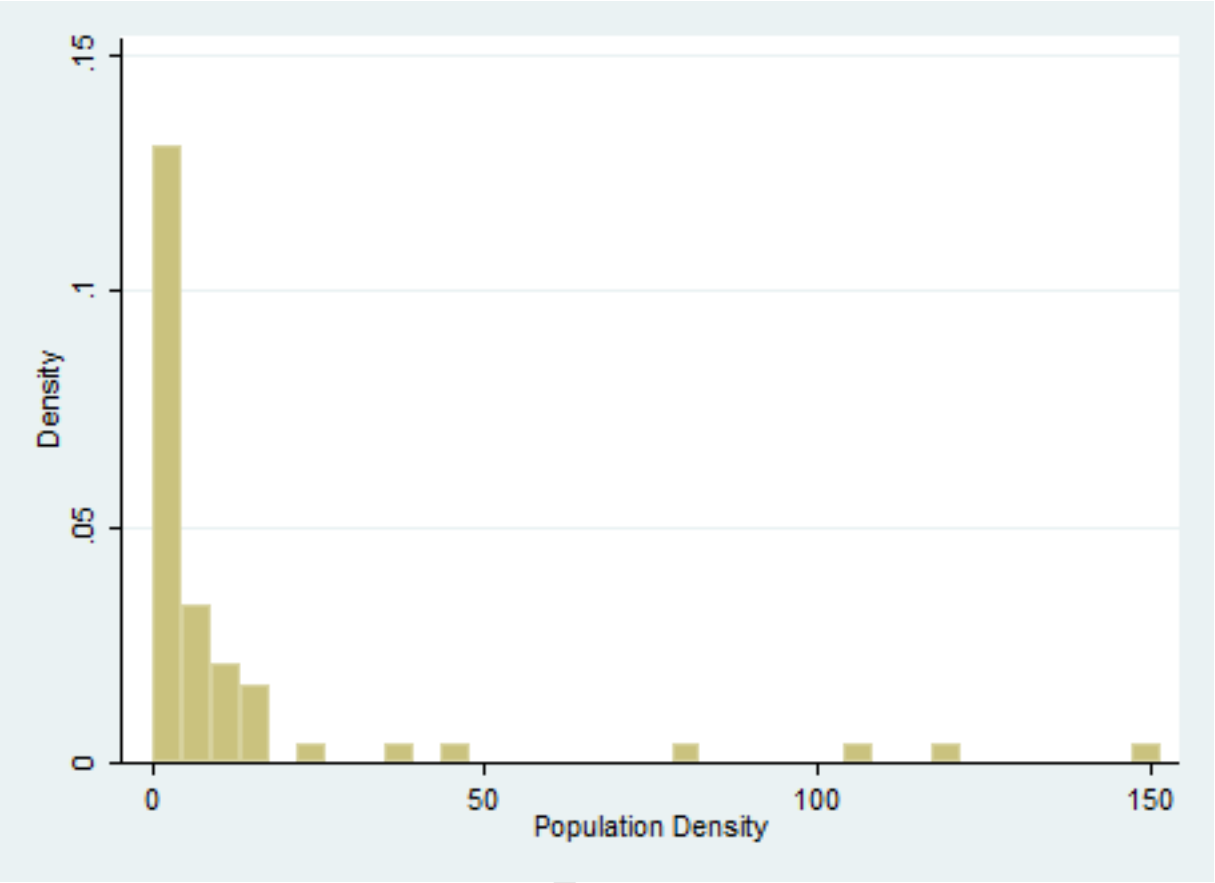


Table 1: Summary Statistics

Variable	Observations	Mean	Std. Dev.	Min	Max	Median
Number of Wells	2280	1360.6	3586.57	2	22824	120
Wells (per 100 people)	2280	6.18	13.4	0	71.81	.57
Violent Crime Rate	3272	.04	.04	0	.72	.04
Property Crime Rate	3272	.09	.07	0	1.23	.09
Gini Coefficient	3541	.43	.04	.32	.52	.43
Income (per capita)	3541	26821.6	8746.06	15278	66510	23764
Poverty Rate	3541	11.67	4.72	2.1	26.8	11.7
Area (square Km)	3541	4272.34	2788.2	87	12363	3971
Population	3501	86496.32	162913.4	555	645724	15451
Population Density (per square Km)	3541	54.81	195.34	.27	1383.13	4.29

Notes: County-month crime rates are defined as the number of crimes of a particular type per 100 people. Violent Crimes include: murder, manslaughter, aggravated assault, assault, and intimidation. Property Crimes include: arson, extortion, burglary, counterfeiting, confidence games, credit card and automatic telling machine fraud, impersonation, welfare fraud, wire fraud, embezzlement, vandalism, and bribery.

Table 2: Colorado Counties Socioeconomic Data

County	Population	km^2	Per Capita Income	Poverty	Umemployment	Inequality	Percent White
Adams	363857	3062	26736	8.9	7.4	0.38	73.3
Arapahoe	487967	2083	42820	5.8	6.2	0.43	72.7
Archuleta	9898	3508	19159	11.7	6.6	0.48	86.4
Baca	4517	6626	23532	16.9	3.9	0.45	92.6
Bent	5998	3991	17800	19.5	6.8	0.44	79.2
Boulder	291288	1918	40309	9.5	6.1	0.44	87.2
Broomfield	50000	87	40309	7.1	6.5	0.44	86.1
Cheyenne	2231	4615	23634	11.1	3.4	0.42	93.2
Delta	27834	2977	20878	12.1	6.8	0.42	89.7
Denver	554636	401	39107	14.3	7.5	0.47	68.9
Douglas	175766	2182	43506	2.1	5.4	0.36	90.2
Elbert	19872	5513	31164	4.0	6.7	0.35	94.7
Fremont	46145	3971	18745	11.7	8.3	0.41	90.2
Garfield	43791	7662	28046	7.5	5.8	0.39	82.2
Gunnison	13956	8441	22444	15.0	4.7	0.46	92.4
Huerfano	7862	4124	16739	18.0	8.0	0.47	82.8
Jackson	1577	4195	19966	14.0	5.8	0.41	92.5
Jefferson	527056	2002	38241	5.2	6.1	0.40	88.4
Kiowa	1622	4625	34601	12.2	4.7	0.44	96.3
Kit Carson	8011	5601	23876	12.1	4.5	0.44	88.5
La Plata	43941	993	27387	11.7	6.0	0.45	86.8
Larimer	251494	6816	30249	9.2	5.5	0.42	90.5
Las Animas	15207	12363	19895	17.3	6.6	0.51	83.6
Lincoln	6087	6696	17392	11.7	4.7	0.41	89.0
Logan	20504	4779	24305	12.2	4.4	0.32	89.0
Mesa	116255	8665	24923	10.2	6.2	0.43	89.4
Moffat	13184	12318	22380	8.3	6.3	0.38	90.0
Montezuma	23830	5273	22511	16.4	8.0	0.45	81.1
Morgan	27171	3351	21802	12.4	4.6	0.42	79.4
Phillips	4480	1783	24691	11.6	3.3	0.42	89.2
Prowers	14483	4261	22146	19.5	5.0	0.43	81.0
Rio Blanco	5986	8356	26641	9.6	4.2	0.38	91.9
Routt	19690	6118	32746	6.1	3.8	0.43	94.8
San Miguel	6594	3343	34218	10.4	4.4	0.51	92.9
Sedgwick	2747	1421	23685	10.0	4.5	0.43	92.2
Washington	4926	6534	22135	11.4	3.3	0.45	95.3
Weld	180936	10396	25047	12.5	6.1	0.43	82.9
Yuma	9841	6137	23764	12.9	2.8	0.42	88.2

Notes: Data comes from the 2000 United States Census

Table 3: Crimes Against People

	log of Violent Crimes per 100 people			Violent Crimes per 100 people	log of Number of Violent Crimes
	(1)	(2)	(3)	(4)	(5)
Panel A: Including counties with zero well activity					
Wells	-0.0045	0.0042***	0.0059***	0.0001	0.0057***
(per 100 people)	(0.0030)	(0.0015)	(0.0018)	(0.0001)	(0.0017)
County FE	No	Yes	Yes	Yes	Yes
Month-Year FE	No	No	Yes	Yes	Yes
Number of counties	60	60	60	60	60
Observations	2,832	2,832	2,832	2,832	2,832
Panel B: Only counties with non-zero well activity					
Wells	-0.0060**	0.0042***	0.0060***	0.0001	0.0054***
(per 100 people)	(0.0027)	(0.0015)	(0.0017)	(0.0001)	(0.0016)
County FE	No	Yes	Yes	Yes	Yes
Month-Year FE	No	No	Yes	Yes	Yes
Number of counties	38	38	38	38	38
Observations	1,765	1,765	1,765	1,765	1,765

Notes: Estimates are based on Equation 5. The dependent variables are shown in the column headers. Fixed effects are labeled in each column. Samples are restricted based on the observations used in Column 3. All standard errors are clustered at the county level. *** p<0.01, ** p<0.05, * p<0.1.

Table 4: Crimes Against Property

VARIABLES	log of Property Crimes per 100 people			Property Crimes per 100 people	log of Number of Property Crimes
	(1)	(2)	(3)	(4)	(5)
Panel A: Including counties with zero well activity					
Wells	-0.0109***	0.0100***	0.0114***	0.0004***	0.0111***
(per 100 people)	(0.0027)	(0.0021)	(0.0029)	(0.0001)	(0.0029)
County FE	No	Yes	Yes	Yes	Yes
Month-Year FE	No	No	Yes	Yes	Yes
Number of counties	60	60	60	60	60
Observations	2,997	2,997	2,997	2,997	2,997
Panel B: Only counties with non-zero well activity					
Wells	-0.0127***	0.0100***	0.0115***	0.0004***	0.0108***
(per 100 people)	(0.0026)	(0.0021)	(0.0028)	(0.0001)	(0.0026)
County FE	No	Yes	Yes	Yes	Yes
Month-Year FE	No	No	Yes	Yes	Yes
Number of counties	38	38	38	38	38
Observations	1,887	1,887	1,887	1,887	1,887

Notes: Estimates are based on Equation 5. The dependent variables are shown in the column headers. Fixed effects are labeled in each column. Samples are restricted based on the observations used in Column 3. All standard errors are clustered at the county level. *** p<0.01, ** p<0.05, * p<0.1.

Table 5: Outlier Counties

	The dependent variable is the log of the type of crime per 100 people							
	Omits Denver County	Omits Weld County	Omits Denver Metro	Omits Front Range	High Population	Low Population	High Population Density	Low Population Density
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Violent Crimes								
Wells (per 100 people)	0.0059*** (0.0018)	0.0060*** (0.0018)	0.0056*** (0.0017)	0.0053*** (0.0017)	0.0304 (0.0343)	00051** (0.0023)	-2.671 (2.3115)	0.0057*** (0.0018)
Number of counties	59	59	53	49	29	30	8	52
Observations	2,772	2,772	2,412	2,172	1,600	1,172	480	2,352
Panel B: Property Crimes								
Wells (per 100 people)	0.0114*** (0.0030)	0.0117*** (0.0029)	0.0115*** (0.0031)	0.0111*** (0.0026)	0.0150 (0.0312)	0.0122*** (0.0037)	-1.0176 (2.7890)	0.0116*** (0.0031)
Number of counties	59	59	53	49	29	30	8	52
Observations	2,937	2,937	2,577	2,337	1,659	1,278	480	2,517

Notes: Estimates are based on Equation 5. All specifications include both county and month-year fixed effects. In both panels the sample includes counties both with and without any oil or gas production. The sample is split across columns 5 and 6 based on whether or not the county had more than the median population of the entire sample ("high population" is more than 14,523 people). The sample is split across columns 7 and 8 based on whether or not the county had more than 50 people per square kilometer ("high population density" is more than 50 people per square km). All standard errors are clustered at the county level. *** p<0.01, ** p<0.05, * p<0.1.

Table 6: Socioeconomic Characteristics

	The dependent variable is the log of the type of crime per 100 people					
	Income per capita		Poverty Rate		Inequality	
	High	Low	High	Low	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Violent Crimes						
Wells	-0.0121	0.0051*	0.0060**	-0.0166	0.0378	00057***
(per 100 people)	(0.0092)	(0.0029)	(0.0026)	(0.0101)	(0.0501)	(0.0016)
Number of counties	29	31	28	32	33	27
Observations	1,463	1,369	1,276	1,556	1,548	1,284
Panel B: Property Crimes						
Wells	-0.0167	0.0145***	0.0150***	-0.0114	0.0936	0.0104***
(per 100 people)	(0.0130)	(0.0044)	(0.0042)	(0.0145)	(0.0806)	(0.0028)
Number of counties	29	31	28	32	33	27
Observations	1,530	1,467	1,324	1,673	1,629	1,368

Notes: Estimates are based on Equation 5. All specifications include both county and month-year fixed effects. In both panels the sample includes counties both with and without any oil or gas production. The "high" and "low" designations are determined by whether or not the county was above or below the median for the variable of interest. These cutoff points are $23,764 for income per capita, 11.7 percent for poverty rate, and 0.43 for the Gini coefficient. All standard errors are clustered at the county level. *** p<0.01, ** p<0.05, * p<0.1.