AN EXPLORATION OF THE EFFECT OF OIL AND NATURAL GAS ACTIVITY ON CRIME RATES IN TEXAS

by

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DEDICATION

For my childhood sweetheart and love of my life, Scott,

and my two little birds, Ollie and Ellie.

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LIST OF ABBREVIATIONS

Abbreviation	**Description**
ACS	American Community Survey
AEI	American Enterprise Institute
API	American Petroleum Institute
CHS	Center for Health Statistics
ELA	Environmental Law Institute
EPA	Energy Policy Act
FBI	Federal Bureau of Investigation
IEA	International Energy Agency
NDSLIC	North Dakota State and Local Intelligence Center
NIBRS	National Incident-Based Reporting System
SDC	State Data Centers
SDT	Social Disorganization Theory
TCLE	Texas Commission on Law Enforcement
TDC	Texas Demographic Center
TDPS	Texas Department of Public Safety
TDOT	Texas Department of Transportation
THHS	Texas Health and Human Services
TRRC	Railroad Commission of Texas
UCR	Uniform Crime Reporting

U.S.C.	United States Census
U.S.	United States

ABSTRACT

Texas accounts for 43% of the nation's crude oil production and 26% of its natural gas production (EIA, 2021). As a top-producing state, Texas has experienced stability in the oil and natural gas (ONG) industry since the turn of the 20th century. With ONG activity, however, comes social change, including a number of social ills, such as an increase in criminal offenses. Although previous research has assessed the effects of ONG production-related changes on the number of crimes through perception and economic studies, few have examined the relationship between ONG activity and crime patterns in Texas. Consequently, the focus of this dissertation is to determine the impact of changes in ONG production on changes in serious crime while considering indicators of sociodemographic change and known crime correlates. Specifically, this study uses residual change scores and multiple linear regression to examine county-level changes between ONG activity and known Part I criminal offenses between 2009 and 2019 among the counties in Texas. This study adds to the existing rural crime and boomtown literature because it is the first to use residual change scores to assess whether ONG activity contributes to any change in the known Part I crimes or social change variables. The results of this study indicate that six dynamic measures of ONG significantly affect change in specific known Part I offenses, thereby supporting the argument that failure to control for processes of change may lead to specification bias issues that are reflected in previous studies exploring the impact of ONG production on crime rates.

I. INTRODUCTION

Communities experiencing rapid population growth due to the migration of workers into a community to extract natural resources are commonly referred to as "boomtowns" (Ruddell, 2011). Natural resource-based boomtowns are typically associated with sprawling "man camps," new bars, and chain hotels built rapidly to accommodate the influx of oil-field workers (Caraher, Weber, Kourelis, & Rothaus, 2017). Previous studies have identified numerous social ills associated with boomtowns, including diminished social cohesiveness, weakened community bonds, and increased antisocial behaviors and criminal activity (Kassover & McKeown, 1981). The relationship between oil and/or natural gas (ONG) activity and known Part I criminal offenses is explored in this dissertation. The present chapter first reviews the extant literature linking natural resource activity to crime. Then, a description of the current study is provided, along with a discussion of its potential contributions to the body of knowledge about natural resource activity's impact on crime in Texas counties.

Background

For more than a century, the economic fortunes of Texas have depended on oil and/or natural gas (ONG) development and production. Texas is known for being the oil state, in large part because it is the state that produces more ONG than any other state in the country (EIA, 2021). Texas's success and failure largely depends on the success and failure of the ONG industry. When oil prices slumped, for example, in 2014, the state's job growth lagged the nation for the first time in over 12 years (Wright, 2018). The state experienced over 74 billion dollars' worth of debt that pipeline, storage, servicing, energy, and shipping companies left behind (Wright, 2018). Bumper stickers were seen at the time, reflecting the bust experience, reading, “Please, God, send me one more oil boom. This time, I promise not to piss it away” (Wright, 2018, para. 62.). Texas is the recipient of ONG’s many financial benefits but is likewise the victim of ONG’s financial traps that stem from the boom-and-bust cycle of resource development.

For the first time in history, it is estimated that the U.S. holds more oil reserves than either Saudi Arabia or Russia (Wright, 2018, para. 37). Most of the projected oil reserves are in Texas. In 2016, the U.S. Geological Survey revealed that a section in West Texas likely contains 20 billion barrels of oil, calling it the “largest estimated continuous oil accumulation . . . assessed in the U.S. to date” (USGS, 2016). This estimate is due in large part to technological innovations in natural gas recovery. These projections reflect that a new boom and bust in resource extraction is on the Texas horizon; this study assesses the boom-and-bust cycle and its potential adverse effects on resource host communities.

Problem Statement

As of December 2018, the U.S. had an estimated 43.8 billion barrels of proven oil reserves (EIA, 2021). Texas accounts for a large proportion of this total amount, contributing nearly 41% of the nation’s crude oil production and 25% of the nation’s marketed natural gas production (EIA, 2021). Among states, Texas continues to be the top U.S. producer of both crude oil and natural gas (EIA, 2021). This type of natural resource development is often associated with social change.

Social change, including rapid population and economic growth, is often associated with resource-based exploration and extraction, as well as a number of social ills, including an increase in criminal offenses (Ruddell, Jayasundara, Mayzer, &

Heitkamp, 2014). Recent scholarship exploring some of the social impacts of natural resource exploration and production activities of host communities reflect a higher likelihood of female victimization (Amnesty International, 2016; James & Smith, 2017) and increases in property and violent crime (James & Smith, 2017; Stretesky & Grimmer, 2020). This study, consequently, is intended to expand understanding of ONG activity impact(s) on known Part I offenses. It does so by using Texas as its focus, given that the state represents such a large proportion of ONG activity in the U.S.

Purpose of the Study

The aim of this study is twofold. First, it seeks to address the question of whether changes in ONG activity lead to increases in violent offenses. Second, it addresses the question of whether changes in ONG activity increase property offenses. Specifically, the present study seeks to address the following research questions:

(1) To what extent does change in ONG activity affect changes in violent crime rates (2009 to 2019) among Texas counties (211 ONG producing and 34 non-ONG-producing), while considering social change factors?; and

(2) To what extent does change in ONG activity affect changes in property crime rates (2009 to 2019) among Texas counties (211 ONG producing and 34 non-ONG-producing), while considering social change factors?

Overview of Chapters

The following chapters of this dissertation are arranged as follows: Chapter II outlines the relationship between Texas and ONG development. Specifically, this chapter explores the origins of commodity-based boom and busts throughout Texas history. The analysis flows from the initial discovery of oil in Texas to the social impacts experienced within Texas' original boomtown communities. This examination includes recorded first-hand accounts from over 100 years ago from those that lived and worked in the original Texas boomtowns. This chapter also underscores why Texas is the focus of this study; it has one of the longest, most substantial relationships with the ONG industry compared to other states in the country. Consequently, understanding the historical development of this relationship is vital to comprehending the impact(s) of ONG activity on Texas host communities.

Following this overview, Chapter III presents the theoretical frameworks that have been used to explore boomtown criminal activity. These theoretical perspectives are important for each of the research questions posed. This chapter includes a review of the extant literature that contributes to the development of the research questions and how they are related to the present analyses. Specifically, some of the relevant literature reviewed will include prior research on boomtown criminal activity, perceptions of disorder and crime within boomtowns, other types of resource-based boomtowns, law enforcement perceptions of ONG-related criminal activity, calls for service and boomtown activity, and law enforcement experiences addressing boomtown criminal activity.

Given the link between rapidly increasing population and shifting demographics in ONG communities, this research is strongly grounded in several key theoretical concepts. Here, this includes exploring social change as an explanation of crime drawing from Shaw and McKay's social disorganization theory (which also linked crime to neighborhoods that were in constant flux with the population turnover of various groups Given the link between rapidly increasing population and shifting demographics in ONG communities, this research is strongly grounded in several key theoretical concepts. Here, this includes exploring social change as an explanation of crime drawing from Shaw and McKay's social disorganization theory (which also linked crime to neighborhoods that were in constant flux with the population turnover of various groups of individuals), Durkheim's notion of anomie (weakened social constraints that occur from a rapidly changing environment that leads to crime and disorder), and other theoretical explanations for criminal behavior that centers on characteristics often associated with the traditional ONG populations, including life-course theories examining the influence of age cohorts and criminal behavior.

Chapter IV includes the methods for this study – including an exploration of the use of residual change scores, an explanation of the analyzed population, data construction, measurement of the dependent variables, static measures of the independent variable, social change variables, variables used as ONG activity indicators, and the analytical strategy. A discussion of the analysis results is presented in Chapter V, as well a summary of the strengths and weaknesses of the study. Subsequently in Chapter VI, the concluding chapter, the summary and conclusion is provided, including recommendations for future research.

II. DEEP ROOTS: THE START OF OIL AND NATURAL GAS IN TEXAS

When oil was first discovered in Texas over a century ago, the ONG industry displaced agriculture as the main engine driving the state's economy. Since 1970, Texas has been the top U.S. producer of crude oil and natural gas (ELA, 2021). In 2019, the state accounted for 41% of the nation's crude oil production and 25% of its marketed natural gas production (ELA, 2021). Texas' ONG activity, however, has affected more than the pocketbooks of Texans and the environmental landscape; it has also helped shape an entire political and social culture. The existence of many museums, art galleries, colleges, and universities in Texas is directly related to individuals and institutions in the oil and gas industry (Little, 2002). This study examines whether part of this cultural change also includes crime rate increases in places where ONG activity occurs.

The following analysis begins with a synopsis of historical commodity-based boom and bust cycles. Following this general overview of historical boom-and-busts periods, including the initial population boom triggered by the 1901 Spindletop well discovery, the study outlines the national development of ONG activity, including an explanation of the modern hydraulic fracturing revolution that has spurred a tremendous amount of ONG activity throughout the U.S. The analysis then shifts towards focusing exclusively on Texas' historical development and profound relationship with the ONG industry.

Boom and Bust Cycles Throughout History

A range of commodities has brought about boom and bust cycles, including tulip bulbs (Dash, 1999), gold (Dilsaver, 1982), wine (Stanton, 2009), and ONG (Ruddell, 2017). These commodity-based booms often follow a predictable pattern in their impact on a community (see Ruddell & Ray, 2018).

The first part of the cycle, the boom, occurs when a community experiences rapid economic growth. This growth is much faster than the community can adjust to and ultimately leads to an enhanced demand for workers based on the current supply and demand as well as the anticipated growth. The ultimate and often inevitable bust characterizes the eventual collapse of the factors that brought about the growth period (i.e., the asset valuation) (Ruddell & Ray, 2018).

The first recorded commodity boom and bust occurred in Holland during the 1630s, the "Tulip Mania" era (Vaşcă-Zamfir & Slave, 2018). The tulip became an international symbol of the Ottoman Empire's sultan and represented privilege, wealth, and power; tulips became more valuable than human life (Vaşcă-Zamfir & Slave, 2018). The tulip was considered the holiest of blooms by Muslims, believed to be the flower of God (McClure & Chandler, 2017). The very letters that make up *lale*, the Turkish word for 'tulip,' are the same as those that form Allah (McClure & Chandler, 2017). The tulip fed frenzy that resulted in one of Europe's first boom and bust cycles has been described in the following way:

> At the peak of a fever like none other,
> A good burgher whose thrift was his repute
> Might part with two hogsheads of vintage port,
> Twelve stout ewes and eight fat swine,
> A silver chalice and a suit of clothes,
> And brick after wheel after brick of cheese
> For a single bulb, and fancy himself shrewd.
> The logs disclose another who swapped a mill,
> And one a brewery, for their fabled specimens.
> Clouds of golden pollen. The pages crackle.
> All Holland's in thrall -- the tulips have souls.
> Cultivated by sultans, "turbans" from the Persians,

Imported for the delectation of the courts
And the jaded palates of the capitals:
Laced with oil and vinegar in London,
And in Dresden powdered with sugar.
But the Dutchman's taste ran to tulpenwoede --
Florid euphoria, epidemic ardor.
In the smoky taverns of Haarlem and Utrecht,
Flame-tongued goblets fed a blaze of speculation.
A fever like none other. The pages smolder.

The souls of tulips are mulched with Holland's gold.
Before the bottom fell out, before the bubble burst,
There were fortunes to be made from the mutations
That engendered hybrids by the hundredfold.
Pleats and ruffles, scarlet wicks and creamy swatches,
The ruby-veined undercup of the Semper Augustus,
From tightfisted roots the treasured clusters breaking open --
Behold the veritable bounty of beauty!
In vain the pastors thundered from their pulpits.
Once optimism blossoms, only ruin can stem the delirium.
The tulips had souls -- all Holland said so.
A spiked dust flares above the gilded pages.
(Barber, 2000, n.p.)

Tulips became popular throughout Europe, and as they spread, new demands arose (McClure & Chandler, 2017). Carolus Clusius, a renowned 16th-century botanist, developed a classification system to distinguish “care and covetable” tulips from the “common and worthless,” making the tulip trade possible (Dash, 1999, p. 35). Ironically, Clusius lamented that the tulip demand attracted mere status and profit-seekers who were not true botanists but were instead seekers of a socially coveted item in order to profit from the increase in demand (Goldgar, 2007). Indeed, the tulip had become a status symbol.

The tulip mania collapsed largely because tulips are seasonal bulbs, and many buyers had entered into tulip contracts before the prices rose; growers had to plan their tulip cultivation and plant almost a year in advance (McClure & Chandler, 2017). By

February 1637, the industry was oversaturated, and tulip valuations would not hold; growers simply grew too much. Tulip bulbs, once worth thousands, were worth pennies (McClure & Chandler, 2017). The moral of the tulip story is that when there is a rush into an economic sector to produce, and such production occurs, the market can become oversaturated with the product, outweighing the public's demand.

The second notable commodity boom occurred in the late 1840s in California, which experienced a dramatic shift in its landscape within a short period due to the discovery of gold. Gold had been a known and mined commodity by the Nisenan Native American Tribe prior to 1849. However, it was not until the late 1840s that Euro-American gold-seekers were introduced to the presence of gold in the region. James Marshall, appointed to oversee the construction of a sawmill intended to provide lumber to the treeless Central Valley, discovered gold on January 24, 1848, from the tailrace of the mill (Dilsaver, 1982). Marshall decided to keep the gold discovery quiet; however, word spread quickly from the mill's employees, leading visitors to travel to the area to determine if the rumors were true (Dilsaver, 1982).

Gold rush fever started slowly but exploded once President Polk referred to the discovery in his annual address to Congress (Dilsaver, 1982). The hope of discovering gold attracted over 89,000 gold seekers from around the world (Felson & Cundiff, 2018). Rural communities transformed into bustling cities, seemingly overnight. San Francisco's population, for example, increased nearly 125%, from 459 in 1847 to 56,802 in 1860 (Felson& Cundiff). Additionally, the state experienced a dramatic shift in the gender ratio; by 1850, the state was 92.5% male (Dilsaver, 1982). Most newcomers were also between 20 to 45 years of age (Disalvo, 1982). This dramatic population increase and shift are recognized as the leading cause of the high rates of recorded violence during this era (Felson et al., 2018). Research suggests that homicide rates in San Francisco during the Gold Rush years (1849-1860) were the highest in those years than at any other time in the state's history (Felson & Cundiff, 2018).

California's entire economy was based in large part on the gold industry; this monopoly ultimately led to a statewide economic bust (Disalvo, 1982). By 1859, gold was discovered in the Canadian and Nevada territories, and gold production in California consequently fell to half its level five years earlier (Disalvo, 1982; Paul, 1947). With the gold production decline, daily wages also decreased from $20 in 1848 to merely $3 by 1859 (Paul, 1947). The California gold industry was further damaged between 1861 to 1864 when extreme flooding followed by severe droughts restricted regional access (Dilsaver, 1982). These dilemmas caused most mining ventures to close their operations. The once-thriving communities lost significant portions of their population, with some losing nearly 75% of their population (Dilsaver, 1982). Once the production of gold dissipated and wages waned, entire towns ceased to exist as populations simply moved on (Disalvo, 1982).

A third commodity-based boom-bust pattern occurred in 1896 in Fruithurst, Alabama, a town that no longer exists (Stanton, 2009). The town was the brainchild of Ralph Spencer, a young Connecticut salesman who relocated to Tallapoosa, Georgia, in 1880 to work in real estate (Stanton, 2009). It became clear to Spencer that the South offered inexpensive land, resources, and access to railroads. Consequently, he constructed numerous building lots in 1893 in the new "Yankee City Under the Southern Sun" (Stanton, 2009, p. 30). Spencer subsequently engaged in a Nebraska real estate venture that ultimately failed. Upon Spencer's return to Tallapoosa, a resident greeted him and asked if he was just visiting. Legend has it that Spencer replied, "Hell no! I'm back and if the soil is suitable, I'm going to plant grapes!" (Stanton, 2009, p. 31). Soon thereafter, Spencer leased 2,000 acres west of Tallapoosa and established the Georgia Fruit Growing and Winery Association, hiring and moving into the area 200 Hungarian winemakers (Stanton, 2009). Spencer attracted numerous investors who ultimately chose a location between Birmingham and Atlanta to become the Association's winery center and community, known as Fruithurst (Stanton, 2009). Notably, every person who purchased 10 acres of vineyard land received a building lot in town, leading to overwhelmed homebuilders (Stanton, 2009).

This wine-based boomtown was renowned for its beauty, with maple and magnolia trees, public gardens, orchards, and parks complete with wooden boardwalks and gaslights. Understandably, Fruithurst attracted thousands of tourists. The community's success, however, soon faded. Alabama law forbade wine producers to sell directly to customers, while the nearby Tallapoosa vineyards sold their wine along the railway route, Alabama law required agents located in the north to serve as middlemen (Stanton, 2009). The northern agents selling the southern wine faced competition with European winemakers, and during their lengthy negotiations, the stored wine often spoiled. Adding to the community's problems, a freeze caused extensive damage to the vineyards, causing many wineries to shut down completely. Meanwhile, Fruitvale's most prestigious inn closed, and most of the in-town houses were placed on logs and moved out of town (Stanton, 2009). The once-bustling community full of winery and agricultural workers and tourists simply left. The final nail in Fruitvale's coffin was the passage of the Eighteenth Amendment, making the sale of liquor a federal offense (Stanton, 2009).

The fourth commodity-based boom, which serves as the basis of this study, focuses on ONG activity. Prior to the discovery of ONG, the nation used animal fats, such as whale oil, for energy; however, such fats were in limited supply (McNally, 2017). Energy historian Robert L. Bradley Jr. once noted that "[a]rtificial light was a luxury waiting to become a necessity" (McNally, 2017, p. 11). Liquid petroleum (i.e., oil) was the solution to society's increasing desire for affordable and accessible artificial light (McNally, 2017). Extracting oil, however, was considered by many to be a fool's errand. In 1857, James Townsend, a New Haven banker, suggested boring for oil using a method commonly used within the U.S. to extract salt. Invented in China over 2,000 years ago, the process involved using an iron drill bit and a wooden rig to repeatedly lift and drive a shaft into the bedrock, crushing it (McNally, 2017).

Townsend's suggestion was met with apprehension and criticism, with colleagues making such noted remarks as "Oh, Townsend…oil coming out of the ground, pumping oil out of the earth as you pump water? Nonsense! You're crazy" (McNally, 2010, p. 13). Essentially, oil was considered an unattainable resource, with people considering oil extraction ventures as "lunatic schemes" (Yerger, 2011, p. 10). It was not until Townsend hired "Colonel" E. L. Drake to head a venture with a small crew of men to discover, extract, and store oil in Titusville, Pennsylvania, that the once impossible dream became a feasible economic option (Yergin, 2011). The venture faced numerous obstacles, including a year of failed attempts, running out of money, and gaining a new investor who ultimately sought to disband the operation (Yergin, 2011).

On August 27, 1859, Drake sunk a well 69.5 feet deep and struck oil that flowed to the surface at the rate of 40 barrels per day (McNally, 2017). Historian and journalist Allan Nevins wrote that the word of Drake's discovery "flew like a Dakota cyclone" (McNally, 2010, p. 13). The population of Titusville, Pennsylvania swelled from 250 residents to over 10,000 in little more than five years (Dolson, 1959). The Pennsylvania boom, however, did not last forever. Crude oil production exceeded storage and transportation capacity, and prices eventually collapsed. By 1901, the oil boom for Titusville and the surrounding area was over, with the nation's attention shifting toward other states such as Texas (McNally, 2017).

In summary, these examples serve to illustrate what happens when a resource triggering a boom loses value. Ultimately history proves that boom periods will inevitably bust.

Life-Course of Resource-Based Boom

Although there is no single type of boomtown (Jacquet & Kay, 2014), most originate from resource-driven development. This community experience is referred to as the "life course" of the resource-based boom, which typically begins with an increase in the commodity's value, which in turn increases a company's desire to explore and extract the commodity (Ruddell & Ray, 2018). This stage can be designated as the start of the boom, initially causing a significant population increase that typically consists of young men with little to no ties with the resource host community (ELI, 2014; Ruddell & Ray, 2018). Brundage et al. (2011) estimate that nearly 98% of all ONG job opportunities materialize in the drilling and pipeline infrastructure phases.

Employment estimates for the early ONG infrastructure build-out phase range from the low 10,000s to a high of 140,000 jobs (ELA, 2014). This significant influx of typically male workers ultimately leads to a disproportionate number of men (Ruddell et al., 2018). The community's new residents strain the local government's public services. A community's infrastructure, such as housing, is simply not equipped to accommodate the flood of new resident workers (ELI, 2014). Consequently, camps are erected to provide secure housing for new workers (ELI, 2014). Typically, at this time, the community begins to experience an increase in public order offenses (alcohol/drug, driving under the influence, and prostitution) (Ruddell & Ray, 2018). Notably, economists have found that as new labor moves into the resource host community, even if temporarily, rent and home values rise, and an affordable place to live becomes unaffordable, particularly for those not engaged in the business of extraction (BBC Research and Consulting, 2013; ELI, 2014; Yamaguchi & Kuczek, 1984).

Residents, as a result, may move out of the area because of their inability to afford the ever-increasing cost of living in the host community (ELA, 2014; Ruddell et al., 2018). Ultimately, over time, the quality of life for residents decreases, leading to local residential frustration, and ultimately, tensions with the new laborers (Ruddell & Ray, 2018). The host community also experiences increases in intimate partner violence incidents, property crimes, non-lethal violence (i.e., assaults), traffic congestion, collisions, and fatalities (Ruddell & Ray, 2018). Once the resource infrastructure is complete, labor demand decreases, and the temporary workforce leaves (ELA, 2014; Ruddell & Ray, 2018), resulting in a steadier workforce moving into the area to maintain the day-to-day resource operations (see Figure 1) (ELA, 2014; Ruddell & Ray, 2018). By this time, the local government has increased resources and services to meet the new demands of the ever-changing and growing community, and rates in crime and disorder begin to decline (Ruddell & Ray, 2018). Yet, like all booms, there is an ultimate resource bust, as the commodity's valuation decreases, and companies pull efforts to invest in any further exploration or extraction efforts. Ultimately, the life course of the resource-driven boom reflects a significant amount of social change at the community level. This study seeks to examine the influence and consequences of these social changes, especially as they relate to exposure to crime across communities.

Background of Oil and Natural Gas Production in the U.S.

The U.S. has experienced waves of boomtown growth associated with resource extraction for nearly 200 years, beginning with the mid-1800s California goldrush (Dilsaver, 1982; Komarek, 2014; Shaler, 2020;). However, new drilling techniques such as hydraulic fracturing (i.e., "fracking") have led to a new resource development wave. Consequently, new energy policies have been implemented in response, including the Advanced Energy Initiative (AEI).

The AEI was signed into law in 2005, requiring the replacement of *at least* 75% of U.S. oil imports from the Middle East by 2025 (Energy Policy Act of 2005), leading to an increased reliance on domestically produced ONG. In his February 2006 State of the Union Address, President George W. Bush announced that because of the AEI, "our dependence on Middle Eastern oil [is] a thing of the past" (p. 1). The International Energy Agency ([IEA], 2019) estimates that by 2025, U.S. oil production will be equal to that of Saudi Arabia and Russia combined. Further, the U.S. Energy Information Administration estimates that the world energy demand will grow by 55%, with fossil fuels remaining the primary energy source (accounting for nearly 84%) of the overall increase in demand between 2005 and 2030. The move towards energy self-reliance, the need to satisfy consumer demand, and the advances in ONG extraction (e.g., fracking), have led to a dramatic increase in domestic ONG activity.

Less than two years after the AEI was signed into law, the market price for natural gas soared (AEI, 2019). This increase was attributed to fracking coupled with horizontal drilling in the U.S. (Richards, 2019). Fracking is a process in which producers drill down and then horizontally for up to two miles within a shale formation – instead of simply drilling vertically, straight down into shale formations, see Figure 1 (Plumer, 2015, n.p.). Shale formations are a geological rock formation rich in clay, typically derived from fine sediments, deposited in quiet environments at the bottom of seas or lakes, having then been buried over the course of millions of years. Shale formations can serve as pressure barriers in basins, as top seals, and as reservoirs in shale gas plays. Shale formations are, consequently, used as indicators for the presence of trapped ONG (Speight, 2013). The horizontal drill penetrating the shale allows for a high-pressure mixture of water, sand, and chemicals to be injected into the tight rock formations (Plumer, 2015). The injected sand granules keep the cracks open, allowing ONG to flow into the well area, which is then pumped back to the well (Plumer, 2015).

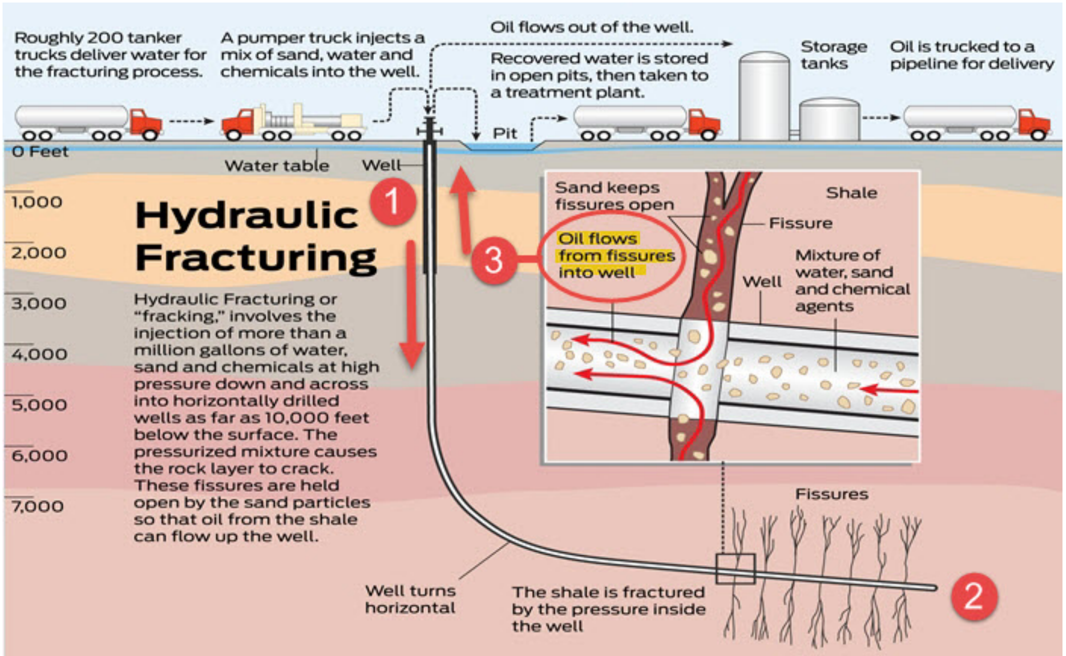

Figure 1. Hydraulic fracturing (Graphic by Al Grenberg - Plumer, 2015).

A standard fracking site referred to as a "pad" site (Burfoot-Rochford & Schafft, 2018, p. 172), may be up to five acres or more in size and contain, on average, three well heads (Burfoot-Rochford et al., 2018; Jacquet & Stedman, 2014). Once a well bore is drilled vertically into the shale rock (often thousands of feet below the surface), the natural gas is released and extracted (Burfoot-Rochford & Stedman, 2018). Shale formations are considered the most abundant sedimentary rocks in the Earth's crust, indicating the presence of trapped ONG (Speight, 2013). The drill is then turned horizontally into the shale layer, stretching a mile or more across the shale rock. A steel pipe is cemented into the open hole or uncased portion of the well, otherwise known as the wellbore, to prevent groundwater contamination (Lee, Herman, & Elsworth, 2011). An explosive charge is then sent into the wellbore that extends across the shale layer where it is detonated and then fractures the shale layer and releases natural gas, which then flows back to the surface (Lee et al., 2011). An estimated 10 million gallons of water may be used per fracturing job, requiring over 1,000 truck trips to transport water to the pad site (Burfoot-Rochford et al., 2018; Lee et al., 2011). Compressor stations then move the natural gas from the wells to consumer markets in pipelines (Burfoot-Rochford & Schafft, 2018). Natural gas fracking is labor-intensive. In Midland County, Texas, for example, 75,258 of the 159,883 residents, or 50% of the population, are ONG employees (Data USA, 2020). As the above details, natural gas fracking is an exhaustive process that requires many workers and resources for each drill site.

The fracking process is regarded as one of the most profound innovations in energy production within the 21st century (Liu & Li, 2018), causing natural gas production to increase over 13 times within 10 years (Liu & Li, 2018). Before the mid-2000s, natural gas was regarded as not economically feasible to extract due to technological limitations and low prices (Liu & Li, 2018). Fracking, however, steadily increased in the U.S., accounting for only 1.6% of the total U.S. natural gas production in 2000, 4.1% in 2005, with a significant jump to 23.1% in 2010 (Wang & Krupnick, 2013).

The "shale revolution" is considered to have started in 2010, and this surge led Texas to increase from the world's 21st highest oil producer in 2010 to the seventh highest in 2017 (Perry, 2018). In short, Texas received a super charge of ONG activity, bringing thousands of workers into the state to oversee and perform the extraction.

Historically, however, each boom period of ONG activity is followed by a bust period in price and production. There have been four recorded ONG boom and bust cycles in the U.S., including: (1) 1870-1880, (2) 1979-1981, (3) 1998-2000, and (4) 2008-2014 (Andreoli, 2015). The initial boom stage is triggered when ONG prices reach high levels and a new ONG field[1] is discovered; speculators then rush in, blanketing the land with wells and causing ONG activity to skyrocket (Andreoli, 2015). As a result of this rapid increase in production, the price of the natural resource will often drop due to too much supply and not enough demand; it is a delicate balance (Andreoli, 2015). This downturn in the price for ONG leads to an inevitable bust period because, as history reveals, natural resource-based booms do not last forever.

The Start of Texas Oil and Natural Gas Production

Since the beginning of the 20th century, Texas has been the epicenter of ONG activity (Price & Ronck, 2017). Due mainly to ONG production, the Texas economy eclipses both Canada and Australia (Wright, 2018). Texas produces more crude oil than any other state or region in the U.S., accounting for 41% of the national total in 2019 (Enercom, Oil & Gas 360, 2020). The national output of oil rose 11% in 2019; 53% of this growth was attributed to oil production in the Permian region in western Texas (Enercom, Oil & Gas 360, 2020). Houston, Texas, has over 5,000 energy-industry company headquarters, making it the world's epicenter for ONG production (Wright, 2018). Given the impact of these resources on the state's economy, ONG is a prominent part of Texans' cultural heritage.

Historical records reflect petroleum seeping from the ground, has been used for centuries in what later became Texas for external and internal medicinal purposes (Price & Ronck, 2017). In 1543, in what is today Sabine Pass, Texas, European shipwreck survivors from the DeSoto expedition used the substance to patch their boats' hull

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[1] A field is defined as "an area consisting of a single reservoir or multiple reservoirs all grouped on, or related to, the same individual geological structure feature and/or stratigraphic condition" (ELA, 2015, p. 1).

(Rundell, 1977). Drilling for oil, however, did not occur until the 1860s when John F. Cotton and Edward von Hartin of Galveston signed a contract to drill for oil in the Saratoga field (Rundell, 1977).[2] Soon Texas experienced a rush to drill for oil, or what some would call "Texas tea" (Specht, 2010, p. 295).

The elevation of ONG activity as a staple of the state's economy did not occur until the mid-19th century; the first well to produce oil was drilled in the Saratoga oil field in Nacogdoches County in 1866 (TSHA, 2018). Soon thereafter, crudely dug oil wells were drilled in Bexar County in 1889 and in 1893 in Hardin County, which led to the construction of the state's first two oil refineries in 1896 and 1898 (THSA, 2018).

It was not until June 9, 1894, in Corsicana, that Texas had its first major oil discovery (Price & Ronck, 2018). Oil, however, was not the initial goal of this famously drilled well. Initially, well producers were searching for water to drill artesian water wells: an effort they hoped would diversify the town's economy by attracting industry (Rundell, 1977). However, the newly drilled artesian water wells had become heavily polluted with oil. So much so that an onlooker to the drilling dropped a match on the ground after lighting his tobacco to see what would happen; it immediately caught fire and spread (Rundell, 1977).

Consequently, the drillers had to drain the oil away from the well to prevent additional fires (Rundell, 1977). Initially, this oil was perceived as a nuisance, polluting the otherwise attractive artesian water wells (Rundell, 1977). This accidental discovery later led to the formation of the Corsicana Oil Company, which by the end of 1897, had 43 oil-producing wells and annually produced an estimated 66,000 barrels of oil (Price et

[2] John Cotton was first made aware of the oil on his property when he and William Hart were led to tar wells by their pigs who enjoyed wallowing in the substance (Rundell, 1977).

al., 2018). This first major finding, though, was nothing compared to the Spindletop discovery seven years later.

Spindletop, 1901. The first well of consequence was the Sour Spring Mound, a sulfurous hill located near Beaumont, Texas. Historical accounts detail how the hill had natural gas seeping to the surface, allowing young boys to easily set it on fire for entertainment (Wright, 2018). A local man, Patillo Higgins, who had previously lost his arm in a gunfight with a Beaumont deputy sheriff, was unwavering in his belief that there was oil in Sour Spring Mound. Higgins had no geological proof that oil was present in the area, only a hunch; however, guesswork was not uncommon in identifying ONG development in Texas. As one oil field worker explained, "at that time the larger oil companies didn't believe in geology. And they didn't believe in engineering, and they didn't believe in chemistry" (Gillock, 1953). Accordingly, Higgins hired a mining engineer, Captain Anthony F. Lucas (not a geologist) in 1898 to oversee the drilling site. The oil well presented numerous tactical issues, including the almost impenetrable salt rock dome that prevented successful drilling.

Captain Lucas hired the Hamill brothers – Curt, Jim, and Al – to go to Beaumont as drillers (Rundell, 1977). Their first drilling attempt failed, with the drilling pipe collapsing with the weight of the hardened salt rock (Wright, 2018). The drilling team decided to use a rotary bit at the tip of the drilling pipe, which permitted penetration of the Sour Spring Mound layers (Wright, 2018). They used water to soften the ground for drilling, cool off the drilling bits, and flush out the drilling shavings; however, the water failed to accomplish this last task (Rundell, 1977). Curt Hamill devised a plan to address this dilemma; he ran cattle back and forth in a shallow pond to create a gummy mud substance that was used to pump down the drill to bring up the cuttings (Hamill, 1952; Rundell, 1977). This strategy worked. Mud was subsequently poured around the drilling pipe, forming a supportive layer around the pipe sides, which served to prevent collapse (Wright, 2018). These drilling attempts helped shape future ONG activity, revolutionizing the entire drilling industry.

Captain Lucas believed oil was present and continued to drill upon the site for nearly eight years (Bowman, 2014). On January 10, 1901, the Lucas rusher was discovered, and this event would change the course of Texas' economic, political, and cultural future (Bowman, 2014). Historical accounts describe how mud began to bubble from a hole that had been drilled, and soon after that, the site blew a 150-foot geyser of drilling mud, natural gas, and crude oil into the air (Bowman, 2014; Linsley, Rienstra, & Stiles, 2002). Reportedly, when Captain Lucas was informed that the site successfully produced oil, he came running immediately "over the small hill with his horse in full run. He decided his horse was too slow, so he jumped or rolled out of the buggy and ran…shouting 'Thank God'" (Houston Chronicle, 1901, n.p.; Hamill, 1952). News of the geyser quickly spread throughout the state, and shortly after that, the country. Higgins named the Sour Spring Mound drill site – "Spindletop" (Wright, 2018). For a complete list of ONG discoveries in Texas, see Appendix Figure 1.

Allen Hamill, (1952) one of the Hamill brothers primarily responsible for drilling and subsequently capping Spindletop, described the event as follows:

> [P]eople would come to that fence and that was close enough cause when the wind was in the direction, they couldn't come that close, you see, because the oil was travelling. It would go up there in this spray and the wind would carry it for miles. Even-- take buildings in Beaumont, in a short time were all discolored. But a lot of that was from the fumes from the gas, the sulfur gas that tarnished the paints. And every house in Beaumont, I daresay, had to be repainted after that ten

> days flow. Of course, a lot of it may have been from this spray that was carried in the wind, you see, and would settle. (Hamill, February 9, 1952, n.p.)

A train from Houston and Galveston reportedly held over 1,500 passengers, all clamoring to see the Spindletop geyser (Bowman, 2014). The geyser spewed for 10 days until they were able to cap it and contain the valuable resource (Houston Chronicle, 1901). Allen Hammill (1952) explained how the capping process took a bit of ingenuity on the part of the workers:

> I went over to the railroad – better not tell the Southern Pacific this, but I swiped two railroad irons. Of course, they were light, little railroad irons out there on the switch track. And we drug those over with the team that hauled our slabs you see. The old fellow, he drug them over and we fastened those up on the derrick, the crate affair fixed and assembled these-- all these fittings, the valves and the "T" and the connections, you see, and all in this crate affair and it was all bolted solid to this here carriage that was on the rail-road irons.
>
> Of course, those railroad irons were secured at both ends very securely to the derrick…. We had it all arranged and thought we was ready, why, the well was still throwing out rock every once in a while.
>
> Throw it up high as you could see. They'd go up, you see there was rock, and come back down…. So he said, "Well, now, we'd better not shut that in today for one of those rocks might damage our valve, might knock it off." So we waited till the tenth day, and it seemed to clear itself altogether and hadn't made any rock that morning at all.
>
> So he came out about 11 o'clock, 11:30, says, "Well, Boys, how's it been acting?"
>
> And we told him, hadn't made anything. He says, "Well, let's shut her in."
>
> So I suggested to Curt, I says, "Curt, you turn the valve there, will you?" And he rushed in -- of course, we had slicker suits and so on and a slicker hat, you see, to protect us from this oil.
>
> So Curt rushed in and closed the valve. Just like that, it was over.
> (Hamill, February 9, 1952, n.p.)

Notably, the amount of natural gas present at the site prevented the workers from working on the site for more than two to three minutes at a time. If an oil-field worker remained near the valves longer than that, the natural gas would render them unconscious or kill them (Hamill, 1952). Once the well was capped, the spilled oil on the ground caught on fire from the spark of an automobile, causing hundreds of thousands of barrels to go up in smoke (House, 1946).

To maintain the new oil tourism, the workers drilled additional, smaller wells, permitting them to flow into the air in order to entertain visitors (House, 1947). Captain Lucas permitted the Hamill brothers and other on-site oil field workers to carry shotguns to protect Spindletop from harm or mischief (Hamill, 1952). Beaumont was turning into a flourishing, thriving town due to the oil discovery.

Individuals who lived within the region of Spindletop suddenly discovered that their land's value had almost quadrupled, seemingly overnight. For example, one man had tried unsuccessfully to sell his land for years for $150, but once the Spindletop phenomenon occurred, he was able to sell it for over $20,000 (Bowman, 2014), which is the equivalent to over $600,000 in 2020 dollars. Due to the developers' rush, oil-field workers, speculators, and spectators moving into the area, unethical land dealings were becoming commonplace, earning the area's nickname "Swindletop" (Rundell, 1977, p. 38).

After the expansion in oil extraction, the community's physical and social environment was rapidly changing, creating a hotbed for antisocial and criminal interactions among community residents. In 1918, Mrs. John Berry, a resident of East Texas during the Spindletop discovery aftermath, explained:

> The oil rigs were just like bristles in a hairbrush…just as thick as they could be. There was no spacing whatsoever…you really have no idea how dense they were…you looked out the door and it was just like cactus. (Little, 2002, p. 414)

The population of Beaumont, Texas swelled from 9,000 to over 50,000 residents in less than two years (Bowman, 2014; Rundell, 1977). Given that there was originally only one hotel in Beaumont, workers were desperate for temporary housing. Residents began leasing everything from rooms in their homes, outdoor shacks, and even cots placed in their front yards (Wood, 1952). The once small rural East Texas town of Beaumont had changed drastically due to the Spindletop discovery.

The Spindletop well, Lucas 1, produced over 100,000 barrels of oil per day, more than all the other oil wells in the U.S. combined (Price et al., 2018). Between 1900 and 1901, the state's oil production increased from 836,039 barrels to nearly 4,393,658 barrels (Price et al., 2018). Spindletop was said to be "an oil well the equal of which cannot be seen elsewhere in the U.S. and probably the world" (Houston Daily Post, 1901). The discovery led to the first and only oil company, The Texas Oil Company, to sell oil in all 50 states under one brand name (Bowman, 2014).

In 1941, an obelisk was erected on the site of Spindletop, with the following lines engraved:

> On this Spot on the Tenth Day of the Twentieth Century a New Era in Civilization Began Petroleum has revolutionized industry and transportation; it has created untold wealth, built cities, furnished employment for hundreds of thousands, and contributed billions of dollars in taxes to support institutions of government. In a brief span of years, it has altered man's way of life throughout the world. (HMDV.org, Lucas Gusher Monument Association, Spindletop Monument, 1941, n.p.)

Because of the damage caused by decades of drilling, the site had become unstable by 1955, causing the obelisk to be moved to a new location (Wooster et al., 2010). Indeed, petroleum has revolutionized our way of life, and cheap energy has also changed our transportation methods and the places we live.

East Texas Oil Field, 1930. In 1930, Columbus Marion Joiner discovered the East Texas Oil Field (Hinton & Hinton, 2002). This new oil field helped revive Dallas's economy during the Great Depression, yet also decreased interest in the West Texas oil production as the new East Texas oil supply led to another major drop in oil prices. Specifically, the amount of oil being produced is more than the quantity demanded in the market at the time. Ultimately, the uncontrolled production in the eastern field destabilized the state's oil industry, which had been trying to control production levels to stabilize prices (Burrough, 2009). Overproduction in East Texas was so great that then-Governor Ross Sterling attempted to shut down many of the wells. During one of the forced closures, he ordered the Texas National Guard to enforce the shutdown. These efforts at controlling production, intended to protect both the independent operators and the major producers, were largely unsuccessful and led to widespread oil smuggling. In the late 1930s, the federal government intervened and returned production to sustainable levels, leading to price stabilization (Burrough, 2009). By 1940, Texas had come to dominate U.S. oil production. Some historians even define the beginning of the world's oil age as the beginning of this era in Texas (Olson, 2001).

The Texas Rangers and Town Taming

In the early 1900s, Texas Rangers were often deployed to carry out "town taming" in oil fields experiencing an influx of oilfield workers, sex workers, con artists, and thieves (Woods, 2006, p. 19). These communities, known as "boomtowns," were notorious for crime and vice. Some even referred to them as the "Sodom of the plains"[3] (Sadler, 2006, p. 16).

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[3] Sodom is a biblical reference In the Old Testament Genesis account, God reveals to Abraham that Sodom and Gomorrah are to be destroyed for their grave sins (18:20). ... Two angels are sent

The economy in boomtowns was often stimulated by ONG operations or vice-related commerce, such as liquor sales and prostitution. Joe Jeffers, a Baptist evangelist who in September 1926 moved into the West Texas boomtown of Borger, explained his first encounter with the town's founder Ace Borger: "When asked by me to donate the lot to the Baptist Church to build a building on, stated he would gladly give me $10,000 not to build a church as it would hurt his business" (Price, 2006, p. 16). Indeed, the boomtown economy was based on activities/commerce that are strongly associated with criminal activity, including sex work and gambling.

One of the most infamous boomtown communities was in Batson, Texas. One of the original Texas drillers, Fain Gillock, described Batson as "an awful, awful rough town. Didn't have any jails, had no store, no restaurants, no nothing …." (1953, n.p.). Batson was also well known for its violence, and a driller recalled, "in the morning, any morning, to go down through the oil fields and find somebody that'd been hijacked and knocked in the head" was not uncommon (Wood, 1952, n.p.). Famous Spindletop driller, Allen Hamill, (1952, n.p.) further described Batson as:

> …. a tough place, saloons and gambling and— I remember one day I was over there and couple of girls in one of those joints had got in a fight and had gone outside of the building there to finish out the fight and they'd about disrobed each other and finally the cops got hold of them and, to separate them, they chained them to trees. That's the way they did a lot of the unrulies over there. So, it was -- quite a place.

Finally, during the early 1920s-1930s that the Texas State government sought help to address the infamous Texas boomtowns by twice enacting martial law due to the substantial increase in the population and the accompanying crime that came with it.

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to Lot in Sodom but are met with a wicked mob who are then struck blind by the angelic guests (19:1–11). Sodom was biblically known as the city of sin.

When martial law is in effect, the military commander of an area has unlimited authority to make and enforce laws, replacing any existing laws or administration of justice (Killam, 1989). The justification for enacting martial law is based on the ineffectiveness of civilian authority or the absence of the rule of law (Killam, 1989).

Borger, Texas was one such boomtown in which martial law was enacted. In the three months after the March 1926 discovery of the Holmes-Huey well, the town's population swelled from 880 residents to 35,800 (Price, 2006). Within one year, the community exhibited increases in minor and major crimes. It was not until three police officers were murdered within a two-month period that Texas Governor Dan Moody called on ten Texas Rangers on April 7, 1927, to help control the community's violence (Price, 2006). These Rangers arrested over 1,200 prostitutes and seized thousands of gallons of bootleg whiskey, in addition to removing and replacing all city officials, including allegedly corrupt law enforcement (Price, 2006). Their presence, however, did not have a long-term crime reduction impact.

The nearby town of San Augustine, Texas also experienced population increases due to resource extraction and the associated increases in crime by the mid-1920s. The increases were significant enough that then Governor of Texas, Miriam Amanda Wallace "Ma" Ferguson, one of the first women to be elected as governor of a state, called in well-known town tamer and former Texas Ranger James W. McCormick to take control of the town (Cox, 2009). McCormick brought two Texas Rangers with him to San Augustine, where they were typically seen

> walking around town with two pistols on his hips and occasionally a third revolver hanging from a shoulder holster (plus a fourth handgun studded in his pocket), the captain guaranteed the townspeople they need not worry about reprisal if they came forward with information on the criminal activities taking

> place in the county. The Rangers soon began taking statements and collecting evidence that would lead to multiple grand jury indictments followed by convictions. By March 22, McCormick and his men had so much progress towards taming the town that local citizens threw a street dance in their honor. (Cox, 2009, p. 168)

Texas Rangers became the judge, jury, jailer, and sometimes executioner through their town taming efforts. Town taming, however, was not an easy task. Considering the drastic social changes brought about by ONG discoveries throughout Texas, the job became a vital undertaking.

Bust Periods within Texas

During the 1930s, oil dominated the Texas economy (McFarlane, 2017). By the 1930s, half of the world's total oil production came from within six hundred miles of Houston, Texas (Melosi, 2009). This boom period, however, was not to last, and by the late 1930s, oil prices crashed to the point that oil was cheaper than water (Wright, 2018). This was Texas' first experience with a resource-based bust.

The early 1980s exhibited a new wave of ONG wealth for Texans. Oil prices were rapidly rising following two Middle East supply disruptions in the 1970s. Thus, oil, which averaged $5.30 per barrel in 1970 grew roughly three times more expensive within 10 years to an average $28.20 per barrel (Duca, Weiss, & Organ, 2015). The surge in oil prices prompted Washington to compel Texas to share its ONG wealth with the energy-poor Northeast (Pedersen & Shapiro, 1986). Defiant Texans responded with songs containing lyrics such as, "We're going to keep all the gas that we can make/And let them Yankees shiver and shake," and cars were slapped with bumper stickers that read, "Freeze a Yankee: Drive 75" (Pederson et al., 1986, p. 16).

The oil industry suffered a third bust in the early 1990s. Oil prices bottomed out at $10 a barrel in 1998, leading oil companies to reduce employment and shut down some drilling sites. According to the Independent Petroleum Association of America (IPAA), in 1997, there were 350,000 oil field service and production employees; however, two years later, there were less than 284,000 employees, a 20% decrease (Forest, 2000, p. 46).

The fourth boom and bust period, 2010-2019, affected ONG activity throughout the U.S. Between mid-2014 and early 2016, there was a 70% drop in oil prices, one of the largest declines since World War II and the longest-lasting since 1986, the last collapse in oil prices (Stocker, Baffes, & Vorisek, 2018). This price drop was the result of an excess of supply and reduced demand (Stocker et al., 2018). Losses within the ONG sector reached over 1 billion in 2013 alone (Etter, 2015). The unemployment insurance claims from energy workers more than doubled in 2014, to over 110,000 in Texas (Etter, 2015). The Executive Director of the Energy Security Council claimed, "unemployed oilfield workers . . . unfortunately . . . resorting to stealing" (Etter, 2015, p. 1). During this period, the sharp price drop in oil resulted in over 200,000 ONG workers losing their jobs (Wethe, 2020). Undeniably, this period marked the beginning of a bust period for the entire U.S. ONG sector.

The Roughneck Culture

A person who works in the oil field is generally referred to as a "roughneck"—a term that has been in use for almost a century. [4] As Allen Hamill explains, "a roughneck is a fellow that does his work on a rotary machine. This started in the early days of the

[4] The Australians call roughnecks "cashed up bogans" (Adams, 2013; Dahlgren, 2019).

business, and I don't know just when, but that was established when I went into the oil fields….” (Hamill, 1952, n.p.). In close association with the roughneck is the “wildcatter,” - a person who explores for ONG drilling opportunities, typically independently. Fain Gillock (1952) explains the wildcatter as follows:

> … a discredited person to a certain extent. He didn't have credit at the banks, he didn't have any credit for anything. He was looked upon as being a speculator, gambler that was unsafe in business….(Gillock, 1952, n.p.)

The term roughneck has developed into a cultural identity for many who work within ONG operations. This roughneck classification is typically applied to men who work as boots on the ground in ONG activity, known to “work hard and play hard” (Amnesty International, 2016). The first part of this persona is the “working hard” trait, which stems from the physical labor required to work within the ONG industry (Bartlett & Conger, 2004). The ONG worker typically must use his body and master machinery in order to fulfill his role in the ONG extraction and production process (Bartlett et al., 2004). Even the machinery added to the work-hard, masculine ideal, with ONG workers typically operating saws, drills, tractors, and other heavy machinery (Brandth & Haugen, 2000). What is more is the level of work expected; one ONG worker explained a typical day on the job in the following way:

> Every day, we’d show up at the Halliburton shop at 4:30 a.m. to get on the bus that chartered us all out to the Jonah Field. We’d relieve the crew in the field, and then we’d sit in the truck and wait for something to break. Sometimes it was 18 hours of nonstop hard labor, but then other times there might be like three days when you wouldn’t leave the truck. (Anselmi, 2020)

Thus, the typical ONG worker is expected to put in long hours and exert intense manual labor, hence the ‘work hard’ ONG motto.

The second part of the ONG persona, “playing hard,” is particularly associated with being a roughneck, as ONG employees typically make a lot of money in a short amount of time. For example, as of May 2019, the Bureau of Labor Statistics listed the average annual salaries of derrick operators at $48,030 and ONG extraction employees’ average annual salaries at $52,970, with the highest salaries going to pipeline crude oil transporters at $77,260 annually (BLS, 2019). These high wages may present a dilemma to young ONG employees, who have little to no experience managing such income, and as a result, may spend their hard-earned money on entertainment in the form of drugs and alcohol (Amnesty International, 2016). One ONG worker explained:

> There are people who put money away, have a nice house, and stick with it. But there’s too few of them . . . I didn’t do drugs at first, but I bought a lot of nice stuff. You start drinking and this and that. It all gets out of hand very fast. That’s oil patch money for you. (Amnesty International, 2016, p. 39)

ONG work often reflects cyclical behavior, with the ONG worker working long hours followed by drug and/or alcohol use. A typical routine may be working nearly 70 hours a week, followed by a week off work. It is this “free week” that allows the young ONG male worker to binge drink or engage in drug usage (Anselmi, 2020). Drug and alcohol abuse, as a result, is strongly associated with ONG environments. For example, in Canada’s oil sands, it was said that it was easier to order drugs than it was to order a pizza in some man camps (Nikiforuk, 2009). One ONG worker explained, “There was a lot of drug use in the oil field. The party lifestyle in that line of work is thrown in your face all the time” (Anselmi, 2020, para. 17).

Some drugs are more popular amongst ONG workers. In Craig, Colorado, Sheriff Buddy Grinstead explained that meth was swallowing his county following the fracking revolution in the mid-2000s (Farrell, 2005). ONG workers have elaborated on this newly prized illicit substance, describing meth usage as almost a necessity within their profession, which requires and rewards long, alert shift work:

> Meth is a rural drug, and it's also connected to the oil field. We've all heard the stories of people working these long shifts and 100-plus-hour weeks with this dangerous equipment—and some of them do meth to help them get through. So some people take it for work reasons, but of course there's a lot of recreational usage, as well. The fact that you could easily cook it yourself made it widely available in places like Rock Springs. It's harder for people to make now since there have been restrictions on some of the ingredients, but it was pervasive at the time. Since the town is isolated, you could just make meth in your trailer or anywhere else. My friend had a trailer on the outskirts of town, and we'd have these raging parties out there. We knew no one would call the cops because the trailers on either side of my friend's were both meth labs (Anselmi, 2020, para. 22).

This ONG worker describes what is now commonly referred to within the ONG industry as the 'you're wired or you're fired' mindset (Farrell, 2005). Between 2003 and 2004, drug positive results for full-time ONG workers in the Colorado Rockies were between 8 and 10% (Farrell, 2005). Consequently, some companies now have zero-tolerance policies, utilizing random urine and breathalyzer samples (Filteau, 2012). This has led to, in some cases, entire rig crews unable to pass a drug test (Farrell, 2005). ONG workers, however, have explained that even if one is caught using drugs and/or alcohol, it is not difficult to find work again (Farrell, 2005). ONG work, as a result, is still strongly associated with drug usage, drinking, and violence (Filteau, 2012).

ONG workers typically reflect characteristics of hyper-masculinity. Hyper-masculinity can be defined as a set of beliefs, attitudes, and behaviors that typify what it is to be a "real man" and is often associated with unhealthy, even dangerous behaviors (Angel, 2014, p. 3). Moreover, ONG field workers are often viewed as being employed in "dirty work" (Hughes, 1958, 1962). Members of the public may express a negative opinion of an occupation, causing those employed within that occupation to feel removed and/or isolated from the community (Filteau, 2015). The workers may be aware of the stigma associated with their line of work. For instance, Filteau (2015) interviewed several Marcellus Shale oilfield workers, who readily discussed how they felt they were generally perceived by the communities they worked in:

> They probably think we're all dirty, and we're stupid and we all got big equipment that's gonna destroy their natural environment, and we're gonna kill the birds, and we're gonna kill the deer, you know, from chemical exposure and contamination. And they think we're out there destroying beautiful fields of corn by drilling them up and cutting them up and drilling holes in them . . . If somebody asks me what I do, I don't tell em . . . " they all thought of as [oil-field] trash…alls we're known for is getting drunk or partying or getting DWIs or getting thrown in jail. (Feinstein, 2015, p. 1157)

The workers, however, may create an image unique to their employment as a defense mechanism, turning the negative stereotype into a positive one. The oil-field worker may reframe the references to being "dirty" to one where being "dirty" is analogous to a "badge of honor" (Ashforth & Kreiner, 1999, p. 421). They may also reframe and justify their occupation, and they may even further isolate themselves from the community to reinforce their subculture (Filteau, 2015). For example, participants in Filteau's (2015) study explained, "If it wasn't for guys like us up here drilling these wells for ONG, they [oldtimers] don't realize how much petroleum is used in everyday stuff . . . what we do is really underappreciated" (p. 1159). When a participant described seeing a sign that was painted on one of the oil rigs underneath an overpass stating, "Go back to Texas, gas bastards," he scoffed, "I'm sure you drove your vehicle to get to that overpass. I'm sure that paint can you used was made from petroleum products. So, if you're going to hate us, hate us all the way . . . " (Filteau, 2015, p. 1161). These methods are used by ONG workers to protect against the perceived negative community perceptions that exist regarding the oil-field worker.

In addition to working side-by-side on a daily basis, ONG workers also typically live together as well throughout the lifespan of the drilling project. Some reside in man camps, which are areas set up for drilling and production workers to sleep in while working a specific drill site (Ruddell, 2017). These temporary living quarters are typically located in rural areas, serving to shelter the transient workers who might otherwise be unable to find accommodations in the host communities (Amnesty International, 2016).

One self-described roughneck explained the classic man camp evening as follows, “The roughnecks in our camps fought and ate competitively; one guy ate thirteen pork chops. Someone always insisted on playing his guitar. It was grim, overwhelmingly masculine landscape” (Gillmore, 2015, p. 38). There is little government regulation over man camp living conditions, which is reflected in the varied environments reported across such communities. Many of these man camps are described as consisting of run-down trailers, men sharing tight quarters, with little to no privacy in rural areas outside of towns and city spaces (Amnesty International, 2016). This social isolation is easily achieved within ONG employment since their work often takes place in rural, isolated locations. In short, the workers live and work together, experiencing the same employment hardships, serving to reinforce their bonds with one another.

Every industry has its own specialized terminology and jargon that gives outsiders a better understanding of that industry’s nature and culture. Oil field workers are especially known for their colorful language and symbology (Weaver, 2010). The language and symbols associated with oilfield workers are often related to their specialized equipment and the danger associated with operating that equipment (Weaver, 2010). For example, if an oilfield worker refers to the Christmas tree, they are referring to an assembly of valves, spools, and pressure gauges fitted to the wellhead that resembles the shape of a Christmas tree (Schlumberger, 2020). Today, oil field workers are often referred to (and refer to themselves) as roughnecks, which is technically a "term used collectively for the four workers supervised by the driller on a rotary rig whose specific names are motor man, derrick man, and two floor hands. Many prefer to refer to only the floor hands as roughnecks" (Weaver, 2010, p. 174). The term, however, has also been adopted as a general reference to anyone who works within the oil field and serves as a source of pride. For instance, when one googles the phrase "roughneck pride," there are over 445,000[5] results and thousands of images to review for roughneck-related merchandise.

The natural resource-based worker is often identified through an exaggerated masculine identity that is reflected in unconventional symbols and images of manhood. For example, Figure 2 and Figure 3 depict the oil field worker through the central image of a skull with cross wrenches (instead of the classic cross bones) wearing a hard hat. These images reflect and reinforce the typecast that these workers are self-sufficient and tough (Cockfield, G., & Courtenay, B. L., 2012). Thus, wrenches, hardhats, and other construction-related equipment contribute to their masculine identities (Brandth &

[5] See https://www.google.com/search?q=roughneck+pride&hl=en-US&sxsrf=APq-WBtBLxsMPhO2HRHr-9w8ij0brcURxA%3A1649451841609&ei=QaNQYuTPJP6hkPIP1s6UgAk&ved=0ahUKEwik9N74roX3AhX-EEQIHVYnBZAQ4dUDCA4&uact=5&oq=rouchneck+pride&gs_lcp=Cgdnd3Mtd2l6EAMyBwgjELADECcyCAgAELADEIYDMggIABCwAxCGAzIICAAQsAMQhgMyCAgAELADEIYDSgQIQRgASgQIRhgAUABYAGDDCWgAcAB4AIABc4gBc5IBAzAuMZgBAMgBBcABAQ&sclient=gws-wiz

Haugen, 2000). This imagery is more than an ideal. It is a depiction for many of a wxay of life.

6

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Figure 2. Oilfield image, "roughneck pride" Figure 3. Oilfield image, "oilfield trash"

An additional term depicting natural resource workers' exclusive self-identification is depicted in Figure 3: "oilfield trash." The creator of the website oilfieldtrash.com, explains that oil field trash:

> does not mean that you are trash. It only refers to a way of life. It is not demeaning nor does it have any negative connotations about it. It is something that real true to life oil field workers strive to be . . . . (Colquitt. 2008, n.p.)

Colquitt (2008) elaborates on the term, providing an example of an oilfield worker he came across, who had a terrible reputation and did not last long in the oilfield. Colquitt explained, "It takes more of a man to be real oilfield trash. He was just plain trash, it's

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[6] https://www.pinterest.com/pin/454230312390373131/
[7] https://legalinsurrection.com/2013/06/oil-field-trash-never-had-it-so-good/

not the same" (Colquitt, 2008). Some, however, may boast the "oilfield trash" identity, with one ONG employee describing the identity in the following way:

> They get tattoos of the rig number they work on, and I've seen people, it's more so down south that you see this, because a lot of these guys up here don't have their trucks, but you go out to the rig and every one of the trucks is going to say essentially, 'get on it,' or maybe a big sticker on the back of the window that says 'oilfield trash. They wear it like a badge of honor; someone who works in the oilfield, and that is supposed to inherently make you, this tough guy. (Filteau, 2012, p. 139)

In short, oilfield trash is a term of pride for many natural resource-based workers, representing the oilfield worker's state of mind.

Images reflecting the theme of ultimate masculinity within oilfield culture are not difficult to find. The images typically emphasize the difficulty of the work and the requirement of workers to possess toughness in order to survive. One image proclaims, "We work through storms, through snow, in hard hats and boots covered in grease and dirt every day in the oilfield. We live to do it rough and tough to support our family" (Teespring, n.d.). There are also sites dedicated to oilfield humor that promote and reinforce the masculine ideal with cartoons, as Figure 4 shows.

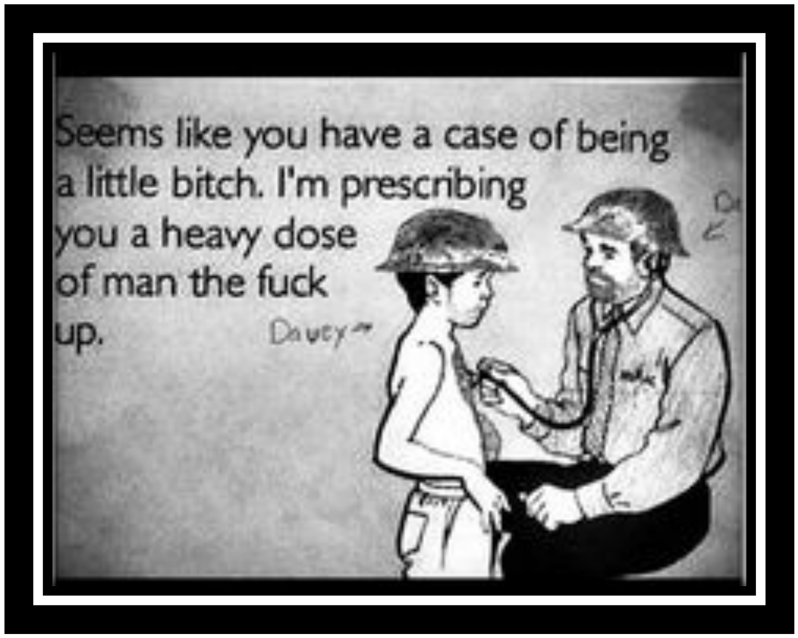


Figure 4. Oilfield humor ([Jenn Pharr], n.d.)

These messages and symbols are typical responses to what oilfield workers perceive as threats from voiced environmental concerns. Thus, they emphasize the unique culture arising from ONG work. Colquitt (2008) summarizes this attitude as “Windmills and solar panels will not power our trucks.”

Rural communities in Texas have experienced two extreme boom and bust periods within a ten-year span (2010-2019), a relatively short amount of time. These periods include rapid social growth spurred by ONG companies’ investment within rural areas for resource extraction. Notably, these companies employ a predominantly male, transient, out-of-state workforce (Ruddell et al., 2014), the exact demographic that is reflected within the “roughneck” stereotype. Since natural resource work primarily employs males who are employed in a sector that enhances the social pressure to represent hyper-masculinity, one would expect criminal offenses to be higher in ONG-producing or mining communities. Accordingly, this study examines known Part I crime rates in ONG-producing counties across Texas to determine if the factors associated with resource extraction affect these crimes.

Sub-state Variation in Boom-and-Bust Periods. Texas has five major natural gas shale fields (ELA, 2015; see Figure 5).[8]

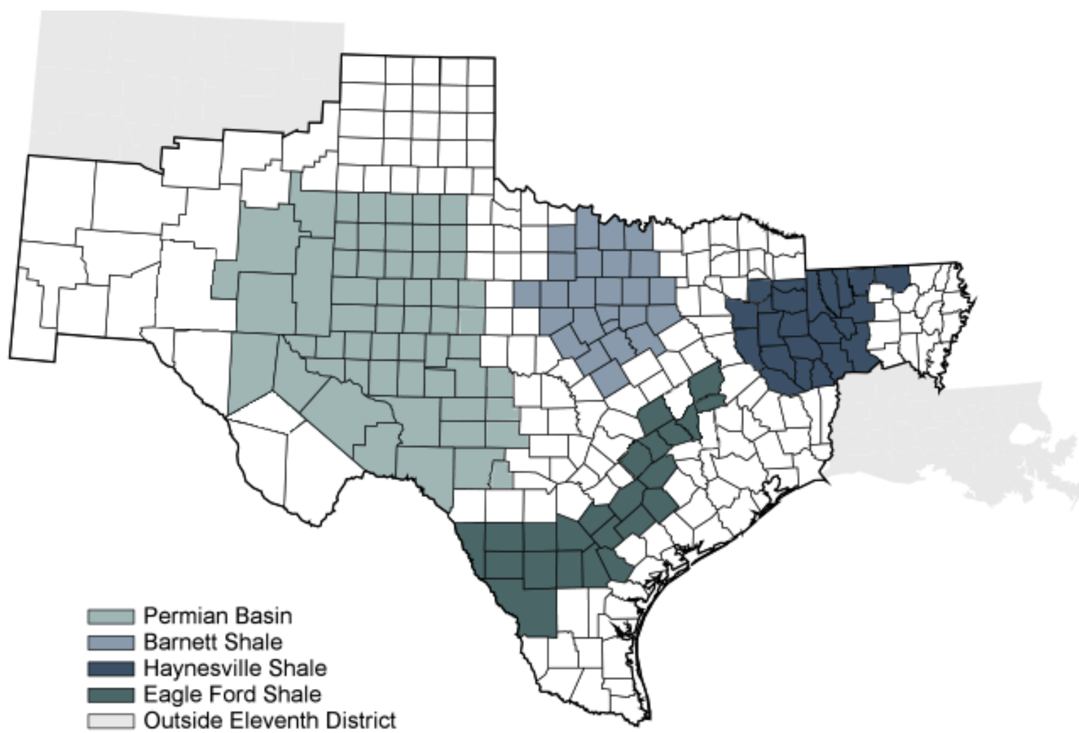


Figure 5. Texas shale geographic regions (Adapted from FRBD, 2021).

The Eagle Ford shale (spanning over 15 counties) was discovered in 2008, and by 2014, the ONG industry had paid nearly $1.6 billion in local government taxes and employed an estimated 130,000 people (Druzin, 2018). In 2014 alone, the ultimate impact was estimated to be $98 billion in revenue (Druzin, 2018). Likewise, the Barnett shale (spanning 25 counties) was discovered in 1981 yet did not attract ONG investment until

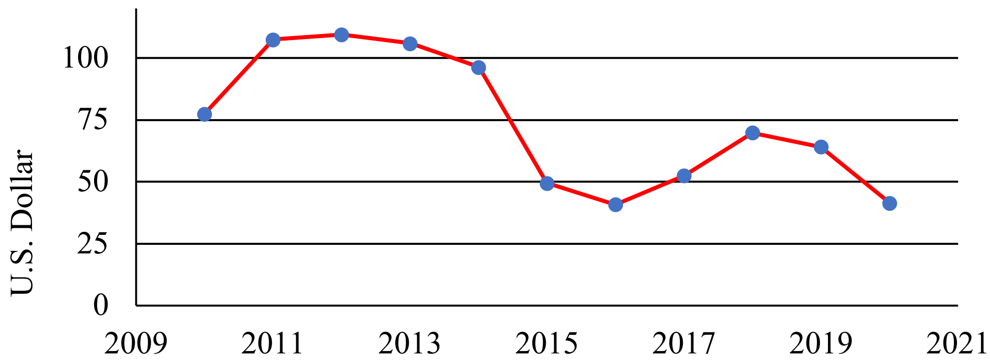
[8] Texas has five major ONG shale formations, including (1) the Barnette shale, (2) the Eagle Ford shale, (3) the Haynesville shale, (4) the Permian shale, and (5) the Granite Wash formation ELA, 2020).

nearly two decades later, when hydraulic fracturing was discovered. The Haynesville shale (spanning 13 counties) was discovered in 2008 and continues to be one of the top producing ONG formations in the state.

The Permian shale was discovered in 1920, yet it was not until 2010 that fracking started to significantly increase both the oil and natural gas production in the region (Cohen, 2018). The Permian shale formation had produced more than four million barrels of oil each day in 2015, surpassing Saudi Arabia's oil fields, and becoming one of the most productive oil reserves on earth (Miller, 2020). Therefore, it would not be appropriate to designate a set boom and bust period to the entire state since Texas experiences booms and busts at varying times, at varying degrees, and within varying regions of the state.

This study analyzes ONG activity and the known Part I crime rates within Texas counties (*n* = 245) between 2009 and 2019. These two time periods were chosen because there were substantial changes associated with ONG during these two eras (see Tables 1-4). Table 1, for example, reflects that during the summer of 2008, crude oil prices soared above \$100 and peaked at \$145.31 in July 2009, the biggest boom ever recorded – creating a production rush throughout the nation (McNally, 2017).

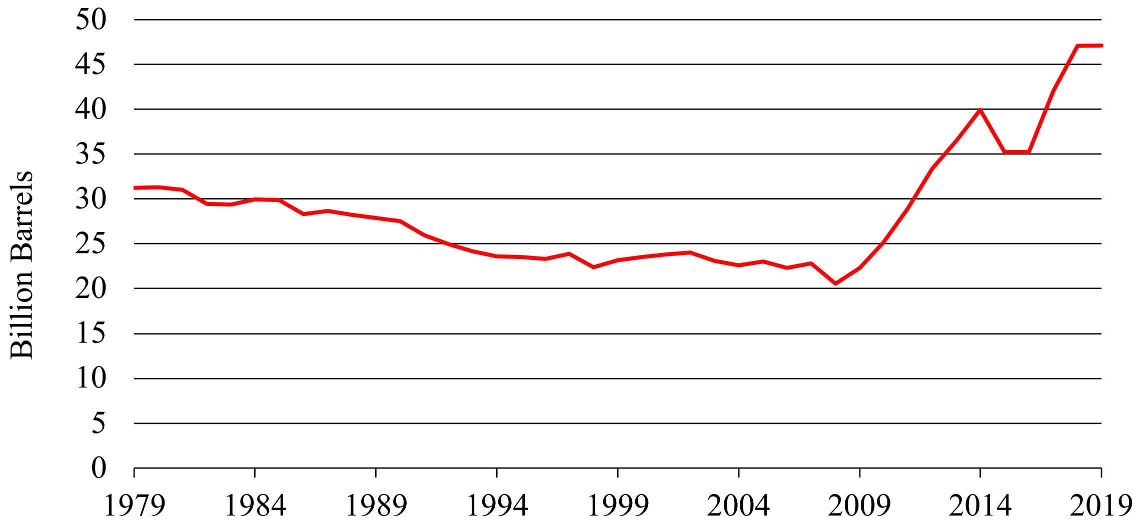
Table 1. Average annual OPEC crude oil price from 2010-2020



Note. Adapted from information obtained through U.S. Energy Information Administration (2020).

In addition, between 2000 and 2014, and associated with the noted price valuation boom, employment grew 58% in the ONG extraction sector (BLS, 2018). Then, abruptly, crude oil prices fell to less than $33 per barrel in less than six months. Prices rebounded, however, to nearly $100 in 2011 and averaged about $95 over the following three and half years. However, from June 2014 to February 2016, prices crashed yet again, from $107 to $26 a barrel – a bust of over 75% (McNally, 2017; Wright, 2018). This crash was mainly due to a worldwide surplus in oil supply, which led to U.S. oil production experience a decline beginning in mid-2014 (see Tables 1 – 4). Essentially, too much ONG was produced, resulting in too much product and not enough demand. Table 2 reflects this dramatic oil valuation fluctuation, demonstrating the initial stagnant amount of oil production from about 2005 through 2008, followed by the significant increase between 2010 through2015 in oil production.

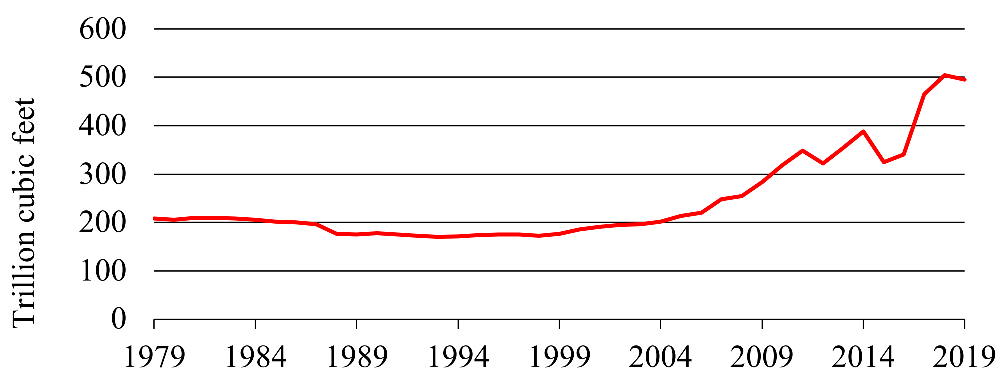
Table 2. U.S. crude oil and lease condensate proven reserves from 1979-2019



Note. Adapted from ELA, Form ELA-23L, Annual Report of Domestic ONG Reserves, 1978-2019.

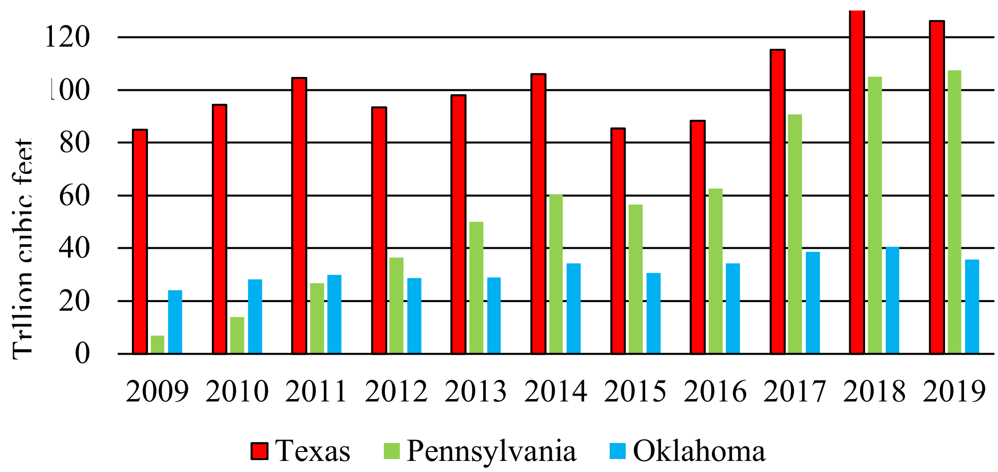
Likewise, Tables and 4 reflect a similar fluctuation pattern in production of natural gas. Specifically, natural gas production was stagnant from about 2004 to 2008, and subsequently increased until about 2015, when natural gas production and reserves (like oil production and oil reserves) outpaced demand.

Table 3. U.S. total natural gas proved reserves between 1979-2019



Note. Adapted from ELA, Form ELA-23L, Annual Report of Domestic ONG Reserves, 1978 2019.

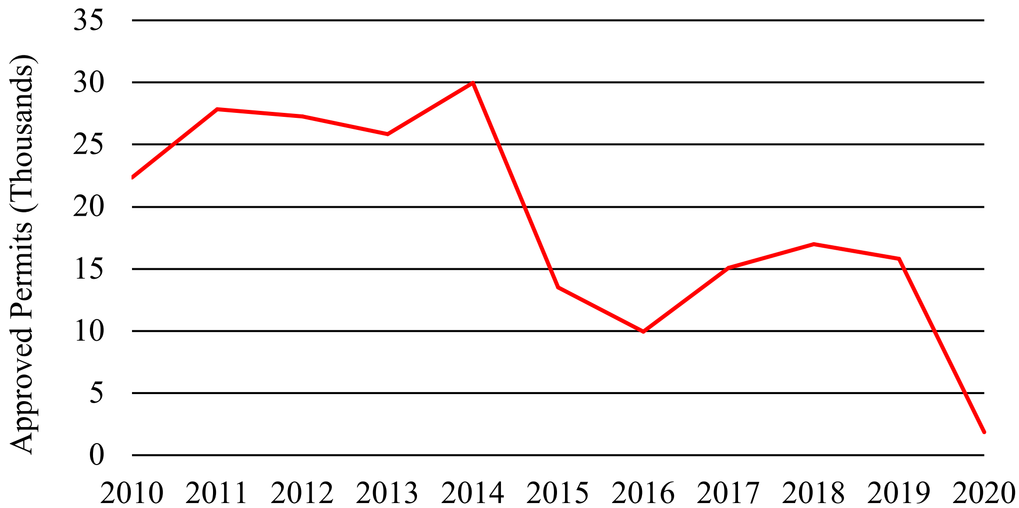
Table 4. Proven natural gas reserves in the top three states, 2015-2019



Note. Adapted from ELA, Form ELA-23L, Annual Report of Domestic ONG Reserves, 1978-2019.

Notably, the decline in ONG valuation led to widespread layoffs in 2015 and 2016 throughout the ONG industry (Hardzinski, 2016; Hiller, 2016; Proctor, 2016). Essentially, lower price valuations for ONG made extraction less profitable for resource production and extraction companies, leading to more than 50 Texas-based ONG producers between January 2015 and December 2016 declaring bankruptcy (Wright, 2018). As Table 5 demonstrates, between 2014 and 2016, the amount of drilling dropped by more than half. Consequently, Texas experienced two significant boom-bust cycles within a ten-year period.

Table 5. Drilling permits approved between 2010-2019 in Texas



Note. Adapted from Railroad Commission of Texas (2020).

Ultimately, Texas had become a victim of its own success, reflecting strong economic growth dependent largely on ONG exploration and production, which ultimately suffered a significant decline due to overproduction and resource devaluation. Thus, this study's focus on Texas is appropriate in that it is the leading ONG-producing state in the country, and is an ideal study site to assess whether changes in ONG activity influences known Part I offense rates in Texas.

New Texas ONG Boom on the Horizon. The Texas Independent Producers and Royalty Owners Association (TIPRO) released a report asserting that 2018 was an all-time high for oil production in the state of Texas. Of course, this report was released prior to the 2020 ONG bust that led to oil valuations dipping below $0 per barrel for the first time in history (Kelly, 2020). However, a record 1.54 billion barrels were produced in 2018 alone, surpassing all other production totals since 1973 (TIPRO, 2019). The second highest oil-producing state in 2018 was North Dakota, which produced 442,926,363 barrels of oil, about one-third of the production in Texas. There was, in total, an overall production increase between 2017 and 2018 of more than 500 million barrels, which is the largest increase ever recorded in the state's history and is projected to increase even more (TRRC, 2019). Certainly, Texas remains the nation's leader in ONG activity.

The massive increase in ONG activity in 2018 is attributed to ongoing innovation and operational efficiencies gained within the industry, as well as more favorable economic and regulatory conditions that were enacted during the Trump Administration (TIPRO, 2019). President Joe Biden, however, has promised to invest heavily in "green energy," so the future of the energy sector is uncertain. Nevertheless, our nation is reliant upon cheap energy, and ONG extraction will likely continue. Consequently, it is important for communities that may be affected by booms to be aware of the impact of mining or ONG activity on their well-being.

Implications of ONG Activity for Crime. Boomtown residents live in places of constant fluctuation. A resource-based boom can reshape an entire region in a matter of months. Community newcomers are often viewed with suspicion (Genareo & Filteau, 2016) by the long-term residents, and these perceptions in turn contribute to fears that an increase in population also means an increase in crime (Forsyth, Luthra, & Bankston, 2007; Huynh, Robinson, Mrozla, Dahle, Archebold, & Marcel, 2019; Ruddell & Ortiz, 2015) and other social ills that are not criminal but reflect social disruption, such as increased number of traffic collisions and fatalities, litter, pollution, and sexual harassment (i.e., cat calls). Women have expressed feeling like "prey" within the ONG boomtown environment (Anselmi, 2020). One woman who grew up in an ONG boomtown in Rock Springs, Colorado, described her experience in the following way:

> Since the ratio of men to women is so high, I grew up being comfortable around men, which isn't to say that I didn't have some negative interactions. Sexual

> harassment and abuse are definitely prevalent there. Women are such a commodity, which made for very different interactions between genders. (Anselmi, 2020, n.p.)

Indeed, the boomtown dynamic may be a recipe for social disruptions that increase criminal and deviant activity.

Population increases also lead to more individuals present in a community who may commit various offenses that burden local law enforcement, courts, and corrections (Ruddell, 2017). Consequently, boomtowns have challenges that are symptomatic of ONG activity.

The following chapter describes several relevant sociological and criminological theories that address how rapid environmental changes can lead to changes in antisocial behavior, crime rates, traffic collisions, and other social ills.

III. THEORETICAL FOUNDATION AND PRIOR RESEARCH RELATED TO BOOMTOWNS AND CHANGES IN CRIME

Many researchers have attempted to explain the causes of crime within communities experiencing economic and social change resulting from rapid resource extraction. As noted in Chapter II, Texas, in particular, has experienced numerous social changes and impacts associated with ONG activity. Consequently, Chapter III explores the specific theoretical explanations for the various forms of social change that occur in resource-based boomtowns, including the specific effects and consequences of such social change, and an exploration of macro theories that have been used to explain the impact of social change on crime.

The examined macro theories used to explain the effect of social change on crime are presented in four main categories: (1) anomie and strain theories, including an overview of gemeinschaft and gesellschaft, as well as an exploration of Durkehim's anomie theory Durkheim's (2) social change, which includes Thomas and Znaniecki's disorganization research and the work of the Chicago School, Shaw and McKay's social disorganization theory, (3) opportunity-based theory, including routine activities theory; and (4) other important characteristics that have been used, theoretically, to explain crime, and a close inspection of characteristics that have been associated with ONG production employees. Additionally, previous research linking boomtowns to criminal behavior is presented, with the chapter concluding with a look at the present study and its potential contribution to the literature.

Texas Boomtowns and Social Change

For more than a century, the economy of Texas has been shaped by ONG extraction and production (Wright, 2018). As explored in Chapter II, oil exploration and production have in fact, displaced agriculture as the principal engine driving the economy of Texas (TSHA, 2018). Texas communities experiencing rapid economic and social changes due to resource development develop dramatic economic, demographic, and social changes (England & Albrecht, 1984). To start, social change within ONG producing counties typically corresponds with rapid population growth, particularly an increase in young males seeking employment (O'Connor, 2015). The first oil discovery in 1901 in Beaumont, Texas, was an early reflection of this boomtown characteristic, with a pre-oil discovery population of 10,000 that tripled in less than three months to 50,000 people (Yergin, 2011). Necessity, Texas, in the early 1900s, rose in population almost 600% in ten years after oil was discovered (Little, 2002). This theme is also reflected in more current Texas boomtown communities, such as Midland, Texas, where, as a result of natural gas fracking, the population grew nearly 30% in less than ten years (Isidore, 2019). In Carrizo Springs, Texas, the population jumped from 5,400 in 2011 to more than 40,000 in 2012, due to natural gas fracking focused operations (Garcia, 2013). Notably, these population increases typically occur in once rural communities, thus, even a small increase in the percentage of the population could strain a community (O'Connor, 2017).

In addition to rapid population growth, Texas boomtowns are also characterized by an influx of young males. Olien and Olien (1982) found that Texas boom counties between 1920 and 1950 had from 33% to 225% more inhabitants younger than 45 years old than did Texas as a whole. In 2000, the majority of census tracts in the Eagle Ford Shale region were above 50% male (Stanley, 2018). These young males typically have little stake in the community, leading to increased involvement in antisocial behavior and crime (Archbold, Dahle, & Jordan, 2014).

The population and the population demographics are not the only thing, however, that changes in resource driven boomtowns; so too does the economy. As population increases due to new job opportunities within resource extraction and production, the cost of living typically rises (Weinstein, 2014). Conversely, however, boomtown communities also incur economic benefits, including an indirect economic benefit, such as the induced effect from workers spending their earnings at local restaurants, bars, hotels, and other commodity driven businesses (Weinstein, 2014). Previous literature generally finds that mining activities have a local multiplier effect of about two (or less), meaning that for every oil and gas job created in a locality there will be at least additional job created in other industries in the area (Black, McKinnish, & Sanders, 2005; Kraybill & Dorfman, 1992). Boomtowns, however, are typically not fiscally prepared to maintain the new infrastructure and necessary maintenance. When Carrizo, Texas, for example, experienced the 640% increase in population in less than one year, the city did not have a planning department, city engineer or any associated growth planners on staff (Garcia, 2013). These strains are further emphasized when the oil boom develops into an inevitable bust (O'Connor & Ruddell, 2021). Once a resource has been fully extracted or cannot be produced economically, the industry closure that follows is often a source of major economic and social upheaval (Lawrie, Tonts, & Plummer, 2011). The literature is replete with studies pointing to high rates of unemployment, poverty and other forms of social malaise in places following the demise of an industry on which a community depends for its economic prosperity (Bradbury & St-Martin, 1983; Neil, Tykklainen, & Bradbury,1992). Indeed, some scholars even argue that boom communities are more disadvantaged after a bust in terms of economic development (Jacobsen & Parker, 2014).

ONG activity changes the social, economic and even the very landscape of the host community. In Denton, Texas, the nearly one-third of the county's land is platted (planned) for wells, with nearly three hundred wells inside the city limits (Wright, 2018). Additionally, the infrastructure of the community changes, leading to heavier traffic, and consequently, increases in the number of traffic collisions and fatalities (Forsyth, Luthra, & Bankston, 2007; Huynh, Robinson, Mrozla, Dahle, Archebold, & Marcel, 2019; Ruddell & Ortiz, 2015). Ultimately, boomtowns reflect social changes within their population, demographics, economy, and landscape. This is a wide range of impacts that have very real consequences.

Social Consequences of Social Change

It has long been proposed that social changes result in social disorder, and ultimately, an increase in crime (Thomas & Znaniecki, 1920). Social change occurs over time and is not based on a single event (Boehnke & Bergs-Winkels, 2002). Boomtown growth often reflects several events that ultimately lead to dramatic social change(s). Researchers, for example, break down boomtown growth and social change into three general phases of events, including the (1) time period before any changes occur, referred to as the pre-boom phase[9], (2) the time period when resource extraction/production is at its highest, referred to as the boom, and (3) the period of time when extraction and production significantly decreases, referred to as post-boom (Ruddell, 2021). One of the first social change events that occurs during the pre-boom/boom phase is that the population increases rapidly with the majority of newcomers being young males

[9] The pre-boom phase is where the community's population has been fairly homogenous and has either remained unchanged or has undergone minor fluctuations in population size or turnover (England & Albrecht, 1984).

(Ruddell, 2021). Coinciding with this population increase is an increase in the number of public order offenses, including alcohol-related crimes and drug offenses (Ruddell, 2021). The increase in population ultimately exceeds the community's ability to meet the demand for basic services, including for health, education, social, and protective services (Ruddell, 2021). These reflect indicators of social change; thus, the more these factors are reflected, the more social change is indicated (Boehnke et al., 2002). This community instability reduces the community's ability to exercise formal social control.

Social change impacts rural communities particularly hard, given that the population increase drastically changes the once familiar neighbors' faces into unfamiliar strangers. Also, many rural communities lack the financial resources to address the increased demand for infrastructure and protective services (including emergency, fire, and law enforcement) (Ruddell, 2011). Rapid population growth, for example, stresses a community's ability to provide housing (Gouveia & Stull, 1995; Prochaska-Cue, & Ziebarth, 1997; Whitener, 2001) education, health care, and welfare services (Broadway, 2000). Consequently, residents feel that their quality of life in their community deteriorated given the large influx of newcomers (Broadway et al., 1994).

The Industrial Revolution was one of the first recorded eras reflecting social change and an increase in criminal activity. It was during this post-Civil War era that the U.S. transformed from a predominantly rural agrarian to an industrial society in the span of a few decades (Hirschman & Mogford, 2009). Employment in manufacturing expanded from 2.5 to 10 million workers from 1880 to 1920, with the majority residing in urban centers (Hirschman & Mogford, 2009). The urban population in the U.S. swelled from more than a quarter of the national population in 1880 to nearly half of the national population by 1920 (Hirschman & Mogford, 2009 citing Carter et al., 2006, pp. 1-105).

City populations were also transformed by waves of immigration, with over 7 million foreign-born immigrants moving to the U.S. for employment in less than 30 years (Hirschman & Mogford, 2004). By 1920, over one-third of the 105 million Americans were first and second-generation immigrants (Hirschman & Mogford, 2004, p. 898). This social change weakened the traditional social controls while creating new challenges for the community, including overcrowding which increases the number of personal interactions, thereby leading to increases in violence (Lane, 1974). E.P. Thompson (1966, p.445) explained that "[t]he process of industrialization is necessarily painful. It must involve the erosion of traditional patterns of life." It is this erosion in the social fabric caused by social change that requires examination. Thompson (1966) further noted that through an examination of these consequences, we may discover "insights into our social evils which we have yet to cure." Indeed, social change brings about a host of societal transformations, including crime.

Macro Theories Addressing Effects of Social Change on Crime

Durkheim's Anomie Theory. Emile Durkheim (1893) argued that a collapse in social solidarity contributes to antisocial behavior. Anomie theory was a product of the era in which the theorists lived. The 19^{th} century was a period in which the agrarian farming community was eroding due to industrialization (Lilly et al., 2007). A household that once held the family unit, including extended family members, was evolving into relatives leaving their core family unit to move into populated city centers to work in factories (Lilly et al., 2007).

The key concept that prevents anomie, according to Durkheim, is solidarity. Durkheim wrote:

> Everything which is a source of solidarity is moral, everything which forces man to take account of other men is moral, everything which forces him to regulate his conduct through something other than the striving of his ego is moral, and morality is as solid as these ties are numerous and strong. (Durkheim, 1893/1933, p. 398)

Durkheim was contrasting the pre-industrialization world in which individuals had a well-defined social and moral place to the post-industrialization world in which collective cohesion were breaking down. Ultimately, Durkheim sought to understand what types of social bonds worked to hold people together in a society.

Durkheim (1893) dichotomized social bonds into mechanical and organic solidarity. Mechanical solidarity is present in traditional societies where there is likeness between individuals, and organic solidarity is seen in modern societies having people with differences and following different pursuits (Durkheim, 1893). These different pursuits and divisions of labor are based on interdependency instead of mechanical solidarity, in which one is working as part of the collective conscious. Ultimately, organic solidarity may lead to an erosion of collective cohesion. In short, Durkheim's view of solidarity indicates that unless solidarity is maintained, crime and delinquency will occur.

Smaller rural communities are known for being close-knit – the residents serve as a social control on other residents' behavior, indicating mechanical solidarity. Boomtown communities, however, reflect Durkheim's industrialized societies that develop organic solidarity. The boomtown community becomes a collection of new residents that differ in many ways from the pre-boom rural community. Unlike communities exhibiting organic solidarity, however, boomtowns may not unify in such diversity. Consequently, boomtown research reflects a common theme: communities experiencing an erosion in their solidarity produces an increase in criminal activity or a perceived increase in criminal activity (Huynh et al., 2019). A community, for example, which once had lifelong residents who went to school together, worked together, lived side-by-side as neighbors for decades, experience anomie when such familiarity decreases and is replaced by unfamiliar, transient workers who only plan on residing in the area on a temporary basis (Ruddell et al., 2014).

In summary, anomie theorists propose that abrupt changes in living conditions contribute to a breakdown in the community's cohesion. This is the situation many communities face when natural resources are discovered and extracted; the discovery produces an influx of non-resident workers who have no intention to stay in the community, creating a breakdown in social cohesion.

Disorganization Theory. The matter of social change leading to disorder is not a novel issue. Thomas and Znaniecki (1920) introduced the concept of disorganization theory in their five-volume study of the effect of industrialization and immigration's effect on the traditional rural Polish peasant community. These scholars defined people's response to social groups and social situations and how the individual responds to them as "social organization" (Thomas & Znaniecki, 1920, p. 33). The emphasis was not on the individual impact of immigration and industrialization, but instead, on the community formation that resulted after such social changes. Specifically, the authors explored how industrialization resulted in rural disorganization in Poland, which in turn, led the Polish peasant class to immigrate to the U.S., which led to urban disorganization and ethnic conflict in America (Thomas & Znaniecki,1920). Their work explained social problems as a product of the relationships between individuals and their surrounding society. The traditional Polish peasant community, for example, had stakes in the bonds between individuals because so many of the social and economic affairs of the community were mediated through these bonds (Thomas & Znaniecki, 1920). This is an important point, as these community bonds may become weakened during social change, transforming once valued community obligations into personalized/individual exchanges with little to no community impact consideration. In short, the emphasis shifts from that of the community needs to that of the individual's needs.

Thomas and Znaniecki's initial research and subsequent theoretical work was based on correspondence with Polish immigrants and newspaper clippings about the community (Zaretsky, 1988). The documents have been recognized for their value in analyzing the Polish peasant experience (Blumer, 1979). Thereafter, social scientists started to further explore rural disorganization resulting from social change, considering social institutions' effects on community organization. It is noteworthy, however, that for purposes of this study, the initial argument proposed by Thomas and Znaniecki (1920) is reflected in the experience of the oilfield worker who typically leaves behind their family to temporarily reside in a community in which they do not have any mutual obligations. Instead, they are focused on their individual (and family) needs in which they prioritize maintaining employment and earning a salary. It is this shift away from community needs to those of the individual that may help explain the rise in crime expected in boomtowns.

Shaw and McKay's Social Disorganization Theory. Social disorganization theory, developed by Shaw and McKay (1942, 1969), is one of the most applied theories within boomtown research (Carrington et al., 2011; England & Albrecht, 1984; Freudenburg, 2011; O'Connor, 2015; Tauxe, 1998). Shaw and McKay's research on social disorganization grew out of the research conducted by the Chicago School. After studying Chicago's juvenile court records Shaw and McKay noted that rates of crime were not evenly dispersed across time and space in the city. Creating hand-drawn maps of juvenile delinquency rates for Chicago and other North American cities, Shaw and

McKay (1942) discovered that juvenile delinquency tended to concentrate in slum neighborhoods. Further, crime rates were highest in these neighborhoods regardless of which racial or ethnic group happened to reside there at any time, and, as the previously crime-prone groups moved to other low-income areas of the city, their involvement in criminal activity decreased accordingly. These observations led Shaw and McKay to conclude that crime was a function of neighborhood dynamics and not necessarily a function of the individuals living within such neighborhoods. Social disorganization creates community breakdown and causes higher rates of juvenile delinquency. In essence, regarding criminal activity, location matters.

Shaw and McKay (1942) sought to identify the characteristics of high-crime neighborhoods that set them apart from low-crime neighborhoods. They found that some neighborhoods were characterized by low socioeconomic status, high rates of residential mobility, and high degrees of racial heterogeneity (Shaw & McKay, 1969). These structural factors or antecedents were posited to produce socially disorganized neighborhoods. This meant that conventional institutions of social control in these places (e.g., schools, churches, voluntary community organizations) were weak and unable to informally regulate the behavior of the neighborhood's residents, especially its youth. In short, factors that lead to deterioration in informal social control is expected to increase an area's crime.

Although popular and influential throughout the 1950s and 1960s, the social disorganization perspective fell into relative disfavor by the 1970s, and many scholars viewed the approach as irrelevant or, at best, marginal to modern criminology (see Davidson, 1981). Even so, social disorganization theory was rediscovered in the 1980s. Research by scholars such as Bursik (1986, 1988), Sampson and Groves (1989), and

Wilson (1987) helped to revitalize, and to partially reformulate and extend, the social disorganization proposition. The deteriorating conditions of inner-city neighborhoods, often marked by rising violence and the growth of an "underclass" (Wilson, 1987), made the notion of disorganization seem relevant once again.

Social disorganization theory rejects the prominence within criminological theory of individual pathology (Lilly, Cullen, & Ball, 2002) and instead focuses on macro-level processes that impact community member behavior. The social disorganization perspective argues that neighborhoods within a community are complex systems of continuing relationships which serve, in part, to preserve and enforce informal social control over residents (Sampson 1986; Sampson and Groves 1989). Crime and delinquency will ultimately occur when communities are unable to maintain internal stability and community members lack self-regulation because they lack neighborhood commitment (Bursik, 1986; Shaw & McKay, 1969). This theory is often operationalized using measures of racial and ethnic heterogeneity, population turnover, income-based estimates of socioeconomic status, and indicators of residential mobility (Bursik & Webb, 1982; Pratt & Cullen, 2005) over a single point in time. However, changes in the social and economic composition of communities have also been found to affect the change in the level of delinquency. For example, Bursik and Webb (1982) discovered communities exhibiting the highest amount of social change were characterized by the highest increases in delinquency levels. Specifically, they found that communities with the highest rates of population change had an average of 12 more offenses per 1,000 youth than areas with either moderate or slow change (Bursik & Webb, 1982). The dramatic population shifts resulted in people moving in and out of the community, making it difficult for social institutions, social networks, and informal social controls to maintain order within the community over time. In short, social changes, such as population changes within a neighborhood, introduced a source of instability that decreased the community's ability to regulate itself, thereby increasing delinquency levels.

Social scientists have relied upon social disorganization theory to study the impact of social changes on community crime rates since the 1940s. Generally, communities experiencing rapid population growth associated with resource extraction also experience deteriorated relationships, including a decreased "density of acquaintanceship" (Freudenburg, 1986), or the proportion of a community's population that knows one another. This, in turn, leads to deterioration within the community's solidarity and subsequent feelings of disorganization and insecurity (O'Connor, 2015). Most boomtown studies to date have focused on community member's perceptions of disruption.[10]

Researchers theorizing about social disorganization argue that as laborers move into communities experiencing a significant increase in resource extraction, the community becomes less socially cohesive (Brown e al., 2005; England and Albrecht, 1984; Freudenburg, 2011). The influx of newcomers into the community breaks down the informal social controls that once existed, and such community ties may become further weakened if long-term residents move out of the community, seeking a more stable community environment (Ruddell, 2017). It is not, however, just the informal social controls that suffer a result of such community change, as formal controls also face

[10] A recognized limitation of relying on social disorganization theory is that it is a theory of evolutionary change that occurs within and across neighborhoods/communities. The theory is typically not applied at the county level.

challenges caused by the social disruption accompanying large-scale resource extraction projects. For instance, law enforcement may struggle to keep up with the increased calls for service (Vose, Miller & Koskinen, 2020) and financial resources become strained trying to address the needs of an increasing population (Ruddell, 2011). These community-based changes associated with boomtown growth are suggested to increase criminal activity and other social ills. Often referred to as "boomtown effects", these changes often occur during the life course of the resourced-focused boom (Ruddell et al., 2018). Researchers have found that communities that experience rapid population growth due to natural resource extraction often face increases in serious criminal offenses (Covey & Menard, 1983), suicide (Seydlitz, Laska, Spain, Triche, & Bishop, 1993), violent and property crime rates (Gourley & Madonia, 2018), alcohol-related violence (Ennis & Finlayson, 2015), rates of crime per law enforcement officer (Ruddell, 2011), incidents of driving under the influence (Alberta Transportation, 2017; Ruddell & Ray, 2020; Archbold, Dahle & Jordan, 2014) and disorderly conduct (Rhubart & Brasier, 2019; Archbold et al., 2014).

The number of law enforcement personnel is of particular importance since police visibility indicates social order (Vose et al., 2020). As the face of community authority, police presence is crucial to both the perception and reality of safe and orderly communities, so ensuring an ample population of police is an essential part of social organization. A number of studies have shown that the local justice system in boomtown communities is often unable to meet the demands for service (Archbold, 2015; Ruddell, 2010; 2017). As a result, the threshold for arrests is increased and acts that warranted an arrest prior to the boom are not sanctioned by the police because of their workloads. Blumstein and Cohen (1973), explored the issue of changing thresholds for punishment, hypothesized that during stable historical periods, societal level of crime and punishment (as measured by imprisonment rates) will remain stable as well. If deviant behaviors, however, become more common, the threshold is moved to punish fewer types of behaviors, but the threshold shifts to punish more behavior if the opposite occurs (Blumstein & Cohen, 1973). Thus, over time, when society adjusts the response to maintain a relatively stable average level of punished behaviors, it becomes a priority-setting process that is determined by available resources (i.e., law enforcement).

However, some studies report contradictory findings regarding the relationship between crime and population growth attributable to ONG activity. Ruddell, Jayasundara, Mayzer and Heitkamp (2014) found that the relationships between natural resource development and crime disappeared when other socioeconomic factors were included in their multivariate models. Those researchers contend that increases in antisocial behavior and crime might not be statistically significant but may have a profound impact on community residents.

Social Disorganization Theory and County-Level Analyses. Social disorganization theory advances understanding of crime and delinquency that occurs within communities. Consequently, social disorganization theory has been used as a theoretical framework in over 60% of the studies between 2005-2019, to hypothesize the connection between ONG activity and crime (Stretesky & Grimmer, 2020; *see* Berger & Beckmann, 2010; Deller and Schreiber, 2012; Gorley & Madonia, 2017; Luthra et al., 2007; Ruddell et al., 2014; Stretesky et al., 2018). Further, to explore social disorganization theory, nearly 49% of previous studies have used “county-year” as their primary unit of analysis (Stretesky et al., 2020). This is an important shift in the application of the theory, since, traditionally, social disorganization theory only applied to neighborhoods (Osgood & Chambers, 2003). It is important to emphasize the central theme of social disorganization theory at this point, which is that location matters in relation to predicting illegal activity (Shaw & McKay, 1969). Specifically, delinquency is a response to abnormal conditions that arise within the community context. This response may be attributed to a collapse of community-based controls and rapid growth. These features are not unique to neighborhoods but are experiences that may be felt within larger areas, including rural communities. Therefore, the same system of relationships that are important to crime and delinquency in urban neighborhoods are also relevant to small towns and rural communities (Osgood et al., 2003).

Expanding social disorganization theory to counties also expands understanding of a wider segment of the population. Focusing solely on neighborhoods within large urban areas omits a large segment of the population. Traditionally, rural areas reflect sparse populations, low housing density, and are generally far from urban centers. Rural areas, as of 2019, made up 97% of the country's landmass and were home to nearly 20% of the country's population (U.S. Census, 2019). These statistics are echoed in Texas, where in 2010, nearly 16% of the population lived in rural areas (TDC, 2017). Consequently, researchers have called for more focus on rural settings, which may reflect some of the same crime-based issues as urban neighborhoods (Smith & Huff, 1982; Weischet, Wells, & Falcone, 1995). Therefore, applying social disorganization theory to counties, as opposed to limiting its application to only neighborhoods, allows for a better understanding of location/crime dynamics.

Routine Activity Theory. Like social disorganization theory, routine activity theory, is a place-based theory, focusing on *situations* where crime is likely to occur (Lilly, Cullen, & Ball, 2007). Routine activity theory states that offender's make choices to commit crime based on three specific criteria. First, a criminal event must have a "motivated offender" who has the opportunity to act on those motivations. Second, there must be a "person or object providing a suitable target for the offender" (1979, p. 590). Finally, there must be an absence of guardians capable of preventing violations. Notably, the term "suitable target" includes not only people but also property; thus, the theory takes into consideration that property can be victimized as well as people. Cohen and Felson (1979) also chose the phrase "capable guardians" rather than "police" because they meant to include all means by which a target might be guarded. Most often, such guardianship is provided informally by family members, friends, neighbors, or other members of the public. However, guardianship also can be provided through other means, such as guard dogs and security cameras. In short, if an opportunity is not present, a crime is less likely to occur.

The combination of these three components produces an opportunity conducive for crime. Just as a loaf of bread cannot rise without all the necessary ingredients mixed, Felson (1998, p. 52) suggested that the "chemistry for crime" requires all the necessary ingredients. Routine activity theory may help explain the rise in crime within boomtowns. These communities typically experience rapid population growth, which is often followed by an increase in criminal activity. Large-scale social change, such as rapid population growth, influences and increases the number of suitable targets (Felson, 1979). The capable guardian who serves as a formal social control mechanism in this environment is law enforcement.[11] As the population of the host community increases, so

[11] Notably, there is also a stress on the once, influential informal social controls, comprising of the actions taken by citizens to signal unacceptable behavior within their community (Groff, 2015). Such informal social controls cease to be effective, since newcomer ONG workers are typically spatially separated from the community and consequently, unknown/anonymous to the community's residents (Groff, 2015).

too does the demand for services from local and county agencies, including those within the criminal justice system (Archbold, Dahle, Huynh, & Mrozla, 2016).

For instance, in Williston, North Dakota, the calls for service increased 857.51% within a 13-year period (Archbold et al., 2016). One officer described his experience working in a resource-driven boom community in the following way:

> We have a much higher call volume. More bar fights. A lot more alcohol-related calls. The city is growing and the number of officers is not. We need to hire more people. Now we have to cover more area. They just recently expanded the city limits, which also means that there is more to cover for the officers with the same number of officers working here. That does not seem to work out well for us. (Archebold et al., 2016, p. 60)

Police officers have also reported that they had to change the way that they respond to calls for service due to the increased demand, as calls had to be prioritized based on the perceived level of seriousness (Archbold et al., 2014). Likewise, Taft (1981) reported that law enforcement in nearly every energy boomtown reported tremendous growth in criminal activity after the energy industry moved into the Mountain West region.

The North Dakota State and Local Intelligence Center (NDSLIC) explored the impact of population growth on law enforcement in the Williston Basin Region (BBC Research and Consulting, 2013). The local police departments were significantly impacted by the social changes due to the increased calls for service and a greater number of index crimes (known Part I crimes). Simply put, the officers were having difficulty keeping up with the increased pace of criminal activity (BBC Research and Consulting, 2013). Using data from the Uniform Crime Reporting (UCR) Program, researchers discovered that the known Part I violent index crimes increased in the Williston Basin region by 121% between 2005 and 2012, and during this same period, the population increased by 98% (BBC Research and Consulting, 2013). Thus, boomtown communities are conducive for motivated offenders who have a wide range of suitable targets due to the large population influx and the absence or lack of capable guardians (i.e., police officers).

Summary of Social Change as an Impact Factor for Crime

Ultimately, community leaders experiencing a boom face the dilemma of encouraging economic growth in a way that the benefits offset any associated increase(s) in crime and other ill effects. In this way, social change can be considered a mixed bag of gains where any economic benefits are balanced by an increase in social disorganization and criminal activity. This population growth and crime calculation is significant to this study since the operations of extractive industries can expand quickly and may end just as quickly. Both sides of this equation (boom versus bust) may lead to community disorganization and crime. In short, social change is an established causal factor to crime (Burgess 1925, Park & Burgess, 1921; Shaw & McKay, 1969; Thomas & Znecki, 1920) and serves as an important foundation for this study.

Other Important Characteristics/Variables to Explain Crime

Thus far, several theories have been described that consider various environmental and structural factors, representing social change, that may influence criminal activity. ONG active counties, however, also offer additional population composition characteristics that may also contribute to changes in crime rates, especially gender and age composition. Oilfield workers are overwhelmingly younger males, working long hours, and many are non-residents who immigrate to the boomtown or commute from their home communities (Carrington, Hogg, & McIntosh, 2011; Goldenberg, Shoveller, Koehoorn & Ostry, 2010; Petkova et al. 2009; Price, 2015; Zhengyu et al., 2019).

Gender as a Correlate of Crime. Extractive industries are male dominated. Male beliefs, attitudes, characteristics, and values are reflected throughout the oilfield and mining subcultures (Akers, 1990; Martin & Collinson, 2002). Several elements of this work reproduce conventional hegemonic masculine characteristics. First, the industry's long hours, shift work, physically demanding labor, and transience perpetuate conventional masculine norms (Collinson, 1999). The working conditions are grueling and serve to reinforce an employee's masculinity, and workers are exposed to the elements, and fatigue from physical exertion and rotation shifts elevate the risks of injury and death (Barnes et al., 1998; Bjortatn et al., 1999; Bjortatn et al., 2006; Gibbs et al., 2002; Harvey, 1990). Furthermore, research has shown that some professions that have male majority populations reward specific destructive characteristics, including risk-taking behavior, engaging in violent assaults (Barber, 2003; Griskevicius, Tybur, Ackerman, Delton, Robertson, & White, 2012), and high rates of alcohol consumption and alcohol-related offenses (Measy, Li, Parker, & Wang, 2006).

One self-proclaimed "rough neck," Christian Wallace (2015), explained the male persona in the oilfield the following way,

> The fashion may have changed, but the work is as filthy today as it was decades ago. Getting soaked with oil or blasted with mud is inevitable. There's grease on everything, including us (there's a reason we call the FR clothes "greasers"). Pipe dope, a thick, grey goop used to lubricate and seal threaded connections on pipes and flanges, gets everywhere. You are constantly sweating, no matter the temperature. Some companies provide laundry services, but many don't. A regular washing machine will be ruined after a few loads, so once every couple weeks you find yourself at the laundromat looking for a washer designated "GREASERS ONLY" …. The first safety lesson I learned on the rig was profoundly simple: "Never stick your hand where you wouldn't stick your dick. (para. 17)

The predominance of men, rigorous labor, and working conditions perpetuate a hegemonic "roughneck" masculine structure within the ONG industry, a profile associated with higher crime rates (Messerschmidt, 1997). For this reason, the present study includes gender composition as a possible correlate of criminal activity in Texas counties.

Age as a Correlate of Crime. ONG workers are typically between the ages of 25 to 40 years (DataUSA, 2019). Most of the "hands on" positions that require employees to be onsite performing manual labor are dominated by employees less than 35 years of age (DataUSA 2019). Does an increase in the number of residents between 25 and 35 reflect an increased likelihood for criminal activity to occur? One of the most cited criminological facts is the age-crime profile, Criminal activity typically increases in the teenage years and peaks around 19 or 20, and then gradually decreases (Bindler & Hjalmarsson, 2017). This age-crime curve is often attributed to the fact that as a person ages, they gain more things of value that they are reluctant to lose, including jobs, family, and social respect (Bindler et al., 2017). In short, the older we get, the more we have to lose, and as a result, the less likely we are to engage in crime. This is an important theme for boomtown communities that experience an influx of young male employees who are characteristically unmarried, between the ages of 25 and 35, and have no ties or little stake in their new community. Because of this, the present study also examines age composition as a possible explanation for criminal activity in Texas counties.

Current Study

Crime at the community level is multi-layered in nature. Consequently, this study examines the effect of ONG activity on known Part I offense rates in Texas counties in three distinctive ways. First, this study examines ONG activity exclusively in Texas. Second, this study does not designate boom or bust periods, nor does it provide boom indicators; instead, this study utilizes residual-change scores that reflect social changes in

ONG counties over time. Third, whereas previous studies have relied almost exclusively on social disorganization theory, this study includes a broader range of variables that are theoretically informed. Each of these features will be discussed in turn.

There is a distinct advantage in focusing exclusively on Texas. While there has been a large amount of scholarship devoted to boomtowns in Canada, North Dakota, and Pennsylvania, there has been very little research devoted to Texas boomtowns. This is a particularly glaring gap in the literature, because Texas has over 100 years of ONG extraction activity and in 2018, produced over 40% of the nation's oil (Parietti, 2019). Consequently, this study examines the impact of ONG production exclusively on Texas county levels of known Part I crime rates.

Second, this is the only study to date to use residual-change scores to assess ONG activity's effect on known Part I offenses, while considering social change factors. Following Bursik and Webb (1982) and Chamlin (1989a; 1989b), residual change scores were used to estimate change in the levels of the known Part I property and violent offense rates in 2009 and 2019. Residual change scores allow a thorough evaluation of the influences of ongoing social dynamics and the unexpected changes in Texas counties on the change in the level of known Part I offense rates. In short, residual change scores provide insight as to whether ONG activity does in fact, affect the rate of known Part I offense rates in Texas counties.

Finally, this study assesses a broad range of variables that were theoretically informed to explore the impact of ONG activity on known Part I offense rates in Texas counties. This is to say the main objective will be to explain variance in the type of known Part I offenses at the macro level (in ONG producing Texas counties), as opposed to explaining individual criminal acts. Prior studies almost exclusively relied on SDT when assessing the connection between ONG and crime (Stretesky & Grimmer, 2020; see Berger & Beckmann, 2010; Deller and Schreiber, 2012; Gorley & Madonia, 2017; Luthra et al., 2007; Ruddell et al., 2014; Stretesky et al., 2018). This study, however, utilizes variables from multiple theories for purposes of this research, including RAT, SDT, and Durkheim's anomie, as well as known gender and age composition correlates of crime rates.

Previous Research Linking Boomtowns to Crime

Previous research exploring the link between ONG activity and crime share similar methodological problems. Remarkably, there is no consensus in boomtown research on when ONG booms begin and when they end. Researchers have used assorted measures to define boom periods, yet each approach exhibits methodological shortcomings. For example, previous research has used annual oil production totals (Ruddell, Dheeshana, Jayasundara & Mayzer, 2014), population changes (Archbold, 2006; Freudenberg & Jones, 1991; Malamud, 2014), and ONG well density (Rhubart et al., 2019) to gauge ONG boom periods. These approaches, however, have serious limitations that fail to accurately assess boom and bust periods. These shortcomings are examined in turn.

To begin, researchers relying on annual oil production totals as a proxy for the start of a boom typically omit natural gas totals and historical trends within the community at issue. For example, Ruddell et al. (2014) classified 26 communities as "boom" counties when they produced, between 2006 and 2012, over 20,000 barrels of oil annually. The authors hypothesized that smaller oil production equated to less criminal activity than larger amounts of oil production. This approach, however, ignores the fact that some counties may have consistent annual oil production totals that support a more stable and permanent workforce. For example, if a county produces less than 20,000 barrels of oil every year for 20 years, this will indicate a reliable workforce that is more likely to be invested in the community, as opposed to temporarily residing in it. This, in turn, supports the argument that those workers will have stronger ties to the community (i.e., family, friends, community groups, work) that deter them from engaging in crime.[12] Likewise, some Texas counties may produce less than 20,000 barrels of oil annually yet may produce a significant annual amount of natural gas. Omitting natural gas from boom-period designations overlooks the fact that natural gas production is just as labor intensive (if not more) than oil extraction. Thus, historical trends in ONG production in addition to annual totals of both oil and natural gas, are important indicators for boomtown research that this study takes into account.

Furthermore, some studies have assessed boom and bust periods by the number of oil wells drilled within a geographic region. Rhubart et al. (2019) used the number of wells drilled per 100 square miles per year as an indicator of ONG activity. The well density was assigned to one of three categories: the first included counties with a well density of 0, the second category was for counties in the lower 50th percentile of well density and the third was reserved for counties in the upper 50th percentile of well density among those counties with any drilling (Rhubart et al., 2019). One issue with such an approach is that not every well produces every time it is drilled. Further, relying only on well count does not take into consideration when the well was initially drilled/built. The Pennsylvania Department of Environmental Protection (DEP) reports the number of wells per square mile, but this report can be further refined through numerous filters, including

[12] Twenty thousand barrels is equivalent to approximately 100 semitruck loads of oil annually or about two trucks per week.

whether the well is active, plugged, proposed but never materialized, or abandoned (DEP, 2021). The Rhubart et al. (2019) study does not take these characteristics into account. An area may have a large number of reported wells, but the presence of a well is not always consistent with its ability to produce, an important feature to take into account when measuring oil and natural gas activity. Los Angeles, for example, reports over 5,000 wells within its city limits, yet only about one thousand are active (Galperin, 2018). Thus, relying on the density of oil wells does not take into account the production status of a well, which may be inactive, orphaned, or non-producing, indicating a lack of ONG activity/labor.

Previous research has also relied on population totals to indicate when a boom period begins. Researchers who rely on annual population totals, however, overlook key characteristics of ONG-producing communities. For example, oilfield workers are often transient and temporarily migrate to these places with no intent to remain permanently (ELI, 2014). Many ONG workers opt to move to the community for a short time while others commute long distances daily (ELI 2014). This latter type of ONG employee who commutes to the job sites either daily and/or weekly is referred to as a "DIDO" (drive-in and drive-out) worker; likewise, these employees may also commute by plane and are referred to as "FIFO (fly-in and fly-out) workers (Ruddell et al., 2014). If, however, these workers do live in the community, they typically live in "man camps," which are temporary housing units that are intended for short-term residency (ELI, 2014; Feneer, 2016). U.S. Census records, as a result, may be unable to capture what has been described as a "shadow population" (O'Connor, 2015). Additionally, the percentage increase in population may ignore the fact that even a small increase may have tremendous consequences. Specifically, given that rapid growth often occurs in sparsely populated rural communities and/or remote locations, these places may be less adaptable than larger cities to accommodate the population increase (Freudenberg & Jones, 1991).

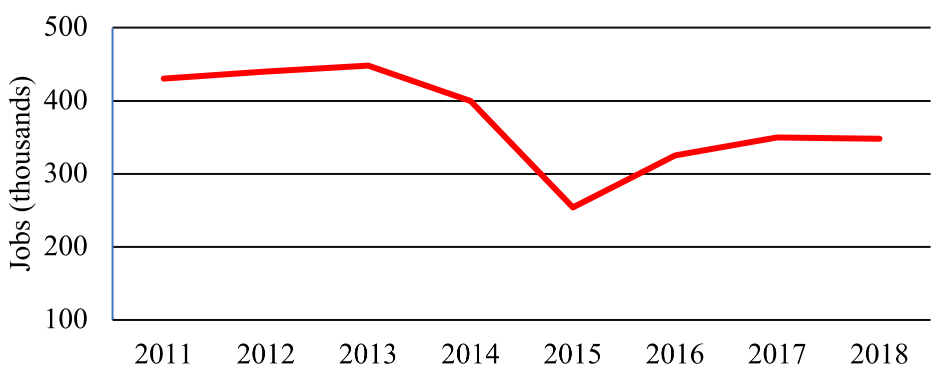
An additional limitation in prior boomtown research is the small sample sizes used for analyses. Most early quantitative boomtown studies included less than 30 communities/counties (Luthra, Bankston, Kalich, & Forsyth, 2007; O'Connor, 2017; Park & Stokowski, 2009). For example, O'Connor (2017) evaluated 17 oil-producing counties, calculating the average violent crime rate, property crime rate, disorder rate, and law enforcement rate for two time periods (1999-2005; 2006-2012), limiting the confidence in what does or does not cause crime in a pre-and post-boom community. Sample size insufficiency is seen as a threat to validity and generalizability of study results (Hackshaw, 2008). If the sample size is too small, it may result in a Type II error, which rejects the null hypothesis (there is no relationship between the cause and effect), when in fact, the opposite is true: the cause does result in the effect (Hackshaw, 2008). Studies carried out after 2010 have typically examined a larger number of counties (see Stretsky & Grimmer, 2020).

ONG activity has a predictable ebb and flow; every boom will ultimately result in a bust. Changing crime patterns within communities experiencing this cycle must be understood as occurring in a larger context. Specifically, change in ONG activity is not the only characteristic within a community experiencing change. Change may also occur within other community characteristics, including law enforcement strength, percent of renter-occupied homes, rate of males 25 to 35 years of age, rate of males 25 and older without a high school diploma, rate of liquor licenses, and rate of males employed in ONG. While this study assesses change in ONG activity, it is assessed within the broader context of social change.

Potential Contributions of This Research

The focus of this study is specific to one persistent and for the most part, unanswered question regarding the possible related social changes that have occurred with the boom and busts of the ONG industry: what, if any, has been its influence on crime? Much of the evidence to date suggests there is a connection between ONG development and crime; however, little specific attention has been directed at Texas. As previously discussed, this is a glaring oversight within boomtown literature. Focusing exclusively on Texas is now, more than ever, paramount in importance due to two events currently on the Texas ONG horizon. First, the United States Geological Service (USGS) announced in 2016 the discovery of the Wolfcamp shale formation, which two years later revealed the largest estimate of continuous oil and natural gas deposits ever assessed in the United States (Cohen, 2018). This discovery represents a more than 100% and 65% increase in U.S. oil and gas reserves, respectively, that can be extracted (Cohen, 2018). Second, the ONG industry is recovering from one of the lowest oil valuations in U.S. history as a result of the Coronavirus (Covid-19) and an oversupply of oil. According to IHS Market (2021), oil prices sank to their lowest level in history, dropping into negative pricing as oil supplies overwhelmed the globe's storage capacity (Beitsch, 2020). There was a buildup of the oil supply from 800 million to 1.3 billion barrels in just the first six months of 2020 alone (Kelly, 2020). This buildup resulted from mandated isolation, which prohibits residents from traveling to and from work, which accounts for $67 billion in natural gasoline purchases (Conca, 2020). The widespread quarantines led to declines in traffic of nearly 53% in almost every metro area and, in some areas, traffic levels dropped by at least 75% within less than one year (Tomer & Fishbane, 2021). This is critical for the ONG industry as shrinking demand leads to lower prices and, consequently, less incentive for companies to continue drilling (ONG Vision, 2020). Ryan Sitton, a Texas oil regulator, confirmed that tens of thousands of people in Texas were being laid off as drilling rigs shut down (see Figure 6) (Wethe, 2020). The number of ONG workers has, in fact, decreased by more than 30% since 2015, the peak of the most recent ONG boom. Companies are firing employees daily; the drilling-service company Canary LLC, for example, let go 43 workers in one week, and oilfield pipe-maker Tenaris SA fired 223 in one day from its Houston area facility (Wethe, 2020). Drilling giant Haliburton Co. furloughed 3,500 workers at its Houston headquarters (Wethe, 2020). ONG companies are forecast to lose over 40% of their annual earnings as a result of the pandemic (Wethe, 2020).

Table 6. The number of employed ONG workers from 2010-2019 in the U.S.



Note. Adapted from Bloomberg (2020).

The pandemic is resulting in one of the starkest resource-based bust periods in recent history. Dan Eberhart, chief executive officer of Canary, LLC, one of the largest providers of oilfield services in the country recently declared, “There’s definitely blood in the water” (Wethe, 2020, n.p.). The pandemic may be temporary; however, the crisis within ONG may result in some permanent consequences.

This study assesses the extent to which change in ONG activity affects changes in violent and property crime rates (2009 to 2019) among all Texas counties (211 ONG producing and 34 non-ONG-producing) while considering social change factors. Although valuable, such identification offers Texas communities the ability to prepare proactively as opposed to reactively to ONG activity, allowing for better social and legal interventions. Efforts to improve a community's ability to handle new industry activity and growth are especially imperative considering the current bust and forthcoming boom period. As history reflects, busts, like booms, do not last forever; as such, preparing for an oncoming boom and impending bust is vital for communities to withstand social growth caused by ONG development.

IV. METHODS

This chapter contains a discussion of the research questions and the methods for this study, including a description of the population, datasets combined, and construction of the variables. The main independent variable in this study includes indicator variables of ONG activity—such as the amount of oil produced annually, amount of natural gas produced annually, and the number of annual drilling permits. There are two dependent variables: the change in known Part I offenses for violent crime and the change in known Part I offenses for property crimes. Third, indicators of social change and other control variables are discussed. Finally, the analytical strategy is explained. The results of the analysis are presented in Chapter V, followed by the discussion and conclusion in Chapter VI.

Research Questions

This study assesses the following two research questions: (1) To what extent does change in ONG activity affect changes in violent crime rates (2009 to 2019) across Texas counties (211 ONG producing and 34 non-ONG-producing), while considering social change factors?; and (2) To what extent does change in ONG activity affect changes in property crime rates (2009 to 2019) across Texas counties (211 ONG producing and 34 non-ONG-producing), while considering social change factors?

Description of the Population

The population of this study includes 96% of Texas ($n = 245$)[13] counties to determine the extent that ONG activity affects the changes in known Part I offenses. Although other studies typically compare ONG with non-ONG units of analysis (Gourley

[13] Nine counties (4%) were omitted from the sample because they were outliers and needed to be removed in order to employ multiple regression.

& Madonia, 2017; Kamarek, 2018; O'Connor, 2017; Rhubart & Brasier, 2019; Ruddell, 2014), Texas does not have enough non-ONG-producing counties to allows such comparison. Instead, two time periods (2009 and 2019) are compared to assess the effects of ONG production on Texas county-level known Part I crime rates. The years 2009 and 2019 were chosen for two reasons. First, using two years with a ten-year gap, is in line with Bursik and Webb (1982), Bursik (1986), and Chamlin (1989a, 1989b), who used the level of a variable at time t and regressed it on its own level at time t_{-10}. This equation is then used to predict the level for each county at time t. Secondly, these two time periods were chosen because there were substantial changes associated with ONG during these two eras (see Tables 1 – 4). In 2009, for example, the price of oil soared to $145.31, the biggest valuation boom recorded to date (McNally, 2017). This boom was followed by a 70% drop in oil prices in 2016, leading to an oil valuation market crash (Stocker et al., 2018). Therefore, these two time periods correspond to a period reflecting ONG activity affect that may reflect change in violent and/or property crime rates across Texas counties.

Dataset Construction

This study combines county-level data from six sources: (1) The American Community Survey (ACS) (2) the small-area income and poverty estimates (SAIPE), (3) the Railroad Commission of Texas (RRCT), (4) the Texas Department of Public Safety's (TDPS) UCR reporting for known Part I crime counts, (5) the Texas Commission on Law Enforcement (TCLE), and (6) the Texas Alcoholic Beverage Commission (TABC). All the sources are publicly available and accessible, except for the TCLE. These data were requested and received via a Freedom of Information Act request.

The dataset is constructed in such a way as to facilitate analysis of concomitant variation in crime patterns within the 245 Texas counties. The dataset is constructed as a wide file. In the classic wide format, a subject's repeated responses are presented in a single row, and each response is in a separate column. Consequently, there are 245 rows, each representing a single county in Texas (*n* = 245).

The dataset includes county-level information for two years, 2009 and 2019, for each included county in Texas (*n* = 245) for the following variables: population size, percent non-Hispanic Black, percent Hispanic, percent of males with less than a high school education, law enforcement strength, active liquor license rate, poverty rate, percent renter-occupied homes, percent males employed in ONG, total oil produced, total natural gas produced, total drilling permits, the annual rate of known Part I violent offenses and the annual rate of known Part I property offenses. Rates are measured as the total number per 10,000 population. The sources and measurement for each of these variables are discussed below. I first explain in detail how the static variables are measured, and then describe the procedure for transforming these static variables into their dynamic counterparts to measure change.

Measurement of Static Dependent Variables: Known Part I Offenses

Uniform Crime Reporting Data. This study assesses whether ONG activity affects the number of known Part I violent and property crime rates in Texas. As such, the "offenses known" data from the TDPS Index Crime Report from 2009 and 2019 are analyzed. These data come from the crime data submitted by local law enforcement departments throughout Texas to the TDPS for the FBI's UCR Program. The UCR Program was established in 1930 to provide crime statistics for national comparisons. Throughout the years, the UCR developed into a broad utility for summary-based reporting of crimes, offering the means to measure the level and scope of crime occurring throughout the nation. Participating law enforcement agencies submit information on the number of Part I crime counts that become known to them each year (UCR, 2012). County-level data for all Texas counties are available for the periods of interest, 2009 and 2019. The TDPS provides crime counts for all the following Part I offenses[14]: criminal homicide, forcible rape, robbery, aggravated assault, burglary (breaking or entering), larceny, arson, and motor vehicle theft.[15] For this analysis, the following known Part I offenses were collapsed to create a count of the "Part I Violent Crimes": murder, rape, robbery, and aggravated assault. The remaining crimes, including burglary, larceny, and motor vehicle theft, were combined to create the variable "Part I Property Crimes." The seven Part I reported offenses are measured as rates, the total number of offenses per 10,000 population.

Measurement of Static Independent Variables

The independent variables included in this study measure two broad concepts: (1) indicators of ONG activity and (2) indicators associated with social change. Table 7 presents the variables used to measure these concepts.

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[14] The UCR's definitions for known Part I offenses resulting in arrest are provided in Appendices C and D.

[15] Arson is excluded from the measure of crime rates because this category represents a small number of offenses. Additionally, previous research (Jackson, 1988) raises serious doubts about the validity of UCRs arson data.

Table 7. Description of concepts, associated variables, and data source for all the independent variables

Concept	Independent variables for each county (Annual)	References relied upon for this variable
Social change	County population	Wilkinson et al. (1984); Krannich et al. (1985); Jobes (1999); Park & Stokowski (2009); Ruddell (2011); Ruddell et al. (2014); Jones (2016)
	Law enforcement strength rate	Park & Stokowski (2009); Ruddell (2011); O'Connor (2017)
	Percent non-Hispanic Black population	Seydlitz et al. (1993); Genareo &Filteau (2016); Scott et al. (2012); Huynh et al. (2019)
	Percent Hispanic population	Kent & Jacobs, 2005; Nadel, Pesta, Blomberg, & Bales, 2021; Pedroza, 2019
	Percent of those living at or below the poverty level	O'Connor (2017); Schafft, McHenry-Sorber, Hall, & Rochford (2018); Murphy, Brannstrom, Fry, & Ewers (2018)
	Percent of males 25 years or older with less than a high school education	Freudenberg (1984); Schafft et al. (2014); O'Connor (2017)
	Rate of active liquor licenses	Lantz & Halpern (1982); Geisbrecht & McKenzie (2009)
	Percent renter-occupied homes	O'Connor (2017); Carter, Louderback, Vildosola, & Roy (2020)
Oil and/or natural gas (ONG)	Total amount (count) of annual oil and/or natural gas drilling permits.	Brown, Fossum, Hecht, Dorrington, & McBroom (2013); Mauro, Wood, Mattingly, Price, Herzenberg, & Ward (2013)
ONG activity boom indicators	Annual volume of oil drilled/produced	Brown, Fossum, Hecht, Dorrington, & McBroom (2013); Mauro, Wood, Mattingly, Price, Herzenberg, & Ward (2013); Ruddell (2014)
	Annual volume of natural gas drilled/produced	Brown, Fossum, Hecht, Dorrington, & McBroom (2013); Mauro, Wood, Mattingly, Price, Herzenberg, & Ward (2013); Ruddell (2014)

Oil and Natural Gas Activity Indicators

Given the size of Texas, it stands to reason that the ONG-producing counties do not experience a natural resource-based boom and bust period at the same time (see generally: O'Connor, 2017, Ruddell, 2011; Ruddell et al., 2014; Ruddell & Ortiz, 2015). Rather, the boom periods occur with a different intensity and duration throughout the state. Thus, ONG production should not be measured at a single cut-off point applied to every county. Consequently, to determine the level of ONG activity within Texas counties (n = 245), two separate years, 2009 and 2019, are used. These years were selected because they capture the highest oil valuation (2009) and the lowest oil valuation (2016) ever recorded in Texas (Stocker, et al., 2018). In short, these years were selected because they contain a boom-and-bust period that occurred in Texas.

ONG Activity. The annual ONG activity totals from January 1, 2009 – December 31, 2009, and January 1, 2019 – December 31, 2019, are obtained from the TRRC. The variable "annual volume of ONG produced" has been used in previous studies assessing the relationship between resource extraction and crime (Brown, Fossum, Hecht, Dorrington, & McBroom, 2013; Mauro, Wood, Mattingly, Price, Herzenberg, & Ward, 2013). The annual totals are reported in terms of volume expressed in 42-gallon barrels (American ONG Society, 2016). Natural gas is reported in terms of 1,000 cubic feet, which is abbreviated as MCF[16] (Chen, 2019). To provide some context, if a natural gas well produces 400 MCF of natural gas per day, it has a daily production rate of 400,000 cubic feet (Chen, 2019). The annual amount of ONG produced may reflect whether a

[16] The letter M represents the roman numeral M, which stands for 1,000, while CF is an abbreviation for per cubic feet.

county is experiencing an increase in ONG activity; the more ONG produced, the more associated ONG workers present in the county.

ONG-drilling permits. The number of annual ONG-drilling applications was obtained from 2009 and 2019 for every county. The variable *annual number of drilling permits* has been included in previous studies assessing the relationship between industrialization and crime (Brown, Fossum, Hecht, Dorrington, & McBroom, 2013; Mauro, Wood, Mattingly, Price, Herzenberg, & Ward, 2013). The ONG-drilling data are also retrieved from the TRRC.

Social Change Variables

ACS Data. One of the sources of data used for this study is the ACS pooled five-year estimate data from 2009 (2005-2009) and 2019 (2015-2019). The U.S. Census Bureau (U.S. Bureau), since 2005, has conducted the ACS, which replaced the long form decennial census that was previously conducted since 1790 (U.S. Census Bureau, 2020). By 2010, the ACS completely replaced the decennial census long-form survey (Macdonald, 2006). The long-form census survey that was used before the ACS asked sampled households detailed information including marital status, educational attainment, racial and ethnic background, income, employment status, and home and vehicle information (i.e., number of rooms in home and availability of a vehicle) (U.S. Census Bureau, 2000). The ACS has expanded upon the original decennial census long form, measuring the changing social and economic characteristics of the U.S. population, including sex, race and ethnicity, veteran status, educational attainment, marital status, parental status, income, employment, state of residence, urban/rural residence, language ability, migration, disability, and housing characteristics (U.S. Census Bureau, 2020).

These individual-level variables are assessed by the ACS as estimates, which are based on data collected over a period of time (U.S. Census Bureau, 2020). This is an important feature given that a primary shortcoming of the Census decennial survey was that one had to wait a decade for updated demographic information. The ACS addressed this weakness, implementing a rolling sample design with repeated surveys on non-overlapping groups with smaller samples sizes, generating estimates over multiple years (U.S. Census Bureau, 2020). In this manner, the ACS divides the sample sizes over months or years to increase the number of surveys, as opposed to increasing the number of surveys within a single year. Accumulation of monthly survey data reduces the cost and enables the calculation of estimates on a yearly basis. Multiyear pooled survey data is, therefore, used for annual estimates (Jung, Thill, & Issel, 2019).

This approach is particularly beneficial when confronted with small geographic units, where having a sufficient sample size can be a challenge. For example, if a geographic unit has a population under 20,000, five-year pooled survey data can be used, overcoming the decennial's inability to provide more current annual data (Jung et al., 2019). Thus, the primary advantage of using multiyear estimates is the increased statistical reliability of the data for less populated areas and small population subgroups (U.S. Census, 2020). The following variables are presented below and were obtained through the ACS unless otherwise noted.

Law Enforcement Strength. The police strength data were obtained through TCLE. Police strength is an indicator of social disorganization as specified in Shaw and McKay's social disorganization theory, as well as an indicator of guardianship as specified in Cohen and Felson's routine activity theory. This variable has been relied upon in previous studies assessing the relationship between social change and crime

(O’Connor, 2017; Park & Stokowski, 2009; Ruddell, 2011). Some scholars argue that rapid population growth overwhelms law enforcement, who become unable to address and/or respond to calls for service, which ultimately results in increased criminal activity (Ruddell, 2011). Thus, law enforcement strength was measured as a rate, with the total number of full-time law enforcement employees in the county as the numerator, divided by the county total population, multiplied by 10,000.

County Population. The annual Texas county population data were obtained through the ACS pooled five-year estimate data from 2009 (2005-2009) and 2019 (2015-2019). The annual population has been relied upon in numerous studies that assess the relationship between social change and crime (Jones, 2016; Krannich, Geider, & Little, 1985; Jobes, 1999; Park & Stokowski, 2009; Ruddell, 2011; Ruddell et al., 2014; Wilkinson, Reynolds, Thompson, & Ostrech, 1984).

Percent Non-Hispanic Black. The annual Black population within each included Texas county (*n* = 245) is an indicator of social change. Previous studies have examined the Black population variable as a percentage when evaluating adverse criminal justice outcomes (Padgaonkar, Dapretto, Galvan, Frick, Steinbergm, & Cauffman, 2020; Sampson, 1987). According to social disorganization theory, a significant change in the minority racial/ethnic composition can contribute to adverse outcomes, including unfavorable social circumstances (Sampson & Wilson, 1995; Shaw & McKay, 1969). Furthermore, those who are most disadvantaged in the United States are typically Black, and studies indicate they are more likely than other races to be treated harshly by criminal justice officials (D’Alessio & Stolzenberg, 2003; Kamalu, 2016; Ousey & Lee, 2008; Ridgeway, 2006; Spohn, 2013). This variable was constructed using the count of individuals identifying as non-Hispanic Black as the numerator and the county total population as the denominator.

Percent Hispanic. The annual Hispanic population within each included Texas county (*n* = 245) is an indicator of social change. Hispanics are now the largest ethnic minority group in the United States, and recent studies suggest that percent Hispanic influences arrest rates (Nadel, Pesta, Blomberg, & Bales, 2021; Pedroza, 2019). Further, recent studies reveal that as the percent of the Hispanic population increases, so too does law enforcement strength (Kent & Jacobs, 2005). These findings may reflect the increased threat perception Hispanic represent to law enforcement and the populations that mobilize this resource of social control (Kent & Jacobs, 2005). This variable used the count of individuals identifying as Hispanic as the numerator and the county total population as the denominator.

Rate of those Living at or Below the Poverty Level. The rate of county residents living at or below the poverty level is collected from SAIPE. The SAIPE is a program under the U.S. Census Bureau providing annual estimates of income and poverty statistics for every county in the U.S. The SAIPE estimates a regression model predicting the number of people in poverty using single-year county-level observations from the ACS as the dependent variable and administrative records and census data as the predictors (U.S. Census, 2020).[17] The proportion of residents living at or below the poverty line has been relied upon in previous studies assessing the relationship between social change and crime (Murphy, Brannstrom, Fry, & Ewers, 2018; O'Connor, 2017;

[17] A single ACS sample estimate is used for every county, even those below 65,000 population for which the ACS data are unpublished (U.S. Census, 2020). Single year estimates are used for all counties in order to maintain model comparison uniformity (U.S. Census, 2020).

Schafft, McHenry-Sorber, Hall, & Rochford, 2018). The poverty rate was measured as the total number of those at or below the poverty level within a county per 10,000 population.

Percent of Male with Less than a High School Education. The rate of men 25 years of age and older, who had less than a ninth-grade education is also a predictor for criminal activity. Previous studies have relied upon this variable to assess the relationship between social change and crime (Freudenberg, 1984; O'Connor, 2017; Schafft, Glenna, Green, & Borlu, 2014). For purposes of this study, these data were used to provide contextual, county-level data related to social disorganization theory. The percent of male residents 25 years of age and older without a high school diploma was measured as the total number of males 25 years of age and older without a high school education within the county, divided by the annual county population of males 25 years of age and older.

Percent of Renter-Occupied Homes. The percent of renter-occupied homes within a county is also a predictor for criminal activity. The percent of renter-occupied homes variable has been specifically relied upon in previous studies assessing the relationship between routine activity theory, social disorganization theory and crime (Carter, Louderback, Vildosola, & Roy 2020; O'Connor, 2017; Ruddell, 2011). The percent of renter-occupied homes is a demographic community factor affecting the spatial pattern of crime; specifically, an area with a high rate of residents who rent their home is associated with higher rates of crime (Carter et al., 2020). For purposes of this study, percent renter-occupied homes is operationalized as the total number of housing units that are counted as rental properties divided by the total number of housing units in the county.

Percent of Males Employed in ONG. The rate of males employed in the ONG industry may be an indicator of social change and social disorganization within a community. The measure "Natural resources, construction, and maintenance occupations" was pulled from the ACS and further refined to only include only males. Notably, this measure includes oil and gas extraction (Data USA, 2021). Males employed in the ONG industry typically reflect a transient population, traditionally lacking commitment to their host community (O'Connor, 2017; Ruddell, 2011). Carrington et al. (2011) suggests that young males employed in extraction may commute to work or live in work camps, hotels, or short-term accommodation near extraction sites and are often isolated from their families and friends who may serve to attenuate their criminal activity and/or deviancy. Consequently, a community with a large rate of males working within ONG may similarly reflect significant social changes within a community, which ultimately reveals a breakdown in social cohesion, an indicator of social disorganization (see Bursik & Grasmick, 1993). This variable was measured as the number of males 25-35 years of age employed in ONG divided by the total count of males 25-35 years of age in the county population.

County Rate of Active Liquor Licenses. The county rate of active liquor licenses is an indicator of social disorganization as well as routine activities theory. The liquor license rate was measured as the total number of active liquor licenses within a county per 10,000 population. The variable, "annual number of active liquor licenses," has been relied upon in previous studies assessing the relationship between social change and crime (Felson et al., 2018; Geisbrecht & McKenzie, 2009; Lantz & Halpern, 1982). The liquor license totals were obtained and converted into rates for each Texas county for

2009 and 2019, through the open-sourced Texas Alcohol and Beverage Commission (TABC) public inquiry system dataset.

Measurement of Dynamic Variables: Residual Change Scores

The focus of this study is change, specifically, whether changes in ONG activity and other variables related to ongoing social change processes correlate with change in known Part I offenses in Texas counties (*n* = 245). Given that the emphasis is on the dynamics of each county's change, the operationalization of this concept is vital.

Change is operationalized through residual change scores. This is the best approach, given that residual change scores provide estimates of change in the level of variables over time (Bursik, 1986; Chamlin, 1989a; Chamlin, 1989b; Kisbu-Sakarya, MacKinnon, & Aiken, 2013). Residual change scores also allow for an evaluation of the *expected* changes in ONG activity within a county in relation to the unexpected changes in offense rates (i.e., the known Part I offenses). In particular, residual change scores remove the effects of ongoing processes of change that may be commonly experienced amongst all counties, allowing for a more focused analysis of the changes in variables of interest that are solely responsible for processes of change within counties (Chamlin, 1989). Residual change scores are obtained using the following formula:

$$y'(\text{X}2019) = \beta 0 + \beta X2009 + \epsilon$$

Coefficients are calculated not by subtracting the predicted Time 2 scores from the observed Time 1 scores, but rather by regressing the posttest scores of Time 2 onto the pretest scores of Time 1 and then saving the residuals as its own variable (Allison 1990; Paternoster et al., 1998). Thus, for purposes of this study, the residuals were first calculated based on the process of regressing each predictor variable measure for 2019 on each predictor variable measure for 2009 for nearly every county in Texas (*n* = 245). The residuals for each bivariate regression then constitute the new measure (i.e., the dynamic measure) for inclusion in the model predicting change in known Part I violent crime rates and the model predicting change in known Part I property crime rates.

Residual change scores have several advantages over difference scores. Several researchers, for example, have found residual change scores as the most appropriate method of measuring the change in constructs over time (Mattes & Roheger, 2020; Prochaska, Traub, 1967; Velicer, Nigg, & Prochaska, 2008), producing higher statistical power than other difference scores (Bohrnstedt, 1969; Castro-Schilo, 2018; Kisbu-Sakarya et al., 2013; Mattes & Roheger, 2020).

Difference scores are susceptible to ceiling and floor effects because of baseline imbalance (Jennings & Cribbie, 2016). Ceiling effects can cause underestimation of averages and standard deviations, weakening the validity and reliability of the measure (Jennings & Cribbie, 2016). Notably, when either a floor or ceiling effect is present, a negative correlation between the initial status and change can occur, decreasing the variance from the pre-test to post-test (Jennings & Cribbie, 2016).

Finally, difference scores, unlike residual change scores, have been criticized for potentially low reliability and correlation with the initial score (Kisbi-Sakarya et al., 2013). Given that the value of a difference score typically regresses to the average, the correlation between a Time 1 value and a difference score is frequently negative (Bursik, 1986). Second, residual change scores are preferred because the post-test change score excludes all variance that could have been linearly predicted from the pretest score (Allison, 1990). Accordingly, the coefficients will represent the change in the variable that is not expected at Time 1, allowing one to assess the influence of stability and change on the known Part I offenses (Bohrnstedt, 1969). Thus, residual change scores ultimately provide a better estimate than traditional methods of the relationship between a county's experience during ONG activity and its known Part I offenses outcome.

In order to estimate the impact of changes in ONG activity and other social changes on changes in criminal activity, the static measures of the dependent and independent variables described above were then transformed into dynamic measures of the same variables using residual change scores.[18]

Analytical Strategy

Descriptive statistics are initially used to explore the 245 individual ONG-producing Texas counties to specifically examine levels of the social change variables, annual ONG activity, and the annual number of known Part I crime counts in 2009 and 2019.

To assess the two research questions, several multiple linear regression models are employed. Given that the dependent and several of the independent variables are continuous, multiple linear regression is appropriate (Peng, Lee, & Ingersoll, 2002). Overall, this analysis is used to determine the level of significance for multiple continuous predictor variables related to social change on change in the known Part I violent and property offense rates. First, the static measure of the UCR Part I violent offense rate is regressed on the static measures of the 12 predictor variables, and likewise the static measure of the UCR Part I property offense rate is regressed on the static measures of the 12 predictor variables. Then, change in the UCR Part I violent offense rate is regressed on the static and dynamic measures of the 12 predictor variables, and

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[18] Notably, before residual change scores are calculated, static variables were examined for normality and transformed if needed using the approach that achieves the distribution most closely aligned with a normal distribution. Ultimately, the known Part I violent and property crime rates were transformed using natural log transformations.

finally, the change in UCR Part I property offense rate is regressed on the static and dynamic measures of the 12 predictor variables. The final multiple regression analyses disaggregate the violent and property rates by offense, and regress each offense rate (murder, rape, robbery, aggravated assault, burglary, larceny-theft, and motor vehicle theft rates) on static and dynamic ONG activity and social change predictor variables. Ultimately, running multiple linear regression will reflect whether there is a relationship between ONG activity in Texas counties and change in the known Part I offense rates, controlling for other social changes.

Multiple Linear Regression

The use of multiple linear regression serves three purposes: it allows the researcher to analyze the strength of the relationship between variables, predict effects, and forecast trends (Abdullah & Rahim, 2016). To analyze the variable relationship, multiple linear regression can be used to pinpoint the strength and magnitude of the effects that the independent variables have on the dependent variable. Effects can be predicted using multiple linear regression analysis, as the statistical method enables the researcher to quantify how much the dependent variables change when the independent variables are altered. Trends can be forecasted using multiple linear regression when the researcher explores projects that utilize hypothetical manipulation of the variables. The projection for purposes of this study may be that a county may anticipate higher violent crime rates when there is a change in the level of oil and/or natural gas production.

This research involves assessing the relationships that exist simultaneously between the static and dynamic influence of 12 predictor variables, and potentially exercise the ability to predict possible outcomes of either on the known Part I offense rates. The static and dynamic versions of the same variable are uncorrelated and therefore can be included in the same model without issues with multicollinearity.[19] The predictor variables include county population, percent non-Hispanic Black, percent Hispanic, percent males 25 years of age and older without a high school education, percent of males 25 to 35 employed in ONG, law enforcement strength, active liquor license rate, poverty rate, percent renter-occupied homes, total amount of oil produced, total amount of natural gas produced, and number of annual drilling permits.

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[19] Multicollinearity is not present due to the nature of residual change scores. Static measures an occurrence at one point in time, 2009. In contrast, dynamic measures the change between two points in time, while controlling for the initial static point (2009). The “change” part is not dependent on the “static” part; thus, collinearity is not present.

V. RESULTS

This study examines whether the observed change in ONG activity from 2009 to 2019 influences observed changes in violent and property crime rates among the counties in Texas, while considering social change factors. An overview of the counties, along with the known Part I violent and property crime rates is provided in this chapter. After examining the assumptions of multiple linear regression, the results of the regression models are presented.

Characteristics among Texas Counties

As noted by the Texas Department of Agriculture (2018) rural counties are those with a population of 150,000 or less. Regarding change from 2009 to 2019 (see Table 8), the average population among these counties in 2009 was 91,242 (n = 245), whereas the average population in 2019 was 106,119. The average increase from 2009 to 2019 among these counties, therefore, was 14,877 (n = 245).

The demographics and other characteristics of this population also changed from 2009 to 2019. For example, the population of Hispanics grew nearly five percent within 10 years, on average. Moreover, the average poverty rate from 2009 to 2019 decreased. In 2009 nearly 343 out of 10,000 Texas residents were living at or below the poverty level. In 2019, approximately 287 out of 10,000 Texas residents lived at or below the poverty level. The rate of active liquor licenses from 2009 to 2019, also substantially changed. In 2009, there was less than 1 liquor license per 10,000 Texas residents, in 2019 there was more than 2 liquor licenses per 10,000 Texas residents.

Though less dramatic, other changes occurred with regard to the other county characteristics. For example, the law enforcement strength rate from 2009 to 2019 decreased from 11 law enforcement officers per 10,000 Texas residents to approximately

10 law enforcement officers per 10,000 Texas residents. For comparative purposes, law enforcement agencies in the U.S. reported in 2009, an average of 29 fulltime law enforcement officers per 10,000 inhabitants (UCR, 2009). There were nearly 16 law enforcement officers per 10,000 residents in jurisdictions reporting between 50,000 to 100,000 residents (Maciag, 2014). Consequently, a less than average law enforcement strength rate exists in Texas. Also, the average percent of non-Hispanic Blacks decreased slightly from 2009 (14%) to 2019 (13%). The average percent of renter-occupied homes in 2009 and 2019, remained relatively stable (approximately 21%), as did the average percent of males 25 years of age and older without a high school diploma (3%).

Table 8. Characteristics of counties in Texas (*n* = 245)

County Characteristic	2009 Average ***(SD)***	2019 Average (***SD***)	2009 Minimum (Maximum)	2019 Minimum (Maximum)
Population	91,242 (329,938)	106,119 (388,542)	81 (3,950,999)	98 (4,646,630)
Percent non-Hispanic Black	13.55 (13.77)	12.77 (13.29)	0 (.680)	0 (.660)
Percent Hispanic	30.65 (23.07)	34.82 (23.05)	0 (.983)	0 (.991)
Percent renter-occupied homes	21.24 (6.80)	21.75 (7.71)	0 (46.1)	0 (46.7)
Percent of males 25-35 years of age employed in ONG	13.44 (76.41)	12.92 (66.72)	0 (31.10)	0 (25.36)
Percent of males 25 years of age and older without a high school diploma	3.10 (.632)	3.12 (.667)	0 (5.36)	0 (5.42)
Poverty rate	343.5 (157.3)	286.72 (123.1)	29.89 (994.15)	22.13 (708.58)
Law enforcement strength rate	10.65 (9.570)	9.63 (13.33)	1 (91.32)	1 (142.12)
Active liquor license rate	.6528 (.9651)	2.380 (2.544)	0 (7.21)	0 (18.16)

Note. Rates are based on per 10,000 persons.

In summary, from 2009 to 2019, the following changes occurred among the counties: increased population, an increase in the number of Hispanics, an increase in the rate of liquor licenses, lower overall poverty rate, fewer males 25 to 35 years of age employed in ONG, and fewer law enforcement officers. The rates of males over the age of 25 without a high school diploma and renter-occupied homes remained relatively stable.

Violent and Property Crime Changes among Counties in Texas

With regard to Part I violent crimes, the average rate from 2009 to 2019 increased generally (see Table 9). The rate increase in the known Part I violent crime rate, however, may be driven by the rate of rape and aggravated assault. In 2009 the rate of rape was 2.74 (*SD* = 2.72) and in 2019 increased to 3.4 (*SD* = 3.11). This increase in the rate of rape is likely attributable to the 2013 revision of the UCR rape definition. Previously, offense data for forcible rape was collected under the legacy UCR definition, which identified rape as "the carnal knowledge of a female forcibly and against her will" (UCR, 2019). In 2013, the term "forcible" was replaced with "a lack of consent" from the offense definition. Also, the definition change included a gender-neutral approach, thus, including a wider range of acts committed by persons of any sex or gender (UCR, 2019). Also notable, murder was the least committed violent crime in both 2009 and 2019, whereas aggravated assault was the most committed violent offense in 2009 and 2019.

The average rate of Part I property crimes from 2009 to 2019 generally decreased (see Table 5). The disaggregated offenses for Part I property offenses reveal this decrease is particularly driven by the levels of larceny-theft. In 2009 the rate of larceny-theft was 142.35 (*SD* = 101.2) and in 2019 decreased to 83.20 (*SD* = 68.10). Also notable, burglary represents the most committed property offense for both 2009 and 2019, and motor vehicle theft represents the least commonly committed property offense for both 2009 and 2019.

Table 9. Descriptive statistics in 2009 and 2019 of Texas county Part I offenses (*n* = 245)

UCR Crimes Rates	2009 Average (*SD*)	2019 Average (*SD*)	2009 Minimum (Maximum)	2019 Minimum (Maximum)
Part I violent crime	21.42 (19.231)	23.47 (18.713)	0 (119.43)	0 (123.53)
Murder	.3928 (.6852)	.3026 (.5905)	0 (6.00)	0 (5.98)
Rape	2.737 (2.716)	3.480 (3.114)	0 (14.50)	0 (16.31)
Aggravated assault	21.708 (17.359)	17.496 (14.667)	0 (124.49)	0 (90.66)
Robbery	3.579 (5.1270)	2.197 (3.4979)	0 (37.90)	0 (25.65)
Part I property crime	221.79 (139.91)	131.24 (102.93)	0 (1022.78)	0 (706.32)
Burglary	882.50 (4047.28)	785.35 (7307.24)	0 (48,028)	0 (112,958)
Larceny theft	142.35 (101.20)	83.201 (68.10)	0 (713.77)	0 (464.51)
Motor vehicle theft	12.02 (10.30)	11.75 (10.51)	0 (68.32)	0 (85.73)

Note. Rates are based on per 10,000 persons.

Regarding ONG production, nearly 84% of Texas counties report some oil and/or natural gas production from 2009 to 2019 (211 counties out of 254 report ONG production). In 2009 the average amount of oil produced in Texas was a little over 1 million barrels of oil (see Table 11). This amount nearly doubled in 2019, with an average amount of over 5.5 million barrels of oil produced. Natural gas production remained relatively stable from 2009 to 2019 (reflecting an 88,058 MCF production difference); however, there was a notable increase from 2009 to 2019 in the maximum amount of natural gas produced. The number of drilling permits went from a mean of 53 in 2009 to 58 in 2019. In summary, Texas had more oil production, stable natural gas production, and an increase in the number of drilling permits from 2009 to 2019.

Table 10. Description of oil and natural gas production in Texas counties from 2009 to 2019 (*n* = 245)

	2009 Average (*SD*)	2019 Average (*SD*)	2009 Minimum (Maximum)	2019 Minimum (Maximum)
Total Oil Produced (Barrels)	1,045,217 (2,422,253)	5,684,637 (20,826,182)	0 (17,473,762)	0 (189,515,493)
Total NG Produced (McF)	24,642,002 (60,206,063)	24,553,944 (88,098,165)	0 (513,666,411)	0 (826,581,404)
Total Number of Drilling Permits (Count)	53.13 (80.09)	58.00 (176.692)	0 (612)	0 (1,478)

Assumptions of Linear Regression

Prior to running multivariate regression, assumptions of linearity, statistical independence of residuals, homoscedasticity, and normality were assessed. Notably, the general rule of thumb for regression analysis is to assess a sample size of at least 20 cases per independent variable in the analysis (Harrell, 2001). Here, most Texas counties (*n* = 245) were assessed for each of the predictor variables; thus, the sample size baseline is satisfied.

In order to assess linearity, one of the assumptions of linear regression (Harrell, 2001), a scatterplot was configured between the fitted and normalized residuals (i.e., predicted versus observed values). In this study, a linear relationship exists between the outcome variables of change in Part I violent offenses and change in Part I property offenses and the predictor variables. When plotted, the standardized residuals versus the predicted Y values demonstrated the presence of a linear relationship within each of the four multiple linear regression models.[20]

To further assess linearity, skewness of the dependent and predictor variables was examined. Scheffe (1959, p. 333) stated that skewness is the “most important indicator of the extent to which nonnormality affects the usual inferences made in the analysis of variance.” The joint distribution of several variables against a multivariate normal distribution is assessed, and if skewness differs from 0, the distribution deviates from symmetry (DeCarlo, 1997). Logarithmic transformations were conducted on the dependent variables to remedy high skewness; this included the 2009 Part I violent crime rate, the 2019 Part I violent crime rate, the 2009 Part I property crime rate, the 2019 Property crime rate, as well as indicators of the change (in violent offense rates and the change in property offense rates included in descriptive and zero-order correlation matrix tables.

An additional regression assumption includes independence of the error terms. To test this assumption, the Durbin-Watson statistic was examined (1.87) and was found to exhibit positive autocorrelation, suggesting that the error terms were not independent. However, given that the value was close to 2, autocorrelation is not likely to be serious issue in the analysis (Field, 2009).

Another assumption is that no multicollinearity exists, in short, that the independent variables are not highly correlated with each other (Daoud, 2017). This

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[20] Model 1 (Table 12) includes the effects of static measures of the predictor variables on change in Part I violent crime rates in Texas counties (*n* = 245), Model 2 (Table 13) includes the effects of static measures of the predictor variables on change in Part I property crime rates in Texas counties (*n* = 245), Model 3 and 4 (Table 14) includes the effects of static and dynamic measures of the predictor variables on change in the Part I violent and property crime rates in Texas counties (*n* = 245).

assumption is confirmed by the Variance Inflation Factor (VIF) and low tolerance statistics. Both the VIF and low tolerance score directly measure how much the variance of the coefficient (i.e., the standard error) is being inflated due to multicollinearity. The VIF and TI reflect estimates of the degree of interrelationship between an independent variable and other explanatory variables in a regression model (O'Brien, 2007). As a rule of thumb, a "tolerance of less than 0.20 is cause for concern; a tolerance of less than .10 almost certainly indicates a serious collinearity problem" (p.66). Likewise, a VIF value exceeding five is typically used to identify dependencies among the predictor variables (Marcoulides & Raykov, 2019). An assessment of multicollinearity yielded no VIF score above 10 and no tolerance below .10; therefore, multicollinearity was not an issue in this analysis. The highest VIF score obtained was 3.219, and the lowest tolerance was 0.311.

Additionally, to assess multicollinearity, a zero-order correlation matrix was examined (see Table 11). A zero-order correlation matrix is a measure of a direct effect (LeBreton, Ployhart, & Ladd, 2004), as they determine the magnitude of the bivariate relationship between the independent and dependent variable without accounting for the contributions of other variables in the regression equation. The correlation matrix presented in Table 7 reflects several significant bivariate relationships. Notably, as the county population increased, so too did the active liquor license rate (.469) and both the known Part I violent crime rate (.515) and property crime rate (.540). The number of drilling permits increased with both the total amount of oil produced (.507) and the total amount of natural gas produced (.688). This makes sense, as the applications for drilling permits increase, the more oil and natural gas production will occur given that natural resource extraction requires companies to obtain permits.

Also, the rate of males employed in ONG increased, so too did law enforcement strength (.395). Notably, several independent variables show high zero-order correlations, yet may not be "particularly important to independent prediction" (Nunnally & Bernstein, 1994, p. 192) after accounting for contributions from the other independent variables in the regression equation. Accordingly, it is best to complement use of zero-order correlations with measures of total and partial effects that consider the contributions of other variables to the regression equation in their assessments of variable importance.

Table 11. Zero-order correlation matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	--	.422	.025	-085	.549	.126	-.557	-.570	.469	-.120	.179	.025	.515	.440
2		--	-.396	-.046	.201	-.040	-.367	-.338	.136	.004	.115	.026	.363	.322
3			--	.412	.301	.112	-.061	.031	.066	.139	.056	.093	.123	.103
5					--	.051	-.367	-.334	.285	.047	.015	.033	.406	.534
6						--	-.016	-.071	.050	-.006	.226	.145	.108	.084
7							--	.395	-.276	.007	-.135	-.095	-.342	-.389
8								--	-.197	.145	.111	.115	-.356	-.377
9									--	-.044	.059	-.018	.238	.339
10										--	.081	.407	.056	.021
11											--	.688	.121	.051
12												--	.008	-.020
13													--	.457
14														--

Note. 1 = Population; 2 = Percent Black; 3 = Percent Hispanic; 4 = Poverty rate; 5 = -occupied homes; 6 = Percent males without high school diploma; 7 = Males employed in ONG; 8 = Law enforcement strength; 9 = Active liquor license rate; 10 = Total oil produced (barrels); 11 = Total natural gas produced (MCF); 12 = Drilling permits; 13 = Violent crime (logged); 14 = Property crime (logged).

Table 11 continued. Zero-order correlation matrix

	15	16	17	18	19	20	21	22	23	24	25	26	27	28
1	--	-.119	.082	-.045	.089	.143	-.152	-.129	.019	.049	-.080	-.034	.067	.216
2		--	-.076	-.019	-.271	.071	-.119	-.025	.028	.054	.260	.025	.070	-.111
3			--	.021	.162	-.045	-.001	.076	-.072	-.003	-.168	-.002	-.022	.109
4				--	.048	.053	-.049	-.038	.019	-.050	.046	.062	-.033	-.135
5					--	.002	.078	-.090	.000	-.012	-.030	.027	-.058	-.070
6						--	-.091	.113	.029	-.010	.056	-041	.078	.172
7							--	.065	.083	-.001	-.017	-.002	-.239	-.213
8								--	-.031	.170	.052	.167	.008	-.199
9									--	-.029	.148	-.087	.095	.162
10										--	.065	.409	.121	-.009
11											--	.208	.077	-.077
12												--	.125	.002
13													--	.342
14														--

Note. 15 = Change in population; 16 = Change in percent Black; 17 = Change in percent Hispanic; 18 = Change in poverty rate; 19 = Change in percent renter-occupied homes; 20 = Change in percent males without high school diploma; 21 = Change in males employed in ONG; 22 = Change in law enforcement strength; 23 = Change in active liquor license rate; 24 = Change in total oil produced (barrels); 25 = Change in total natural gas produced (MCF); 26 = Change in the number of drilling permits; 27 = Change in violent crime (logged) 28 = Change in property crime (logged).

Table 11 continued. Zero-order correlation matrix

	15	16	17	18	19	20	21	22	23	24	25	26	27	28
15	--	-.076	-.019	-.271	.071	-.119	-.025	-.028	.054	.260	.025	.070	-.111	-.081
16		--	-.021	.162	-.045	-.001	.076	-.072	.003	-.168	-.002	-.022	.109	.129
17			--	.002	.078	-.090	.001	-.012	-.030	-.027	-.058	-.070	-.097	-.028
18				--	.146	.101	-.025	-.060	.088	-.062	.027	-.027	-.032	-.054
19					--	-.037	-.080	.097	.037	.001	-.028	-.118	-.064	-.123
20						--	.170	-.003	-.050	-.057	-.009	.024	.021	-.115
21							--	-.043	-.065	-.097	-.083	-.075	-.171	-.167
22								--	-.037	.021	.049	.067	-.030	.186
23									--	.198	.118	.121	-.021	.158
24										--	.446	.468	.016	.093
25											--	.409	.098	.032
26												--	.128	.119
27													--	.447
28														--

Note. 15 = Change in population; 16 = Change in percent Black; 17 = Change in percent Hispanic; 18 = Change in poverty rate; 19 = Change in percent renter-occupied homes; 20 = Change in percent males without high school diploma; 21 = Change in males employed in ONG; 22 = Change in law enforcement strength; 23 = Change in active liquor license rate; 24 = Change in total oil.

Another assumption of multiple linear regression is homoscedasticity, which requires that the variance of error terms be similar across the predictor variables (Casson & Farmer, 2014). A residual scatterplot is relied upon to determine whether, upon visual inspection, the assumption of homoscedasticity is violated between the predicted dependent variable scores and the errors of the prediction. Conducting this type of analysis allows one to determine if there are outliers in the dataset. The scatterplot reflected scores that were consistent across the horizontal line, indicating the assumption of homoscedasticity is achieved.

Finally, to assess normality and the absence of outliers numerical and graphical methods were employed. The numerical method used included the Shapiro-Wilk normality test and the Kolmogorov-Smirnov test (Mishra, Pandey, Singh, Gupta, Sahu & Keshri, 2019). The results indicated a p-value of each test greater than .05 meaning that the variable weight is normally distributed. The graphical techniques typically used to test normality are the histogram and the Q-Q plot (Karadimitriou & Marshall, 2017). Notably, nine outliers were identified, reflecting influential points in the regression analysis.

A box plot revealed that the standardized residual was greater than +3 standard deviations, reflecting the presence of outliers. Because extreme values pull the regression line towards them, outliers can have a significant impact on the coefficients of the model (Karadimitriou & Marshall, 2017). The models' residuals were additionally examined to determine if the Cook's Distance (Cook's D) statistic reflected any outlier cases (Martin, 2015). Cook's D is calculated for each individual and is the difference between the predicted values from regression with and without an individual observation (Cook & Weisberg, 1983). Notably, Cook's D was originally created to identify influential cases in linear regression models and has since been extended to log-linear models (Martin, 2015). The value of Cook's D for Gaines County (*CD* = 4.7), Andrews County (*CD* = 6.3), Ector County (*CD* = 4.2), Johnson County (*CD* = 5.1), Kenedy County (*CD* = 5.3), Loving County (*CD* = 4.2), Sherman County (*CD* = 5.0), Tarrant County (*CD* = 4.6), Terrell County (*CD* = 8.5) and Yoakum County (*CD* = 6.1) exceed 4.0, indicating that these nine counties have sizeable influences on the parameter estimates. Including Gaines County in the sample, for example, would influence one to mistakenly conclude that the annual static total of natural gas produced significantly affects changes in the known Part I violent crime rate. The outliers created a strong association for change in violent and property offense rates, leading to their exclusion from the dataset. The following counties, therefore, were omitted from the analysis: Sherman and Terrell Counties (for males employed in ONG); Tarrant County (for drilling permits); Loving and Kenedy Counties (for law enforcement strength); Gaines, Andrews, Ector, and Yoakum Counties (for the total amount of oil produced).

Assessing Violent and Property Crime Change from 2009 to 2019 in Texas Counties (Research Questions 1 & 2)

Several multiple linear regression analyses were used to address the research questions for this study. To address the first research question (the effect of ONG-production on violent crimes), the static and dynamic effects of the predictor variables on change in the known Part I violent offense rates were examined first. Table 12 presents the multiple linear regression results of the impacts of the static measures of the predictor variables on change in the known Part I violent crime rate. The static measures of the predictor variables account for an estimated 9% of the variation in the rate of change in the known Part I violent offenses, as indicated by the R^2. The total amount of oil produced is revealed as a significant predictor for change in the known Part I violent offense rate. In particular, the static amount of oil production ($B = .202, p < .01$) is associated with change in the known Part I violent offense rate. Consequently, as the amount of oil production increases, so too does change in the known Part I violent offense rates, controlling for other static predictors in the model. Additionally, the static predictor variables, drilling permits variable ($B = -.225, p < .05$) is associated with change in the known Part I violent offense rate, controlling for other predictors in the model. This relationship, however, reveals that as the number of drilling permits increase, change in the known Part I violent offense rate decreases.

Table 12. Effects of static measures of the predictor variables on change in Part I violent crime rates in Texas counties ($n = 245$)

	Change in Part I violent offenses 2009-2019	
	B	*Beta*
Total oil produced (barrels)	1.16	.202**
Total natural gas produced (MCF)	1.90	.769
Drilling Permits	-.004	-.225*
Population size	3.70	.088
Percent non-Hispanic Black	-.245	.090
Percent Hispanic	.179	.030
Percent males employed in ONG	.087	.048
Percent males with less than high school education	14.9	.100
Percent renter-occupied homes	2.29	.112
Law enforcement strength rate	-.014	-.095
Active liquor license rate	.035	.024
Poverty rate	-.001	-.091
Intercept	-.481	
R^2 Nagelkerke	.093	
Adjusted R^2	.046	

Note. * p < .05, ** p < .01, *** p < .001

The multiple linear regression results of the impacts of the static measures of the predictor variables on change in the known Part I property crime rate is presented in Table 13. The static measures of the predictor variables account for nearly 10% of the variation in the rate of change in the known Part I property offenses, as indicated by the R^2. The total amount of oil produced is revealed as a significant predictor for change in the known Part I property offense rate, net of other variables in the model. In particular, the static amount of oil production ($B = .156, p < .05$) is associated with change in the known Part I property offense rate, controlling for other static predictors in the model. Consequently, as oil production increases, so does change in the known Part I property offense rate. Additionally, population size and law enforcement strength rate were revealed as significant predictors for change in the known Part I property offense rates. In particular, the static amount of population size ($B = .180, p < .05$) is associated with change in the known Part I property offense rate, controlling for other static predictors in the model. Thus, as the population size increases, so too does change in the known Part I property offense rate. The static amount of law enforcement strength ($B = -.167, p < .05$) is inversely associated with change in the known Part I property offense rate; as the static amount of law enforcement increases, change in the known Part I property offense rate decreases.

Table 13. Effects of static measures of the predictor variables on change in Part I property crime rates in Texas counties (n = 245)

	Change in part I property offenses 2009 – 2019	
	B	*Beta*
Total oil produced (barrels)	1.85	1.56*
Total natural gas produced (MCF)	3.17	.066
Drilling permits	-.002	-.067
Population size	1.56	.180*
Percent non-Hispanic Black	.701	.034
Percent Hispanic	1.10	.088
Percent males employed in ONG	.248	.066
Percent males with less than high school education	20.23	.065
Percent renter-occupied homes	.270	.006
Law enforcement strength rate	-.050	-.167*
Active liquor license rate	.043	.015
Poverty rate	-.001	-.074
Intercept	-.494	
R^2 Nagelkerke	.098	
Adjusted R^2	.051	

Note. * $p < .05$, ** $p < .01$, *** $p < .001$

To further understand the impact of changes in ONG activity, Table 14 presents the results of regressing change in the known Part I violent and property crime rates in Texas (n = 245) on the effects of both the static and dynamic measures of the predictor variables. When the dynamic measures are controlled, the static effect of the total amount of oil produced (B = .251, $p < .01$) is associated with change in the known Part I violent crime rate, controlling for other static and dynamic predictors in the model. Yet, when the total amount of oil changes (dynamic), it does not reflect an appreciable effect on change in the known Part I violent crime rate. A similar pattern is found with drilling permits, where the static effect of number of drilling permits (B = -.296, $p < .05$) is associated with a significant decrease in the change in the known Part I violent crime rate but change in number of drilling permits is not associated with change in the violent crime rate, controlling for all other variables in the model. In contrast, the static amount of natural gas may not influence change in the known Part I violent crime rate, but the dynamic total of natural gas does. When the change in total amount of natural gas increases, so too does the change in the known Part I violent crime rate. However, the total amount of natural gas (static) had no appreciable influence on the change in the known Part I violent offense rates. The static effect of the poverty rate (*B* = -.163, $p < .01$) on change in the known Part I violent crime rate is significant. As the rate of poverty decreases, the change in rate of violent crime increases. Both change in the population size (*B* = -.189, $p < .05$) and change in the percent of males employed in ONG (*B* = -.172, $p < .05$) is associate with change in the known Part I violent crime rate.

Table 14 also presents the relationship between the static and dynamic measures of the predictor variables on change in the known Part I property crime rate. The static effect of the total amount of oil (*B* = .177, $p < .01$) on change in the known Part I property crime rate is significant, controlling for other static and dynamic predictors in the model. The static poverty rate, again, reflects a negative effect (*B* = -.165, $p < .05$) on change, but this time, the change is with the known Part I property crime rate. Thus, as the poverty rate decreases, the rate of change in the known Part I property offenses increases. Both the static effect of population size (*B* = .159, $p < .05$) and the dynamic effect of population size (*B* = -.163, $p < .05$) are associated with change in the known Part I property crime rate, controlling for other static and dynamic predictors in the model.

In addition to population size, there were several significant dynamic predictors in the model. Specifically, the dynamic percent of renter-occupied homes (*B* = -.145, $p < .05$) effects change in the known Part I property crimes, controlling for other static and dynamic predictors in the model. As change in the percent of renter-occupied homes increases, change in the known Part I property crime rates decreases. The dynamic change in law enforcement strength (*B* = .240, $p < .001$) has a positive and significant relationship with change in the known Part I property crime rate, controlling for other static and dynamic predictors in the model. In other words, as the law enforcement strength rate increases, so too does change in the known Part I property crime rate. Likewise, change in the number of active liquor licenses (*B* = .172, $p < .01$) on change in the known Part I property crime rate is significant, controlling for other static and dynamic predictors in the model. As change in the number of active liquor licenses increases, so too does the rate of change in known Part I property offenses.

Table 14. Effects of static and dynamic measures of the predictor variables on change in Part I violent and property crime rates in Texas counties (n = 245)

	Part I violent crime rates		Part I property crimes rates	
	Static effects beta	*Dynamic effects beta*	*Static effects beta*	*Dynamic effects beta*
Total oil produced (barrels)	.251**	.037	.177*	.103
Total natural gas produced (MCF)	.137	.129	.162	-.033
Drilling permits	-.296*	-.042	-.094	.018
Population size	.077	-.189*	.159*	-.163*
Percent non-Hispanic Black	-.020	.099	.020	.161*
Percent Hispanic	.065	-.063	.163	.019
Percent of males employed in ONG	.079	-.172*	.040	-.116
Percent of males with less than a high school education	.085	.066	-.023	-.073
Percent renter-occupied homes	.061	-.023	-.057	-.145*
Law enforcement strength rate	-.027	-.042	-.129	.240***
Active liquor license rate	.046	.-.012	.080	.173**
Poverty rate	-.163*	-.112	- .165*	-.120
R^2 Nagelkerke .172 Adjusted R^2 .080			R^2 Nagelkerke .255 Adjusted R^2 .172	

Note. * $p < .05$, ** $p < .01$, *** $p < .001$

The multiple regression results for known Part I violent and property crime rates may obscure important differences among the specific offenses included in these rates. Consequently, the known Part I violent crime rates are disaggregated by specific offense, and multiple regression models are estimated separately (for change in murder rates, rape rates, robbery rates, and aggravated assault rates) to explore the effects of static and dynamic measures of ONG activity and social change. Likewise, the known Part I property crime rates are disaggregated by specific offense, and multiple regression models are estimated separately (for burglary rates, larceny-theft rates, and motor vehicle theft rates) to explore the effects of static and dynamic measures of ONG activity and social change. The analyses for the disaggregated known Part I violent and property offense rates are presented in Tables 15 – 18.

The total amount of natural gas reveals mixed results on its effect on the disaggregated known Part I offense rates. Notably, the static effect of natural gas (B = .260, $p < .05$) influences change in the known Part I murder rates, controlling for other predictors in the model. In other words, as the total amount of natural gas produced increases, so too does the change in the known Part I murder rate. The analyses further reveal that change in the total amount of natural gas production (B = .131, $p < .05$) is associated with the change in the known Part I aggravated assault rates, controlling for other predictors in the model. As the rate of change in total amount of natural gas produced increases, so too does the rate of change in known Part I aggravated assaults.

The static effect of total amount of oil reflects a significant positive effect on change in the known Part I rate of burglary (B = .271, $p < .01$), aggravated assault (B = .271, $p < .01$) and motor vehicle theft (B = .180, $p < .05$). Put another way, changes in burglary, aggravated assault and motor vehicle theft rates increase as the total amount of oil produced increases. The change in the total amount of oil produced (B = -.191, $p < .05$), however, has a significant and negative effect on the change in the known Part I rates of rape. Thus, as the total amount of oil produced changes, the change in the known Part I rate of rape decreases.

Table 15. Effects of static and dynamic measures of the predictor variables on change in the Part I murder and rape rates (*n* = 245)

	Part I murder rates		Part I rate of rape	
	Static effects beta	*Dynamic effects beta*	*Static effects beta*	*Dynamic effects beta*
Total oil produced (barrels)	-.013	.122	.131	-.191*
Total natural gas produced (MCF)	.260*	.035	.048	.016
Drilling permits	-.086	.111	-.148	.058
Population size	.087	.033	-.024	-.026
Percent non-Hispanic Black	-.033	.137*	-.037	.028
Percent Hispanic	-.195*	.071	-.004	-.947
Percent of males employed in ONG	-.054	-.054	-.009	-.011
Percent of males with less than a high school education	.041	.030	.078	-.010
Percent renter-occupied homes	.207**	.112	.270***	-.034
Law enforcement strength rate	-.178**	.038	-.099	.076
Active liquor license rate	.080	.080	-.002	.105
Poverty rate	.050	-.113	-.093	-.015
R^2 Nagelkerke .269	Adjusted R^2 .187		R^2 Nagelkerke .186	Adjusted R^2 .094

Note. * p < .05, ** p < .01, *** p < .001

An indicator of both social change and an ONG-related predictor is the percent of males employed in ONG. The static percent of males employed in ONG reflects a negative significant effect on change in the known Part I larceny-theft rate (*B* = -.121, p < .05), and change in the percent of males employed in ONG (*B* = -.196, p < .01) is associated with the change in the known Part I robbery rate, controlling for other variables in the model. Thus, change in the known Part I rates of larceny-theft and robbery decrease as the percent of males employed in ONG increases and as change in the percent of males employed in ONG increases.

The number of drilling permits reflects a negative effect on several Part I disaggregated offensees. The static number of drilling permits negatively affects the change in the known Part I aggravated assault rates (B = -300, $p < .01$) burglary rates (B = -.301, $p < .05$) and motor vehicle theft (B = -.034, $p < .05$) controlling for other predictor variables in the model. That is, as drilling permits increased, the change in specific known Part I offenses decreased, including assault, burglary, and motor vehicle theft. These findings are discussed in greater detail in the following chapter.

Table 16. Effects of static and dynamic measures of the predictor variables on change in the Part I robbery and aggravated assault rates (*n* = 245)

	Part I robbery rates		Part I aggravated assault rates	
	Static effects beta	*Dynamic effects beta*	*Static effects beta*	*Dynamic effects beta*
Total oil produced (barrels)	.030	-.057	.271**	.113
Total natural gas produced (MCF)	.075	.002	.112	.131*
Drilling permits	-.104	.059	-.300*	-.078
Population size	.136*	-.178*	.095	-.196*
Percent non-Hispanic Black	-.002	.236***	.003	.054
Percent Hispanic	.075	-.009	.042	-.062
Percent of males employed in ONG	.111	-.196**	-.002	-.130*
Percent of males with less than a high school education	-.085	.076	.087	.056
Percent renter- occupied homes	.095	.112	.032	.017
Law enforcement strength rate	.017	.027	-.031	-.095
Active liquor license rate	.002	-.039	.052	-.045
Poverty rate	-.104	.033	-.077	-.123
R^2 Nagelkerke .199	Adjusted R^2 .109		R^2 Nagelkerke .161 Adjusted R^2 .067	

Note. * p < .05, ** p < .01, *** p < .001

Table 17. Effects of static and dynamic measures of the predictor variables on change in the Part I burglary and larceny-theft rates (n = 245)

	Part I burglary rates		Part I larceny-theft rate	
	Static effects Beta	*Dynamic effects Beta*	*Static effects Beta*	*Dynamic effects Beta*
Total oil produced (barrels)	.271**	.113	.141	.126
Total natural gas produced (MCF)	.112	.131	.196	-.715
Drilling permit	-.301*	-.809	-.097	.001
Population size	.095	-.196*	-.116	-.104
Percent non-Hispanic Black	.003	.054	.097	.207***
Percent Hispanic	.042	-.062	.210*	.042
Percent of males employed in ONG	-.002	-.130	.035	-.121*
Percent of males with less than a high school education	.087	.056	-.005	-.109
Percent renter-occupied homes	.032	.017	.090	-.088
Law enforcement strength rate	-.031	-.095	-.130	.269***
Active liquor license rate	.052	-.045	.094	.203***
Poverty rate	-.077	-.123	-.169*	-.101
R^2 Nagelkerke .181	Adjusted R^2	.089	R^2 .291	Adjusted R^2 .211

Note. * $p < .05$, ** $p < .01$, *** $p < .001$

Table 18. Effects of static and dynamic measures of the predictor variables on change in the Part I motor vehicle theft rates (*n* = 245)

	Part I motor vehicle theft rates	
	Static effects *Beta*	*Dynamic effects* *Beta*
Total oil produced (barrels)	.180*	.072
Total natural gas produced (MCF)	.003	-.044
Drilling permits	-.034*	.034
Population size	.089	-.072
Percent on-Hispanic Black	.041	.115
Percent Hispanic	.129	.094
Percent of males employed in ONG	-.072	-.027
Percent of males with less than a high school education	-.125	-.054
Percent renter-occupied homes	-.017	-.041
Law enforcement strength rate	-.188**	.193***
Active liquor license rate	.099	.214***
Poverty rate	-.210**	-.082
R^2 Nagelkerke .247	Adjusted R^2 .162	

Note. * p < .05, ** p < .01, *** p < .001

VI. DISCUSSION AND CONCLUSION

Exploration and identification of social change remains a major issue and is, perhaps, *the* central issue for the development of the criminological field's understanding of criminal activity and behavior (Andrews, Bonta, & Wormith, 2006; Wormith, Hogg, & Guzzo, 2012). This is the only known study to date to make use of static and dynamic measures to assess ONG activity's impact on the known Part I violent and property crime rates in Texas counties. This study aimed to determine whether change in ONG activity influenced change in violent and property crime rates from 2009 to 2019 among Texas counties (n = 245) while considering social change factors. The findings from this study, consequently, suggest that both static and dynamic processes are important to an improvement in identifying mechanisms of change in the known Part I violent and property offense rates in Texas counties.

Change in Texas Counties from 2009 to 2019

Texas county characteristics reflected some major shifts in several variables, including the poverty and liquor license rate. The rate of poverty, as shown in Table 8, went from an average of 344 (SD = 157.3) in 2009 to 287 (SD = 123.1) in 2019. This sizable decrease in the poverty rate may be attributable to the Great Recession, an economic period between 2007 and 2009 that involved economic downturns throughout the country (Weinberg, 2013) that likely inflated poverty rates at Time 1 of the study. Additionally, the rate of active liquor licenses from 2009 to 2019 also substantially changed. In 2009, there was less than one liquor license per 10,000 Texas residents; in 2019 there was more than two liquor licenses per 10,000 Texas residents. This marked increase may be due to a law that took effect in 2019, permitting individuals to hold up to 250 retail liquor licenses and add up to 15 new permits a year ("Texas Raises Retail

Liquor," 2019). Previously, individuals could own only five licenses ("Texas Raises Retail Liquor," 2019). Otherwise, there was a lack of change in other county characteristics of interest.

Static and Dynamic Measures of ONG Activity and Crime Rates

Two research questions were assessed in this study: (1) To what extent does change in ONG activity affect changes in violent crime rates (2009 to 2019) among Texas counties, while considering social change factors?; and (2) To what extent does change in ONG activity affect changes in property crime rates (2009 to 2019) among Texas counties, while considering social change factors? An overview of the significant effects of both the static and dynamic ONG measures on the known Part I offense outcomes is presented in Table 19.

It is important at this juncture, to revisit the meaning of static and dynamic measures. Static variables focus on stable differences at a single point in time. For purposes of this study, the static measure is 2009, and the static measure indicates whether the presence of oil effects change in violent crime. The dynamic approach, however, investigates whether a change in something explains why crime may occur in particular periods of time, while others do not - even after including the influence of static measures (Kubrin, 2000). The analyses of change attempts to determine the extent to which change in ONG production is associated with change in the known Part I crime rates over time.

Table 19. The significant effects of both static and dynamic ONG measures on the known Part I offense outcome variables

	Violent crime	Property crime	Murder	Rape	Aggravated assault	Robbery	Burglary	Larceny-theft	MV theft
Static measure of total amount of oil produced	+	+			+		+		+
Dynamic measure of total amount of oil produced				-					
Static measure of total amount of NG produced			+						
Dynamic measure of total amount of NG produced	+				+				
Static measure of males employed in ONG									
Dynamic measure of males employed in ONG	-				+	-		-	
Static measure of drilling permits	-				-		-		-
Dynamic measure of drilling permits									

Note. + indicates a significant and positive effect; - indicates a significant and negative effect.

The analysis indicates that only a handful of the dynamic county characteristics were significant predictors of change in the known Part I violent or property offense rates among Texas counties. Specifically, three dynamic variables were associated with change in the known Part I violent offense rate from 2009 to 2019: population size, percent males employed in ONG, and the total amount of oil produced. Furthermore, five dynamic variables were associated with change in the known Part I property offense rate: population size, percent non-Hispanic Black, percent renter-occupied homes, law enforcement strength rate, and active liquor license rates.

ONG dynamic measures reflected appreciable effects on change in the known Part I violent and property offense rates[21]. The results ultimately highlight the lifecycle of the ONG process, revealing associated significant effects within each stage of the process. To start, the static measure of drilling permits reflects a decline in the known Part I violent offense rates, and across all disaggregated violent and property crime rates. At first glance, this may seem like an unexpected result to obtain; however, it makes sense when one considers the life cycle of ONG.

Drilling permits do not indicate an active ONG labor force but rather the *expectation* of a labor force (Hamilton & Matos-Sharifan, 2016). A company is legally not allowed to put drill bit to dirt until they first obtain a drilling permit. As the literature review revealed, however, many drilling permits never come to fruition, meaning that the operator may obtain a permit but may not decide not to drill at that point in time. Further, even if the well is drilled, it may not be completed (allowed to produce oil or natural gas)

[21] Recall, ONG measures included the total amount of oil produced, total amount of natural gas produced, and number of drilling permits.

for months or even years (Lieskovsku & Yan, 2019). Producers may decide not to complete a well for several reasons, including economic reasons; for example, the market price for ONG may not be sufficiently favorable (Lieskovsku & Yan, 2019).[22] Thus, the permitting stage is the precursor to the well-site's development and completion stage; the labor and production associated with well development and completion has not occurred yet.

The second seemingly unexpected, yet related, result involves percent of males employed in ONG. Change in the percent of males employed in ONG revealed a significant negative effect on change in the overall known Part I violent crime rate. Previous researchers have likewise found significant and negative associations between percent employed in ONG and violent crime (Luthra et al., 2007; Ruddell et al., 2014). From a social disorganization perspective, one would assume that as oil production is high, new employees would enter the community resulting in a breakdown in social cohesion and, consequently, more crime. This result, however, makes sense if one considers the fact that oil production indicates a workforce, and that employment decreases violent crime (Luthra et al., 2007).

Likewise, it appears that change in the percent of males employed in ONG also produces a significant negative effect on change in the known Part I robbery and larceny-theft rates. This result may be reflective of routine activity theory, which advances that crime may occur when three elements converge: (1) a motivated offender, (2) a suitable

[22] "From June 2014 to February 2016, U.S. crude oil benchmark prices declined from more than $107 per barrel (b) to less than $27/b. With lower crude oil prices, the number of newly completed wells in North Dakota decreased. Simultaneously, the number of DUC wells increased as the monthly average time to complete a well expanded from about three months to nearly one year. Despite the lower prices, the average time to drill a new well remained less than two months." Lieskovsku & Yan, 2019, para 5.

target, and (3) the absence of a capable guardian (Cohen & Felson, 1979). When oil production occurs, the employed workforce typically works, on average, over 42 hours per week (BLS, 2021). Thus, these workers may not be present near or within their residence (whether a rental, man-camp, or hotel room), providing more opportunity for burglary to occur. This is assuming, however, that these rates indicate victimization within the ONG sector. This burglary rate increase may also indicate the community experiencing social disorganization, with an influx of new ONG employees and a breakdown in social cohesion – increasing the likelihood for victimization, including property crime victimization. In short, there are more new people, fewer personal contacts, or connections within the community, and as a result, increased property crime rates.

In contrast, change in the percent of males employed in ONG reflected a significant negative association with on change in the known Part I larceny-theft rate. In other words, as the percent of males employed in ONG increases, change in the known Part I larceny-theft rate decreased. Larceny-theft involves the "unlawful taking or theft of the personal property of another person or business" (UCR, 2016). This finding contrasts with burglary, which entails a person entering a structure with the intent to commit a crime. Larceny-theft does not necessarily require entering a structure but instead requires taking property without the owner's consent. Taking a person's property without their consent typically entails theft of bicycles, shoplifting, or pocket-picking (UCR, 2016). These instances involve more personal contact between persons; notably, ONG activity typically occurs in rural counties. Thus, there is less potential for close contact between individuals; however, more research is needed.

The percent of males employed in ONG was significantly and positively associated with violent crime within the disaggregated violent crime model (see Table 16). Change in the percent of males employed in ONG, showed a significant and positive effect on change in the known Part I aggravated assault rates. The static amount of oil produced and change in the total amount of natural gas produced, were significantly and positively associated with aggravated assault. These results, taken together, are not surprising in that the oil and gas industry is nearly 90% male employees (Zippia, 2020), and the majority are between the age of 25 to 35 years of age (BLS, 2020). Notably, the median age-crime involvement is 30 years of age and younger for most crimes reported in the FBI's UCR program (Ulmer & Steffensmeier, 1998), and males account for nearly 80% of all arrests in the United States for violent crimes, in particular, assaults (Beauchamp & Chan, 2014). Likewise, aggravated assault remained a significant outcome for oil production and changes in natural gas production. Therefore, it stands to reason that the rate of assault increases when there is change (increase) in the percent of males employed in ONG, a change in natural gas production, or the oil production. Each of these predictor variables consist of male dominated populations, which are the most likely to engage in this specific form of violence.

The final development stage in ONG drilling is a producing well (Pearson, 2022). Hence, the two ONG measures, total amount of oil produced, and total amount of natural gas produced, indicate a completed well. To be clear, producing means the drilling permit has been obtained, preparation and construction of the site has been completed, and now, the well is producing. The results revealed that the static amount of oil production is associated with change in *both* the known violent and property crime rates.

The disaggregated models revealed that the static amount of oil is also associated with change in burglary, assault and motor vehicle theft. Change in the total amount of oil production, however, was not associated with any change in the known Part I offenses. The static amount of oil production may be associated with change in violent and property crime rates based on the lack of people needed for completed well maintenance. Specifically, an oil well site operation goes from an estimated 50-75 people to prepare, create, and complete the well site, to 2-3 people to check on the site bi-weekly to ensure site stability (Zion Drilling, 2020). Consequently, once the wellsite is complete, the site no longer needs a large labor force to maintain it (US Bureau of Labor Statistics, 2021). Thus, there may be a change in the known Part I offenses as the amount of oil production increases because of an unemployed or underemployed workforce.

In contrast, change in natural gas production *is* associated with change in known Part I property crime rates as well as change in aggravated assault rates. Unlike oil production, a producing natural gas well is maintained by a larger workforce post site completion. Whereas a producing oil well is maintained post site construction by only two to three individuals, a producing natural gas site is maintained by numerous workers (Lioudis, 2022). Once a natural gas well produces, it requires individuals to install tubing for flowback, a mixture of water, dirt, sand and chemicals that flow to the surface after a well has been fracked (Rosenblum, Nelson, Ruyle, Schultz, Ryan, & Linden, 2017). Additionally, the flowback water is stored in nearby pool sites, which require workers thereafter to come in and truck out for offsite disposal (Rosenblum, et al., 2017). In essence, unlike oil production, a change in natural gas production indicates an extended workforce, and consequently, a male workforce with little to no ties with the host community. This may help to explain why a change in natural gas production is associated with change in aggravated assaults: there are simply more males onsite for longer periods of time with natural gas production as opposed to oil production.

The findings of this study are in line with previous research that linked natural resource production and well density to increases in violent crime (Gourley & Madonia, 2018; Komarek, 2014; Stretesky, Long, Mckie, & Aryee, 2018). Consequently, these findings indicate that social change characteristics, including the presence of oil production, diminish social cohesion within a community and are associated with change in the known Part I violent offense rates. Additionally, other community characteristics reflecting change help to explain increases in the known Part I violent and property crime rates across Texas counties. The results of this study reveal that including control variables reflecting social change in county characteristics account for change in the known Part I violent and property crime rates. Social disorganization, measured as a county characteristic through county population size, law enforcement strength rate, and percent of males employed in ONG, helped to explain differential county change in known Part I crime rates. Increases in these county characteristics indicate social disorganization, which is a consequence and a trait of social change.

Policy Implications

This study examines whether change in ONG production affects change in the Part I crime rates (2009 to 2019) among Texas counties (n =245) while considering social change factors. If these social changes reflect social problems, and the social changes can be predicted, they can be prevented (Thomas, Smith, and Ortiz, 2016). As such, host communities can identify strategic policies to proactively versus reactively, address the negative social changes associated with ONG production. Identifying potential social problems associated with ONG production is of particular importance to Texas ONG producing communities considering United States President Joe Biden's recent Executive Order that bans "the import of Russian oil, liquefied natural gas, and coal to the United States…" (Exec. Order No. 14066, 2022). Russia is responsible for seven percent of U.S. oil, and Texas may be the energy producing solution to fill that energy production gap (Livingston & Ferman, 2022). Consequently, Texas may dramatically increase its ONG production to meet new world energy needs (Livingston & Ferman, 2022). Therefore, local Texas municipalities can prepare for the oncoming onslaught of ONG production demand in several ways. Each proactive approach will be discussed in turn.

Local governments often lack the resources to manage rapid population increases due to ONG production (Morrison, Wilson, & Bell, 2012). The speed at which a host community can grow creates a situation in which the host community lacks sufficient law enforcement presence, social services, and housing. Ruddell (2017) suggests minimizing negative impacts associated with ONG related population growth at the earliest stages of the boom. Drilling permits occur during the first phase of ONG operations, specifically, they represent an expectation of a labor force, the labor force has not moved into the area at this point (the pre-boom phase). Host communities can engage in strategic thinking and planning when the number of drilling permits increase in their area. This affords the area an opportunity to prepare as a community for the oncoming rapid population growth, solidifying a greater feeling amongst residents of "collective efficacy (Ruddell, 2017, p. 239).

Additionally, this study reflected an increase in Part I crime rates. Host communities should increase population levels of law enforcement early in the boom to "prevent perceptions of newcomers and community residents that their home is a wild west where anything goes" (Ruddell, 2017, p. 243). Addressing crime on the front end of the boom with a sufficiently staffed law enforcement agency, will help to address the rise in criminal offenses associated with rapid population growth attributable to ONG operations.

Lastly, fostering relationships between the ONG companies and the host community's local law enforcement agency and government municipality may help alleviate the burdens associated with such rapid population growth. For example, ONG operators could inform local agencies and municipalities about the estimated number of labor force, length of time expected to complete well construction, and any long-term maintenance expectations associated with their planned production projects. These coordinated efforts would allow host community's to proactively prepare for social changes associated with ONG production.

By understanding the dynamics associated with ONG production, municipalities can anticipate problems and develop strategies to mitigate boomtown related effects. The earlier a locality addresses potential boomtown growth, the better they will be at addressing the social changes associated with ONG production. In short, a prepared community is a protected community.

Limitations

Although this dissertation adds to the knowledge and understanding of social changes related to ONG activity within Texas counties, several limitations should be addressed. To start, the known Part I crime data utilized for this study came from the UCR, which has several shortcomings. Law enforcement agencies are only required to report data for one month of the year to have their data included, resulting in not all agencies reporting crime data, and those that do may not report for all 12 months. Additionally, the results regarding the rate of rape, may be impacted by the 2013 UCR rape definition revision. The original UCR definition of rape was "the carnal knowledge of a female forcibly and against her will" (FBI, 2014, p. 1). The revised definition includes "Penetration, no matter how slight, of the vagina or anus with any body part or object, or oral penetration by a sex organ of another person, without the consent of the victim" (FBI, 2014, p. 1). The revised definition aggregates three sex offenses, that are typically disaggregated under NIBRS, including rape, (except for statutory rape), sodomy, and sexual assault with an object. (FBI, 2014). There are also issues regarding the regional differences in the quality of their data collection, differences in law enforcement training, and underreporting. Despite the limitations of the UCR data, it remains "our best source of crime data" (Center for Criminal Justice Policy Research, 2000, p. 3).

Additionally, this study focuses on counties located exclusively in Texas. The results of this study, as a result, may not be generalizable to the effects of ONG activity in other states. This exclusive focus, as a result, is important to keep in mind for future comparative purposes.

Moreover, specific variables indicating the number of ONG workers moving into an area (i.e., the shadow population) were missing. Often, ONG workers reside in temporary environments that are not neither recorded nor made available (i.e., trailers, personal vehicles, hotel rooms). This study, however, does measure the rate of occupancies that are rented within each Texas county. Nevertheless, this measure may still not specifically identify the number of ONG employees within a county. Alternatively, the measure does provide a good indication of residents that do not own their residence and, consequently, may lack long-term intent to remain within the county.

While this study included the percent of males employed in ONG and the county occupancy rate, it did not account for the potential influence of ONG employees on neighboring county crime rates. In particular, this study did not disaggregate crimes committed by local community offenders versus crimes committed by commuting ONG workers. Many ONG workers opt to commute long distances daily either by vehicle (DIDO) or plane (FIFO) (ELI 2014). A county's crime rate, as a result, may be attributable not to local community residents, but instead, to ONG workers passing through to reach a job site in a neighboring county. This study did, however, include most Texas counties (*n* = 245) crime rates through ONG and social change indicators.

Another limitation stems from using "natural resources, construction and maintenance occupations" as an indicator of ONG employment (ACS, 2021). This measure may include additional forms of mining and construction/maintenance related employment, so it is not limited to oil and gas-related jobs. There is no publicly available annual employment data at the county level that only provides only ONG employment numbers for Texas counties. The focus of this study is whether the change in ONG levels affects the rate of known Part I offenses while considering social change factors. Consequently, some assumptions had to be made based on the geographic location of the communities due to the lack of available data on this specific industry.

There are also issues associated with using ACS data. Specifically, the margins of error on ACS census tract-level data are, on average, 75 percent larger than those of the corresponding 2000 long-form estimate (Spielman, Folch, & Nagle, 2013). Although the margins of error may be high for some ACS data, researchers must proceed using the currently available data (Spielman & Folch, 2015).

Last, this study employed residual-change scores. Despite the numerous benefits of this statistical approach, it is not without some disadvantages. Specifically, the regression models, including the residual scores for static and dynamic factors, initially showed evidence of two problematic multivariate outlier, and sensitivity analyses identified some differences depending on whether the outlier was included or excluded from analyses. Specifically, the moderating impact of Oil and Natural Gas production became non-significant with removing the nine outliers. As a result, it cannot be certain about the nature of these extreme cases; we must exert caution in the moderation effect detected in the full sample.

Despite the data limitations, this study provides clear empirical support that longstanding structural problems are better predictors of crime in ONG-producing Texas counties than the presence of ONG activity itself.

Implications and Directions for Research

Future studies should attempt to include alternate oil and gas development measures to assess its impact on host communities. For instance, it may be beneficial to assess crime based on counties located within specific shale regions which vary in production output. Researchers could divide the counties situated in shale formations by the overall production rates (low, medium, high). This would help to determine whether overall amount of production influences change in crime rates.

Moreover, future research should explore whether ONG production in Texas counties, impacts the twenty-one Part II UCR offense rates. Previous studies have found that areas experiencing rapid population change due to ONG production were linked to increases in disorder offenses, including non-aggravated assaults, drug, and alcohol offenses (Rhubart & Brasier, 2019). Social disorder-based offenses may be more concerning to boomtown residents than violent crime, expressing fear of increases in impaired or dangerous drivers, drug use, and other social disorder-related offenses (Ruddell & Ortiz, 2015).

Furthermore, future research ought to examine the crime rate difference between vertical and horizontal drilling. Current research does not distinguish these two forms of ONG extraction, despite the fact there is a labor difference. Oil and natural gas may be extracted through either method (i.e., vertical, or horizontal), however, vertical drilling is less labor intensive than horizontal drilling (Zrinski, 2014). Vertical wells typically require 20-22 laborers to bring a well to the production stage, whereas horizontal wells require between 400-410 laborers to bring a well to the production stage (Zrinski, 2014). Moreover, horizontal wells require laborers to maintain the site for a longer period, compared to vertical wells (Denton, 2022). This approach would help to determine whether the type of extraction used, influences change in crime rates.

Additionally, future research would examine a broader geographic range of ONG producing regions. Given the rate of ONG development expansion in the world, crime correlation across different regions beyond the U.S. may provide better insight into how ONG activity levels impact its host community. As O'Connor (2017) suggested, "different [areas] might experience increases and decreases in crime and disorder differently…[and]… depends on a combination of complex factors including resources, size, history, culture, work camp locations, worker migration, and previous experiences with booms and busts." Researchers, consequently, should explore whether geographic regions that have a history in ONG boom and busts differ in response to rapid social change brought by ONG production from those communities who have never had such industrial activity occur, lacking such experience with the ONG industry. In the end, history and context matter.

Concluding Comments

Establishing a gold standard for the statistical analysis of change data associated with resource extraction boom and bust periods is one of the most formidable obstacles facing correlational research. As the literature review illustrated, there appears to be no consensus in terms of what constitutes the most appropriate designation for when a resource-based boom or bust occurs. This study took the position that the identification of a specific boom and bust period is inapplicable to Texas, which reflects numerous booms and busts that vary in place, time, and degree. Thus, dynamic change addresses and remedies many of the shortfalls exhibited in earlier studies exploring ONG related criminal activity.

Previous literature suggests that sudden changes in a community and ongoing social processes weaken and disrupt informal mechanisms of control and, in turn, increase crime. In general, the findings are consistent with previous literature concerning the interrelationships among the structure of counties, the ability of residents to establish effective mechanisms of control, and the change in the level of Part I violent and property offense rates. Nonetheless, there are several issues that require further attention and exploration.

In several ways, the results of this study suggest that changes in ONG production levels do not affect known Part I offense rates in general. When offense rates are disaggregated; however, static ONG indicators reveal themselves as significant, including the drilling permit rate and total oil and natural gas production amount. Furthermore, characteristics associated with ONG production, including increases in the rate of males employed in ONG and active liquor license rates, affect known Part I offense rates. In conclusion, social change relating to ONG activity leads to a breakdown in a community's social cohesion, which may lead to an increase in the rate of known Part I violent and property crime.

APPENDIX SECTION

Appendix A. Texas Counties reporting ONG activity from 2009 to 2019

Anderson	Andrews	Angelina	Aransas	Archer	Atascosa
Austin	Bailey	Bandera	Bastrop	Baylor	Bee Bexar
Borden	Bosque	Bowie	Brazoria	Brazos	Brewster
Bexar	Briscoe	Brooks	Brown	Burleson	Burnet
Caldwell	Calhoun	Callahan	Cameron	Camp	Carson
Cass	Castro	Chambers	Cherokee	Childress	Clay
Cochran	Coke	Coleman	Collin	Collingsworth	
Colorado	Comal	Comanche	Concho	Cooke	Cottle
Crane	Crockett	Crosby	Culberson	Dallam	Dallas
Dawson	Deaf Smith	Delta	Denton	DeWitt	Dickens
Dimmit	Donley	Duval	Eastland	Ector	Edwards
Ellis	El Paso	Erath	Falls	Fannin	Fayette
Fisher	Floyd	Foard	Fort Bend	Franklin	Freestone
Frio	Gaines	Galveston	Garza	Gillespie	Glasscock
Goliad	Gonzalez	Gray	Grayson	Gregg	Grimes
Guadalupe	Hale	Hall	Hamilton	Hansford	Hardeman
Hardin	Harris	Harrison	Hartley	Haskell	Hemphill
Henderson	Hidalgo	Hill	Hockley	Hood	Hopkins
Houston	Howard	Hunt	Hutchinson	Irion	Jack
Jackson	Jasper	Jefferson	Jim Hogg	Jim Wells	Johnson
Jones	Karnes	Kaufman	Kendall	Kennedy	Kent
Kerr	Kimble	King	Kleberg	Knox	Lamar
Lamb	Lampasas	La Salle	Lavaca	Lee	Leon
Liberty	Limestone	Lipscomb	Live oak	Llano	Loving
Lubbock	Lynn	Madison	Marion	Martin	Mason
Matagorda	Maverick	McCulloch	McLennan	McMullen	Medina
Menard	Midland	Milam	Mills	Mitchell	Montague
Montgomery	Moore	Morris	Motley	Nacogdoches	Navarro
Newton	Nolan	Nueces	Ochiltree	Oldham	Orange
Palo Pinto	Panola	Parker	Parmer	Pecos	Polk
Potter	Rains	Randall	Reagan	Real	Red River
Reeves	Refugio	Roberts	Robertson	Rockwall	Runnels
Rusk	Sabine	San August	San Jacinto	San Patricio	San Saba
Schleicher	Scurry	Shackelford	Shelby	Sherman	Smith
Somervelle	Starr	Stephens	Sterling	Stonewall	Sutton
Tarrant	Taylor	Terrell	Terry	Throckmorton	Titus
Tom Green	Travis	Trinity	Tyler	Upshur	Upton
Uvalde	Val Verde	Van Zandt	Victoria	Walker	Waller
Ward	Washington	Webb	Wharton	Wheeler	Wichita
Wilbarger	Willacy	Williamson	Wilson	Winkler	Wise
Wood	Yoakum	Young	Zapata	Zavala	

Appendix B. UCR Part I

Criminal homicide, which the Federal Bureau of Investigation (F.B.I.) defines as a.) Murder and nonnegligent manslaughter: the willful (nonnegligent) killing of one human being by another. Deaths caused by negligence, attempts to kill, assaults to kill, suicides, and accidental deaths are excluded. The program classifies justifiable homicides separately and limits the definition to: (1) the killing of a felon by a law enforcement officer in the line of duty; or (2) the killing of a felon, during the commission of a felony, by a private citizen. b.) Manslaughter by negligence: the killing of another person through gross negligence. Deaths of persons due to their own negligence, accidental deaths not resulting from gross negligence, and traffic fatalities are not included in the category Manslaughter by Negligence.

Forcible rape—The carnal knowledge of a female forcibly and against her will. Rapes by force and attempts or assaults to rape, regardless of the age of the victim, are included. Statutory offenses (no force used—victim under age of consent) are excluded.

Robbery—The taking or attempting to take anything of value from the care, custody, or control of a person or persons by force or threat of force or violence and/or by putting the victim in fear.

Aggravated assault—An unlawful attack by one person upon another for the purpose of inflicting severe or aggravated bodily injury. This type of assault usually is accompanied by the use of a weapon or by means likely to produce death or great bodily harm. Simple assaults are excluded.

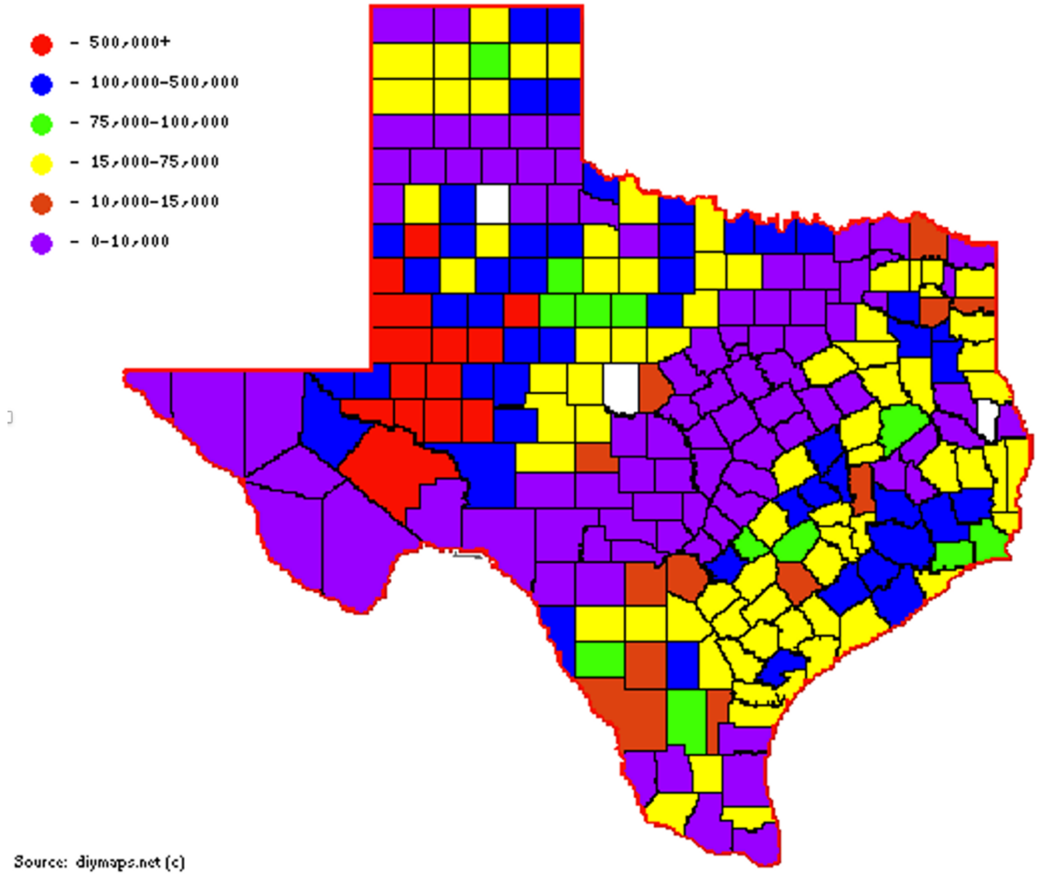
Burglary (breaking or entering)—The unlawful entry of a structure to commit a felony or a theft. Attempted forcible entry is included.

Larceny-theft (except motor vehicle theft)**—**The unlawful taking, carrying, leading, or riding away of property from the possession or constructive possession of another. Examples are thefts of bicycles, motor vehicle parts and accessories, shoplifting, pocket-picking, or the stealing of any property or article that is not taken by force and violence or by fraud. Attempted larcenies are included. Embezzlement, confidence games, forgery, check fraud, etc., are excluded.

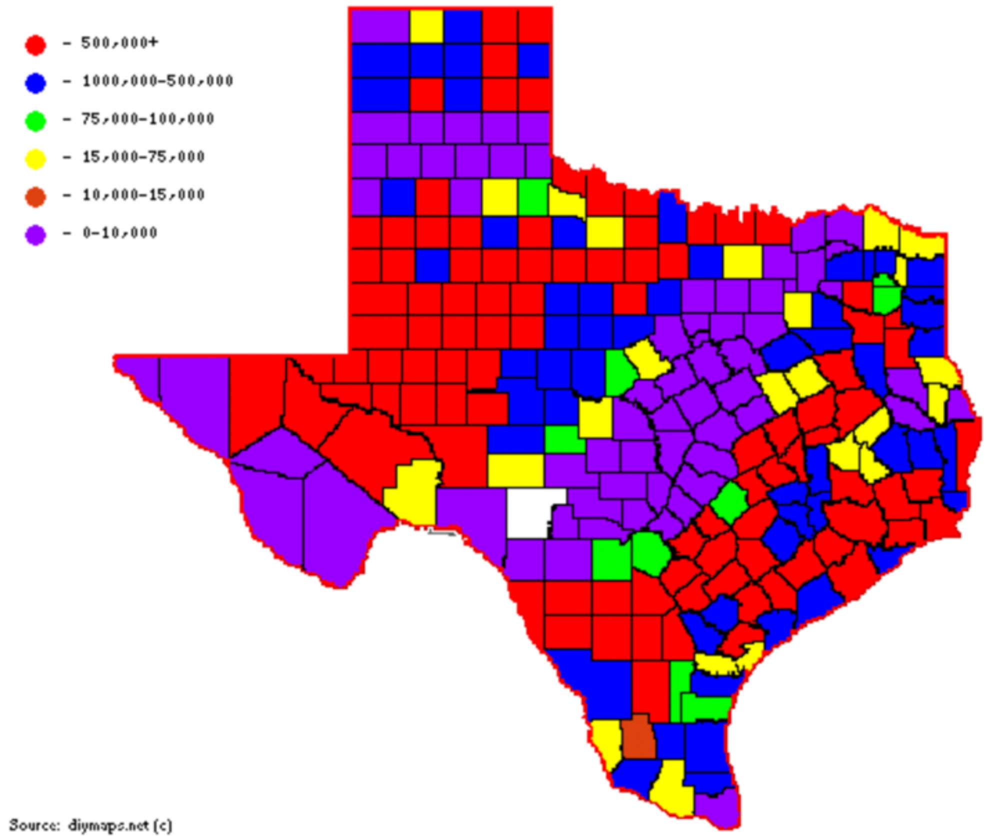
Motor vehicle theft—The theft or attempted theft of a motor vehicle. A motor vehicle is self-propelled and runs on land surface and not on rails. Motorboats, construction equipment, airplanes, and farming equipment are specifically excluded from this category.

Arson—Any willful or malicious burning or attempt to burn, with or without intent to defraud, a dwelling house, public building, motor vehicle or aircraft, personal property of another, etc.

Appendix C. 2009 Texas color coded map for oil production by county

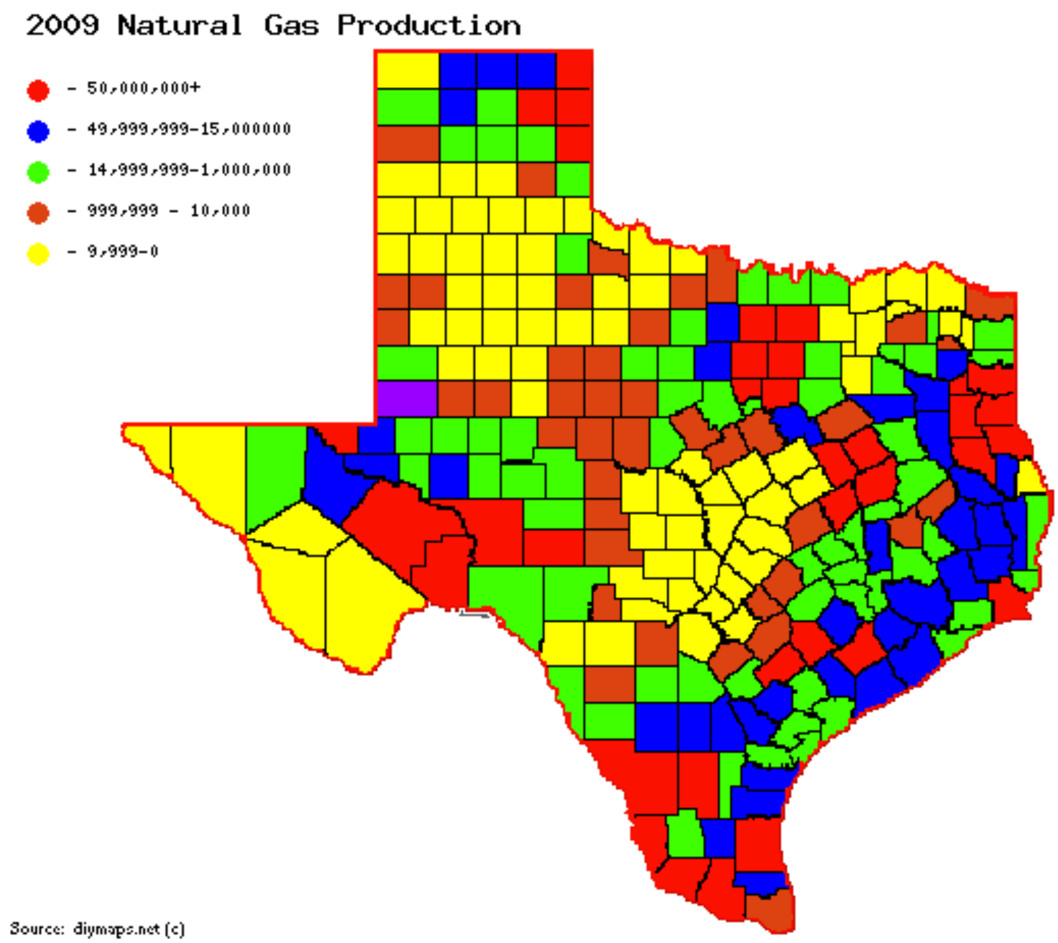


Appendix D. 2019 Texas color coded map for oil production by county

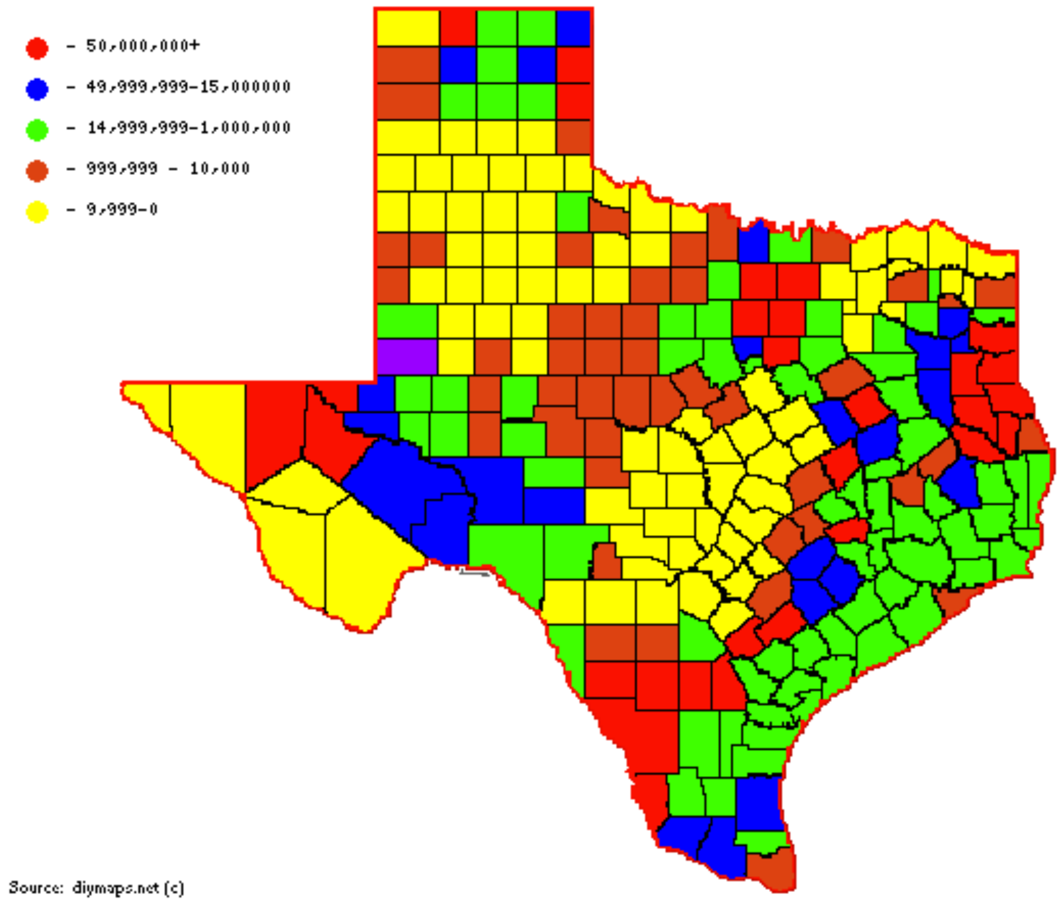


Note. Oil production is measured in barrels.

Appendix E. 2009 Texas color coded map for natural gas production by county



Appendix F. 2019 Texas color coded map for natural gas production by county



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