

Drilling Down for Answers: Unmasking the Impact of Oil and Natural Gas Activity on Crime Rates in Texas

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Abstract

This article delves into the impact of oil and natural gas (ONG) production on the incidence of Part I violent crimes in Texas. Texas holds a prominent position in the energy industry, contributing to 43% of the nation's crude oil production and 26% of its natural gas production (EIA, 2021). However, alongside ONG operations come significant societal changes, including a rise in various social issues, including criminal activities. While prior research has explored the consequences of ONG-related transformations on crime rates through perceptual and economic studies, there is a scarcity of studies that investigate the intricate relationship between ONG activities and crime patterns, particularly in the Texan context. To bridge this research gap, this study employs residual change scores and multiple linear regression techniques to scrutinize county-level shifts in ONG activity and Part I violent crime incidents during the period spanning 2009 to 2019 across Texas ONG-producing counties. The findings derived from this investigation unveil a noteworthy association between six dynamic ONG measures and the alteration in specific known Part I violent crimes. This study makes a noteworthy contribution to the existing body of knowledge concerning rural crime and boomtown dynamics as it stands as the inaugural examination utilizing residual change score analysis to determine whether ONG activity indeed contributes to any variations in known Part I violent crime rates. By scrutinizing the intricate connection between energy production and crime, this research aids in fostering a better understanding of the social implications of ONG activities in resource-rich regions, particularly within Texas.

Keywords: boomtown, boomtown effects, residual change score, Part I known violent offenses, social change

Dedication

To Rick Ruddell, a dear friend and mentor. May this article continue his legacy.

Introduction

The recognized nexus between surges in resource-based economies and criminal activities, scrutinized by Gourley and Madonia (2018), James and Smith (2018), and Komarek (2018), lacks substantive empirical examination regarding its specific ramifications in Texas. Texas, widely acknowledged as the "oil state" due to its dominant role in oil and gas production, (Denning, 2022, para. 2), serves as a compelling yet underexplored terrain to unravel the intricate dynamics between economic booms and crime rates. Population booms from rapid resource extraction have well-documented adverse effects, straining infrastructure and services and leading to inadequate access to necessities (Covey & Menard, 1983; Crank, 2003; UNEP, 2017). Housing shortages, rising rent prices, and informal settlements can further exacerbate social inequality (UN-Habitat, 2003). While the negative impacts on communities are acknowledged, studies on crimes related to oil and gas activities remain limited (Archbold et al., 2014; Gourley & Madonia, 2018; O'Connor, 2015; Ruddell et al., 2022; Ruddell & Ortiz, 2015). This gap emphasizes the need for a comprehensive investigation into the relationship between oil and gas (ONG) activities and criminal behavior, particularly in Texas.

As a significant player in ONG production, Texas is uniquely positioned to address this research gap and contribute to understanding how such activities influence crime rates. This analysis begins by examining the broader societal shifts associated with ONG operations, contributing to a boomtown environment, and highlighting the emergence of social issues, notably criminal activities. An examination of current literature underscores the necessity for a nuanced exploration firmly rooted in the Texan context. The following sections also delineate this study's unique methodological approach, which employs residual change scores and multiple linear regression techniques. Additionally, this study integrates the social disorganization theory to provide a comprehensive lens through which to understand the complex interplay between resource-based economic booms, crime, and the socio-geographic dynamics of boomtowns in Texas. This study will ultimately culminate in a discussion of the findings, delving into the implications for Texas communities grappling with swift population changes fueled by oil and gas production.

Resource-Based Boomtowns

The urgent need to investigate resource-based booms becomes increasingly pronounced amid the rapid exploration and development of new natural resource locations. Notably, the United States is believed to possess greater oil reserves than either Saudi Arabia or Russia (Wright, 2018), with Texas holding the largest continuous oil accumulation assessed in the U.S. to date (USGS, 2016, para. 3). Texas, renowned as the foremost ONG producer among all U.S. states (Denning, 2022; EIA, 2021), experiences profound socioeconomic changes during resource-based booms. These booms trigger demographic shifts and the formation of "boomtowns," leading to social and environmental dilemmas. The influx of workers results in makeshift accommodations, rapid infrastructure strain, and

problems including overcrowding and substandard housing (Ruddell, 2017, p. 193; Morrison et al., 2012).

The implications extend beyond population growth, however, manifesting in an increase in public order offenses related to alcohol, drugs, driving under the influence, and prostitution (Ruddell & Ray, 2018). Heightened demands for critical infrastructure and protective services, including emergency response, fire management, and law enforcement, further challenge communities (Ruddell, 2011). Ultimately, the strain on resources results in a deterioration of residents' overall quality of life, notably associated with the nexus between ONG production and criminal activities. The subsequent analysis delves into studies examining the connection between boomtown dynamics and criminal activity. This focused inquiry aims to provide valuable insights into how these dynamics unfold within communities undergoing rapid changes due to the influence of oil and gas production.

ONG Boomtowns and Crime

A developing body of research reveals the connections between the expansion of resource-based booms and crime. Most studies examining the boomtown-crime relationship reveal increases in crime after the start of the boom (Freudenburg & Jones, 1991; Ruddell, 2017; Stretesky & Grimmer, 2020). These studies, however, are limited since they do not focus on the greatest oil-producing state in the United States, nor do they use reliable statistical techniques for measuring change, such as residual change scores. This study addresses both of those limitations.

Investigations into boomtowns typically indicate that rising crime rates in resource-dependent booming towns are often linked to rapid population expansion, particularly an influx of young males seeking job opportunities (O'Connor, 2015). The increases in crime within these boomtown communities are often driven by offenses typical of an increased population of young males, including simple assault, driving under the influence, disorderly conduct, and drug-related offenses (Archbold et al., 2014; Rhubarb & Brasier, 2019; Ruddell et al., 2018; Ruddell et al., 2020). Researchers have additionally found that communities that experience rapid population growth due to natural resource extraction may also face increases in suicide (Seydlitz et al., 1993). In short, the presence of a large transient population comprised of temporary workers, which is typical within ONG extraction, can contribute to the prevalence of such criminal activities and social ills.

An additional community-based change associated with boomtown growth is the number of law enforcement officers within boomtowns (Ruddell, 2011). Several studies have shown that the local justice system in boomtown communities is often unable to meet the demands for service (Archbold, 2015; Ruddell, 2017). As a result, the threshold for arrests is increased and acts that warrant an arrest before the boom may not be sanctioned by the police because of their amplified workloads. Ruddell (2011) also highlighted the strain on infrastructure and protective services, including emergency, fire, and law enforcement, as a consequence of resource-based booms. This strain often results in delayed response times,

inadequate coverage, and reduced effectiveness in addressing criminal activities. (Ruddell, 2011). Resource-based booms can ultimately overwhelm the capacity of local law enforcement and public services, leading to challenges in maintaining public order and safety.

Notably, some studies report contradictory findings regarding the relationship between crime and population growth attributable to ONG activity. For example, Ruddell, Jayasundara, Mayzer and Heitkamp's (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, nonetheless, have a profound impact on community residents.

Although researchers have preliminarily established links between ONG booms and crime, there has been comparatively little prior examination or focus on the impact of resource-based booms and crime in Texas. Most research examining the impacts of resource-based booms focus almost exclusively on Colorado (Gourley & Madonia, 2018), Montana (Ruddell et al., 2014), North Dakota (Archbold, 2015; Ruddell et al., 2014; James & Smith, 2017), Louisiana (Luthra et al., 2007), and Wyoming (Krannich et al., 1985). There are only a handful of studies that include Texas; however, they do not exclusively focus on Texas. For example, Haggerty et al. (2014) examined Texas and five other ONG-producing U.S. States from 1980 to 2011, revealing that long-term specialization in oil and gas had negative effects on changes in per capita income, crime rates, and education rates. Building on the broader examination of ONG-producing states' crime rates, Texas stands prominently among them, as investigated by James and Smith (2017). Despite its significance, there remains a notable void in the literature as no exclusive study has been conducted to scrutinize Texas in the context of ONG-related crime. This study takes on the crucial task of addressing this gap, focusing squarely on Texas and meticulously exploring the influence of ONG production between 2009 and 2019 on violent crime rates within the state.

Texas - the Oil State

Texas has solidified its standing as the foremost oil state, primarily attributable to its unrivaled position as the top producer of oil and natural gas (ONG) nationwide, as underscored by Denning (2022) and the Energy Information Administration (EIA) in 2021. Texas' success and failure, consequently, depend in large part on the success and failure of the ONG industry. A stark illustration of this interdependence unfolded in 2014 when plummeting oil prices led to Texas experiencing a notable dip in job growth, marking the first instance in over 12 years that the state lagged behind the national average, as highlighted by 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 reaps the financial rewards brought by oil and natural gas (ONG) development but is also ensnared in the financial pitfalls associated with the cyclical nature of resource development,

characterized by booms and busts. Rapid demographic shifts, a consequence of this fluctuating cycle, contribute to some of the downsides associated with boomtown growth in the state.

Texas boomtowns, like most other boomtowns, are characterized by an influx of young transient males. 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 (Olien & Olien, 1982). In 2000, most census tracts in the Eagle Ford Shale region were above 50% male (Stanley, 2018). Rapid population increases, in general, are indicative of Texas boomtown growth. 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, which tripled in less than three months to 50,000 people (Yergin, 2011). In the early 1900s, Necessity, Texas, rose in population by 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, due to 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).

The remarkable population surges in Texas boomtowns, historically and contemporarily, underscore an enduring pattern of transformative societal shifts, particularly in once-rural communities. As Midland and Carrizo Springs experienced substantial growth due to natural gas fracking, and historical instances like Beaumont's explosive expansion following the 1901 oil discovery demonstrate, even modest increases in percentage can strain these communities. The persistence of such demographic upheavals highlights the intricate challenges inherent in the evolution of Texas boomtowns, marking a crucial aspect of their dynamic and evolving socio-economic landscape. The ensuing section will thoroughly examine the Social Disorganization Theory (SDT) and its applicability to the intricate dynamics of both boomtowns and the related crime. This analysis aims to elucidate the potential sociological mechanisms that underlie these complex phenomena.

Theoretical Explanations of the Boomtown-Crime Relationship

The selection of SDT as the theoretical framework for this study is grounded in its widespread application and effectiveness in explaining the increased crime observed in boom communities. Over the period from 2005 to 2019, more than 60% of studies exploring the connection between oil and gas (ONG) activity and crime have utilized SDT (Berger & Beckmann, 2010; Deller and Schreiber, 2012; Gorley & Madonia, 2017; Luthra et al., 2007; Ruddell et al., 2014; Stretesky et al., 2018; Stretesky & Grimmer, 2020). According to Shaw and McKay's seminal work (1942), social disorganization occurs when there is a breakdown of social norms, values, and institutions within a community, creating an environment conducive to crime and deviance.

SDT posits that structural characteristics, such as poverty, residential mobility, and ethnic heterogeneity, contribute to social disorganization, leading to an increase in criminal activities. Oil and gas booms, characterized by a sudden influx of people into stable communities, strain social structures like schools, housing, healthcare, and law enforcement, creating conditions ripe for social disorganization (Bristol, 2022). The rapid population increase can overwhelm institutions, making it challenging to meet the evolving needs of the community.

Additionally, the transient nature of the workforce during booms results in residential instability, with workers residing temporarily in overcrowded housing, disrupting social networks and weakening community ties, further contributing to social disorganization (Ruddell, 2017; Gourley et al., 2018). Economic disparities arising from rising living costs during resource-based booms may increase crime rates, as individuals facing hardships may resort to illegal activities, thereby fueling social disorganization (Parkins & Angell, 2011; Sampson et al., 2002).

Boomtowns may struggle to maintain infrastructure due to rapid population growth and limited resources, leading to challenges during both boom-and-bust cycles (Garcia, 2013). Economic and social upheaval during busts, marked by unemployment, poverty, and social malaise, leaves communities economically disadvantaged (O'Connor & Ruddell, 2021; Lawrie et al., 2011; Bradbury & St-Martin, 1983; Neil et al., 1992; Jacobsen & Parker, 2016).

In summary, SDT is chosen due to its widespread application and ability to explain the impact of rapid socio-economic changes, such as oil and gas booms, on social cohesion and deviant behavior. The theory aligns with the observed dynamics of resource-based booms, ranging from the strain on social institutions to the disruption of social networks and the exacerbation of economic disparities. This choice is critical for identifying sustainable strategies to mitigate the challenges faced during both boom-and-bust cycles in oil and gas boom communities.

Social Disorganization Theory and County-Level Analyses

To explore SDT, 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, SDT is primarily applied to neighborhoods (Osgood & Chambers, 2003). It is important to emphasize the central theme of SDT at this point – which is that location matters concerning predicting illegal activity (Shaw & McKay, 1969). Specifically, delinquency is a response to abnormal conditions that arise within the community context (Zembroski, 2011). This response may be attributed to a collapse of community-based controls and rapid growth (Shaw & McKay, 1969). These features are not unique to neighborhoods but are experiences that may be felt within larger areas, including rural communities (Osgood et al., 2003). Therefore, the same system of relationships that are important to crime and delinquency in urban neighborhoods is also relevant to small towns and rural communities (Osgood et al., 2003).

Expanding SDT 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 and 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, 2020). 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). Therefore, applying SDT to counties, as opposed to limiting its application to only neighborhoods, allows for a better understanding of location/crime dynamics.

Methods

This study examined how change in ONG activity affected violent crime rates (2009 to 2019) among Texas counties while considering social change factors and other known crime predictors. The population of this study includes 96% of Texas ($n = 245$) counties to determine the extent that ONG activity affects changes in Part I known violent offenses. No comparison group (non-ONG counties) is included as other studies have utilized (Gourley & Madonia, 2018; O'Connor, 2017; Rhubart & Brasier, 2019; Ruddell, 2014) because Texas does not have enough non-ONG-producing counties to compare.¹ Accordingly, two time periods (2009 and 2019) are examined to assess the effects of ONG production on Texas county level known Part I violent crime rates.

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 violent 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 annual law enforcement Texas County population. These data were requested and received via a Freedom of Information Act request.

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 high school education, law enforcement strength, active liquor license rate, poverty rate, percent renter occupancy, percent males employed in ONG, total oil produced, total natural gas produced, total drilling permits, and the annual rate of known Part I violent offenses.² The rate is measured as the

¹ Texas reflects eleven counties in 2009 and 2019, that did not produce oil and/or natural gas.

² The selection of independent variables in this study is informed by seminal works exploring rapid population change. Thomas & Znaniecki's (1920's) study on industrialization and immigration in traditional rural communities is foundational, influencing the consideration of variables such as population size, racial composition, and education levels. Elements from Shaw and McKay's Social Disorganization Theory (1942),

total number per 10,000 population. Each of these variables' sources and measurements is discussed below.

Analytical Strategy

In addition to assessing the 245 Texas Counties through descriptive statistics, the following research questions were assessed: (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 do static and dynamic processes influence the mechanisms of change in violent crime rates among Texas counties (211 ONG-producing and 34 non-ONG-producing) from 2009 to 2019, taking into account various social change factors? The formulation of the research questions was intricately shaped by a thorough examination of the existing literature, particularly focusing on the dynamic relationship between oil and gas (ONG) activity and crime rates in the context of Texas counties. The literature review uncovered a significant body of work that explored the phenomenon of crime in the context of ONG boomtowns, shedding light on both the positive and negative correlations between economic activities associated with the industry and crime rates. Recognizing the nuanced nature of this relationship and the need for a comprehensive investigation, the research questions were carefully crafted to assess the extent to which changes in ONG activity, static and dynamic, contribute to alterations in violent crime rates over the span of a decade (2009 to 2019) in Texas counties. The specific choice of the timeframe was informed by the temporal dynamics observed in the literature, considering the potential lag effects and evolving patterns associated with ONG activity and crime.

Several multiple linear regression models are employed to assess the research questions. Given that the dependent and several of the independent variables are continuous, multiple linear regression is appropriate (Peng et al., 2002). Overall, this analysis is used to determine the significance of the multiple continuous predictor variables related to social change and other known criminal predictors on change in the known Part I violent offense rates. The following sections explain how change was operationalized and specifically modeled using multiple linear regression.

The Measurement of Change

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 the Part I known violent 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.

including poverty rates and renter occupancy, are incorporated for assessing community cohesion. Extending the theoretical framework, Sampson, Raundenbush, & Earls' (1997) insights introduce family disruption, collective efficacy, and acquaintanceship density. Variables related to individual choice and opportunity-focused theories, as well as those pertaining to oil and natural gas production, align with the works of Durkheim and Merton. Considerations of gender, sex, and age are reflected in employment demographics.

Change is operationalized through residual change scores. This is the first study to do so in relation to exploring the impact of a resource-related boom and violent crime. This is also the ideal approach, given that residual change scores provide estimates of change in the level of variables over time (Bursik, 1986a; Bursik, 1986b; Chamlin, 1989a; Chamlin, 1989b; Kisbu-Sakarya et al., 2013). This approach also assesses the expected changes in ONG activity within a county on the unexpected changes in violent offense rates (i.e., the known Part I violent offenses). Residual change scores remove the effects of ongoing processes of change that may be common to all counties, allowing an analysis of the changes in variables of interest that are solely attributable to processes of change within counties (Chamlin, 1989a). Residual change scores are obtained using the following formula:

$$y_{post2009'} = \beta_0 + \beta X_{pre2019} + \epsilon$$

Coefficients are calculated not by subtracting the predicted Time 2 (2019) scores from the observed Time 1 (2009) scores but rather, by regressing the posttest scores of Time 2 onto the pretest scores of Time 1 score and then saving the residuals as its own variable (Paternoster & Brame, 1998). Thus, for purposes of this study, the residuals were first calculated based on the process of regressing each predictor variable measure for Time 1 (2019) on (2009) for every county in Texas ($n = 254$). The residuals for each bivariate regression then constitute the new measure (i.e., the dynamic measure) for inclusion in the model predicting change in Part I known violent crime rates.

For purposes of this study, change in the UCR Part I violent offense rate (Model 1) is thereafter, regressed on the static and dynamic measures of the 12 predictor variables. Ultimately, running multiple linear regression will reflect whether there is a relationship between ONG activity in Texas counties and change in the Part I known violent offense rates.

Exploration of the predictive validities of assessments of 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, 2006; Wormith et al., 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 crime rates in Texas counties.

Multiple Linear Regression

Utilizing multiple linear regression serves three purposes: it assesses variable relationships, predicts effects, and forecasts trends by quantifying the impact of independent variables on dependent variables, making predictions, and estimating trends through hypothetical variable manipulation (Abdullah & Rahim, 2016). The projection for purposes of this study may be that a county may have 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 between 12 predictor variables, static and dynamic, and potentially exercising the ability to predict possible outcomes on the known Part I violent offense rates based on the results. The predictor variables include 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, the total amount of oil produced, the total amount of natural gas produced, number of annual drilling permits and two separate dependent variables, and change in the Part I violent crime rate. As a reminder, these regression analyses involve regressing change in Part I violent offenses (Model 1) on static and dynamic measures of the predictor variables (Model 2 and Model 3) using the unstandardized residual change scores as the outcome.

Characteristics of Texas Counties

The Texas Department of Agriculture (2018) identified rural counties as those with a population of 150,000 or less. Regarding change from 2009 to 2019, the average population among these counties in 2009 was 91,242 ($n = 245$), while the average population in 2019 was 106,119. The average increase from 2009 to 2019 among these counties, therefore, was 14,877 ($n = 245$)³.

The demographics and other characteristics of this population also changed from 2009 to 2019 (see Table 4). 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 between 2009 and 2019 also substantially changed. In 2009, there was less than 1 liquor license per 10,000 Texas residents; in 2019, there were more than 2 liquor licenses per 10,000 Texas residents.

Though less dramatic, other changes occurred regarding the other county characteristics. For example, the law enforcement strength rate between 2009 and 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 2.9 full-time law enforcement officers per 1,000 inhabitants (Banks et al., 2016). There were nearly 16 law enforcement officers per 10,000 residents in jurisdictions reporting between 50,000 to 100,000 residents (Maciag, 2014). Consequently, Texas reflects a less-than-average law enforcement strength rate. Also, the average percentage of non-Hispanic Blacks decreased slightly from 2009 (14%) to 2019 (13%). The average percentage of renter-occupied homes

³ Nine counties, including Andrews, Ector, Gaines, Tarrant, Kenedy, Loving, Sherman, Terrell, and Yoakum, were omitted from the sample because they were outliers and needed to be removed in order to employ multiple regression.

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 1

Characteristics of counties in Texas (n = 245)

| County Characteristic | 2009 Average (s.d.) | 2019 Average (s.d.) | 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) |
| Renter occupancy rate | 21.23 (6.80) | 21.75 (7.71) | 2.00 (46.95) | 2.14 (46.74) |
| 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.

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

Violent Crime Change Among Counties in Texas

Concerning Part I violent crime rates, the overall average from 2009 to 2019 likely declined (see Table 2). The known Part I violent crime rate was largely driven by the rate of rape. 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 UCR rape definition revision (FBI, 2014). 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, 2014). In 2013, the term “forcible” was replaced with “a lack of consent” from the definition of offense. 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, 2014). Once rape was omitted from the model, the violent crime rate declined. 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.

Table 2

Descriptive statistics in 2009 and 2019 of Texas County Part I Violent 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) |

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 between 2009 and 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 (see Table 6). 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 between 2009 and 2019 (reflecting an 88,058 McF production difference). There was, however, a notable

increase in the maximum amount of natural gas produced. The number of drilling permits nearly doubled from 2009 to 2019, increasing from 53 to 58 permits. In summary, Texas had more oil production, stable natural gas production, and increased drilling permits from 2009 to 2019.

Table 3

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) |

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

Assessing Violent Crime Change from 2009 to 2019 in Texas Counties

This study used several multiple linear regression analyses to address the research questions. To assess 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. The predictor variables accounted for 9.3% of the variation in the change of Part I violent offense rates, as revealed by the R² in Table 4. The model reflected two statistically significant predictor variables that affect the change in the rate of change in the known Part I violent offense rates, including the total amount of oil produced and the number of drilling permits.

Table 4

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

| | Part I Violent Crime Rates | |
|--|-----------------------------------|----------------------|
| | Static Effects Beta | Dynamic Effects Beta |
| Population size | 0.077 | -0.189* |
| Percent Non-Hispanic Black | -0.020 | 0.099 |
| Percent Hispanic | 0.065 | -0.063 |
| Percent of males employed in ONG | 0.079 | -0.172* |
| Percent of males with less than a high school education | 0.085 | 0.066 |
| Percent renter occupied homes | 0.061 | -0.023 |
| Law enforcement strength rate | -0.027 | -0.042 |
| Active liquor license rate | 0.046 | -0.012 |
| Poverty rate | -0.163* | -0.112 |
| Total oil produced (barrels) | 0.251** | 0.037 |
| Total natural gas produced (McF) | 0.137 | 0.129 |
| Drilling permits | -0.296* | -0.042 |

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

Table 4 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 R². 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. Additionally, the static predictor variables, drilling permits (B = -.225, p < .05) are associated with change in the known Part I violent offense rate. This relationship, however, reveals that as the number of drilling permits increase, change in the known Part I violent offense rate decreases.

The known Part I violent offense rates were disaggregated and assessed for notable effects. Ultimately, the disaggregated known Part I violent offense rates of robbery and aggravated assault were selected and are presented in Table 5.

Table 5

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 Rate | |
|--|-----------------------------|-------------------------|---------------------------------------|-------------------------|
| | Static Effects Beta | Dynamic Effects Beta | Static Effects Beta | Dynamic Effects Beta |
| Population size | 0.136* | -0.178* | 0.095 | -0.196* |
| Percent Non-Hispanic Black | -0.002 | 0.236*** | 0.003 | 0.054 |
| Percent Hispanic | 0.075 | -0.009 | 0.042 | -0.062 |
| Percent of males employed in ONG | 0.111 | -0.196** | -0.002 | -0.130* |
| Percent of males with less than a high school education | -0.085 | 0.076 | 0.087 | 0.056 |
| Percent renter occupied homes | 0.095 | 0.112 | 0.032 | 0.017 |
| Law enforcement strength rate | 0.017 | 0.027 | -0.031 | -0.095 |
| Active liquor license rate | 0.002 | -0.039 | 0.052 | -0.045 |
| Poverty rate | -0.104 | 0.033 | -0.077 | -0.123 |
| Total oil produced (barrels) | 0.030 | -0.057 | 0.271** | 0.113 |
| Total natural gas produced (McF) | 0.075 | 0.002 | 0.112 | 0.131* |
| Drilling permits | -0.104 | 0.059 | -0.300* | -0.078 |
| R2 Nagelkerke | Adjusted R2 0.109 | | R2 Nagelkerke 0.161 Adjusted R2 0.067 | |
| | 0.199 | | | |

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

The analyses revealed that change in the total amount of natural gas production ($B = .131, p < .05$) is associated with change in the known Part I aggravated assault rates. As the total amount of natural gas produced increases, so too does the rate of change in known Part I aggravated assaults. Whereas the static effect of the total amount of oil reflects a significant positive effect on change in the known Part I rate of aggravated assault ($B = .271, p < .01$). Put another way, aggravated assault rates increase as the amount of oil increases.

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 percent of males employed in ONG ($B = -.196, p < .01$) is associated with change in the known Part I robbery rate. Thus, change in the known Part I rate of robbery decreases as the percent of males employed in ONG increases.

The number of drilling permits reflects a negative effect on the change in the known Part I aggravated assault rates ($B = -.300, p < .01$). Meaning as drilling permits increased, the known Part I known violent offense of aggravated assault decreased. These findings are discussed in greater detail in the following section.

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, change in the known Part I rate of rape decreases.

Notably, the static effect of natural gas ($B = .260, p < .05$), influences change in the known Part I murder rates. In other words, as the total amount of natural gas produced increases, so too does the change in the known Part I murder rate.

Discussion and Conclusion

This study emerges as a significant endeavor aimed at bridging the existing void in the literature by delving into the complex relationship between ONG activity and crime rates. This study's primary objective was to investigate whether ONG activity in Texas changed violent crime rates. Employing residual change scores as a critical analytical tool, the study revealed a connection between ONG activity and changes in violent crime rates. The findings from this study also suggest that both static and dynamic processes are important to improve identifying mechanisms of change. Yet, as discerned from the analyses, this relationship is contingent upon the specific resource being examined (whether oil or natural gas production) and is influenced by associated factors.

When analyzing Texas county characteristics, there were major shifts in several variables, including poverty and liquor license rate. The rate of poverty in Texas, for example, decreased from an average of 344 per 10,000 in 2009 to 287 in 2019. This sizable decrease in the poverty rate may be attributable to the Great Recession, an economic period from 2007 to 2009 that caused economic downturns throughout the country (Weinberg,

2013). In the wake of the Great Recession, governments and organizations nationwide enacted numerous policy measures and programs to mitigate the adverse effects of the economic downturn (Auerbach et al., 2010). These interventions included targeted assistance to unemployed individuals, expansions of safety net programs, and initiatives to stimulate economic growth (Cazes et al., 2011). Over time, as the economy gradually recovered from the recession's aftermath, some of these efforts bore fruit, reducing the poverty rate (Cazes, et al., 2011). Job markets, however, improved, enabling individuals to regain employment and stabilize their financial circumstances (Cazes et al., 2011). Hence, the reduction in the poverty rate may not necessarily be attributable to increases in ONG activity but instead could be indicative of the economic effects stemming from the aftermath of the Great Recession.

Additionally, the rate of active liquor licenses among Texas residents increased from less than 1 liquor license per 10,000 Texas residents to more than 2 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).

Implications of the Significant Static and Dynamic Measures

The dynamic analysis results indicate that only a handful of the theoretically informed variables were significant predictors of change in the known Part I violent offense rates among Texas counties. Specifically, among the correlations associated with change in the known Part I violent offense rate from 2009 to 2019, three of the dynamic predictor variables changed significantly, which included population size, the percent of males employed in ONG, and the total amount of oil produced. ONG dynamic measures reflected appreciable effects on change in the known Part I violent offense rates.⁴

Ultimately, the findings underscore the lifecycle of the ONG process, unveiling notable impacts across each phase of its progression. To start, the static measure of drilling permits reflects a decline in the known Part I violent offense rates and across the disaggregated violent 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. An ONG company is legally not allowed to put a drill bit to dirt until they first obtain a drilling permit. Specifically, within the framework of state regulations, an ONG company is legally mandated to secure a drilling permit before commencing any physical operation (Righetti, 2020). This requirement serves as a critical gatekeeping mechanism to ensure that environmental, safety, and legal considerations are adequately addressed before ground-

⁴ Recall, ONG measures included the percent of males employed in ONG, the total amount of oil produced, total amount of natural gas produced, and number of drilling permits.

breaking activities commence (Righetti, 2020). However, a considerable number of these initially sought-after drilling permits fail to materialize into actual drilling activities (Cunningham et al., 2021). This phenomenon, where drilling permits remain unrealized, underscores the intricate complexities of the ONG industry.

Further, even if the well is drilled, it may not be completed (allowed to produce) for months or even years (Lieskovsku & Yan, 2019). Producers may decide not to complete a well for several reasons, including economic reasons (the market price for ONG is not in their favor, for example) (Lieskovsku et al., 2019).⁵ 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 have not occurred yet.

This allows us to turn to the second seemingly unexpected yet related result, 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 studies have likewise found significant and negative associations between the 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. However, this result makes sense if one considers that oil production indicates a workforce, and employment typically decreases violent crime rates (Luthra et al., 2007).

Likewise, it appears that a change in the percent of males employed in ONG also produces a significant negative effect on change in the known Part I robbery rates. In simpler terms, as the percentage of males employed in the ONG sector rises, the change in the known Part I robbery rates decreases. This outcome could be illuminated through the lens of routine activity theory, which posits that criminal incidents transpire when three fundamental elements converge: (1) a motivated offender, (2) a suitable target, and (3) the absence of a capable guardian (Cohen & Felson, 1979). In this context, the influx of employment opportunities in the ONG industry could potentially contribute to a shift in the routine activities of potential offenders. As more individuals find legitimate employment, the allure of criminal activities like robbery may diminish due to the increased presence of capable guardians in the form of employed individuals who are less likely to engage in criminal acts. This alteration in the balance of routine activities aligns with the principles of routine activity theory, which underlines the significance of these three pivotal factors in shaping the occurrence of criminal incidents within a given environment.

The percentage of males employed in ONG did show a significant positive effect in relation to violent crime within the disaggregated violent crime model. Change in the percent

⁵ "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.

of males employed in ONG showed a significant and positive effect on change in the known Part I aggravated assault rates. Notably, aggravated assault was also a significant outcome variable for the static total amount of oil produced and change in the amount of natural gas produced. These results, taken together, are not surprising in that the oil and gas industry is nearly 90% male employees, and the majority are between the age of 25 to 35 years of age (BLS, 2020). The median age-crime involvement is 30 years of age and younger for most crimes reported in the FBI's UCR program (Steffensmeier et al., 1998), and males account for nearly 80% of all arrests in the United States for violent crimes 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 you have a change (increase) in the percentage of males employed in ONG, a change in natural gas production, or oil production. Each of these predictor variables consists of male-dominated populations, which are the most likely to engage in this specific form of violence.

The results also revealed that the static amount of oil production is associated with change in the known violent crime rates. In other words, the presence of oil production influences change in the known Part I violent rates when oil production changes. The disaggregated models revealed that the static amount of oil is also associated with a change in assault. Change in the total amount of oil production, however, was *not* associated with any change in the known Part I violent offenses. The static amount of oil production may be associated with change in violent 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 Oil and Gas, 2016). 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 you now have an unemployed or underemployed workforce.

In contrast, change in natural gas production is associated with change in known Part I 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 2-3 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 flows to the surface after a well has been fracked (Rosenblum et al., 2017). Additionally, the flowback water is stored in nearby pool sites, which requires workers thereafter to come in and truck it out for offsite disposal (Rosenblum et al., 2017). 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 (increase) in aggravated assaults – there are simply more males on site for longer periods of time with natural gas production as opposed to oil production.

The profound insights garnered from this extensive study bear immense significance for local government officials striving to formulate proactive strategies that effectively tackle the challenges arising from boomtown dynamics. Building upon and affirming earlier research findings, such as those articulated by Gourley and Madonia (2018) and Komarek (2014), this study establishes a robust connection between natural resource production, well-density, and shifts in violent crime. This correlation underscores the necessity for nuanced, context-specific interventions that account for the intricacies of boomtown environments.

The study reveals that social change characteristics, notably the presence of oil production, play a pivotal role in eroding social cohesion within communities, consequently influencing changes in known Part I violent offense rates. Beyond this, an examination of various community characteristics reflecting change exposes additional dimensions that contribute to the escalation of known Part I violent crime rates across Texas counties. Moreover, the inclusion of control variables reflecting social change in county characteristics underscores the complexity of the relationship and provides a more comprehensive understanding of the factors influencing known Part I violent crime rates.

Social disorganization emerges as a key explanatory variable, measured through county population size, law enforcement strength rate, and the percentage of males employed in the oil and natural gas industry (ONG). This aspect proves crucial in elucidating the differential county change in known Part I crime rates, as increases in these characteristics serve as indicators of social disorganization—a trait and consequence of social change.

As research progresses in this domain, the primary focus will pivot toward a more in-depth exploration of predictor variables associated with aggravated assault and rape. Unraveling the intricate factors contributing to these specific crime types becomes imperative for advancing our understanding of the broader crime landscape. This dedicated inquiry will play a pivotal role in developing targeted crime prevention strategies that address the root causes and dynamics unique to aggravated assault and rape.

In essence, the enigma surrounding the decline in the overall violent crime rate, upon the exclusion of rape, propels the research agenda into a new phase. The commitment to delving deeper into the predictor variables related to specific crime types underscores the dedication to evidence-based approaches in crime prevention. This forward-looking stance not only contributes to the academic discourse but also holds practical implications for the development of more effective and tailored strategies that enhance community safety and well-being.

Local government officials stand to benefit significantly from these findings, gaining a nuanced understanding of the intricate relationship between boomtown dynamics and crime. Armed with this knowledge, officials can tailor interventions to address the specific challenges posed by social change in their communities, ultimately fostering safer and more resilient environments for their constituents. The study's comprehensive insights pave the way for evidence-based policy development, allowing local governments to proactively

mitigate the adverse consequences associated with boomtown dynamics and promote long-term community well-being.

Limitations

Although this study 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. 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 (Maltz, 2000; Strom & Smith, 2017).

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 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. Albeit this measure may still not specifically identify the number of ONG employees within a county. Yet, it 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.

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, construction/maintenance-related employment – not just oil and gas-related jobs. There is no publicly available annual employment data at the county level that only provides 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 and other known crime predictors. 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 et al., 2014). 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 outliers, and sensitivity analyses identified some differences depending on whether the outlier was included or excluded from analyses. Specifically, the moderating impact of ONG production became non-significant by 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.

Additionally, there is a limitation of linearity when using residual change scores to assess change between two points in time is a critical consideration in research methodology. Residual change scores assume a linear relationship between the predictor and outcome variables, meaning they operate under the premise that changes in the predictor variable are consistently associated with proportional changes in the outcome variable. However, many real-world phenomena exhibit nonlinear patterns of change, and the assumption of linearity may oversimplify complex relationships. In instances where the actual relationship between variables is nonlinear, the use of residual change scores can lead to a misrepresentation of the true nature of change over time. Nonlinear patterns may involve acceleration, deceleration, or other curvilinear trajectories that cannot be adequately captured by a linear model. Consequently, the method may fail to accurately reflect the nuances of how changes in the predictor variable relate to changes in the outcome variable.

For example, if the relationship between oil and natural gas (ONG) activity and violent crime rates follows a nonlinear trend, such as an initial increase in crime rates followed by a plateau or decline, residual change scores might provide an incomplete and potentially misleading picture of the actual dynamics. Researchers should be cautious in assuming linearity and, when appropriate, consider alternative modeling approaches that can better accommodate the complexities of nonlinear relationships to ensure a more accurate depiction of change over time. This acknowledgment is crucial for refining research methodologies and advancing the understanding of the nuanced interplay between variables in dynamic systems.

Future studies should attempt to include alternate oil and gas development measures to assess their impact on host communities. For instance, assessing 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 the overall amount of production 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" (p. 488). Researchers, consequently, should explore whether geographic regions that have a history of ONG boom and busts differ in response to rapid social change brought by ONG production. Those communities who have never had such industrial activity occur lack such experience with the ONG industry. In the end, history, and context matter.

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