Social Change in Shale O&G Communities

Dissertation

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By

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Abstract

The changing landscape of energy extraction in the United States has important implications for demographic outcomes, such as family formation behaviors and human capital accumulation. As the shale oil and gas (O&G) industry has grown over the last two decades, it has exposed new communities to the boom-bust cycles inherent within energy extraction areas. During the economically prosperous boom times, individuals may be drawn to an area as employment and income increases, which could influence the human capital levels within a community. Similarly, increased economic resources brought through O&G development may encourage marital behavior and influence other family formation outcomes, such as divorce and cohabitation. Conversely, an O&G bust could drive away human capital and destabilize marriages and families as employment and income decrease.

This dissertation study enhances scholarship on family formation behaviors in extraction communities during the initial O&G boom and bust, which occurred from 2007-2018. Further, this study also examines migration of human capital during these economic cycles to see if the industry is drawing or decreasing individuals with more educational attainment. I utilize Economic Modeling Specialists International (EMSI) data to measure O&G employment, which allows me to separate shale extraction employment from other sources of mining employment to understand how this industry is

influencing the aforementioned behaviors. I also utilize restricted American Community Survey (ACS) data for many family formation, migration, and educational attainment outcomes. The restricted ACS sample provides access to data for individuals in nonmetropolitan counties, which is severely limited in the publicly available datasets. As shale O&G development disproportionately occurs and influences nonmetropolitan counties, these data will be key to answering several research questions.

In Chapter 1, I introduce the shale O&G industry, as well as trends in family formation behaviors, migration, and human capital accumulation and theoretical frameworks with which this paper will follow. In Chapter 2, I highlight county-level family formation trends in a subset of O&G states for both the boom and bust period. In Chapter 3, I utilize individual-level data to determine how O&G employment share influences the decision to transition to marriage in a subset of O&G states. In Chapter 4, I assess how the O&G industry is influencing the migration of human capital during the boom and bust. In Chapter 5, I close with a discussion about the broad conclusions and implications of this research for the study of demographic outcomes in O&G communities.

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Shepard, M., Betz, M., & Snyder, A. (2020). The shale boom and family structure: Oil and gas employment growth relationship to marriage, divorce, and cohabitation. *Rural Sociology, 85*(3), 623-657.

Fields of Study

Major Field: Human Development and Family Science

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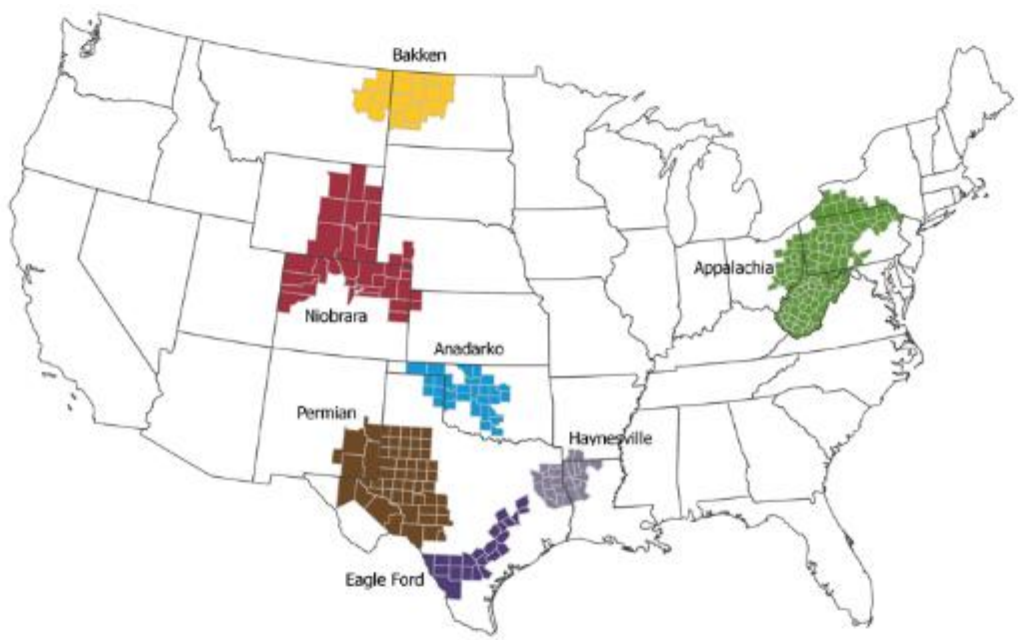
Chapter 1: Introduction

Energy production has significantly shifted in the United States over the last two decades as new technology has been developed to access previously unattainable stores of shale oil and gas. This technology uses a combination of horizontal drilling and hydraulic fracturing to access stores of oil and gas from shale plays; this process is more commonly known as "fracking". Initial shale mining began in the Marcellus Shale region in Pennsylvania and in Texas, but has since expanded to several shale plays nationwide (Figure 1.1; Figures A.1-A.6 in Appendix 1). Domestic energy production has grown exponentially due to this new process, with natural gas production increasing 35% between 2006 and 2015 and oil doubling daily production during this same period (Bataa & Park, 2017; Cook & Perrin, 2016; Perrin & Cook, 2016). The first shale boom, which lasted from 2007-2014, brought 550,000 jobs to communities to support mining and related activities (Maniloff & Mastromonaco, 2017; Figure 1.2 for O&G specific employment). However, as with other extractive industries, market forces (i.e. supply, demand, regulation, etc.) can lead to a steep and swift industry drop, as many jobs were subsequently lost during the O&G bust from 2015-2018 (Abboud & Betz, 2020; Figure 1.2).

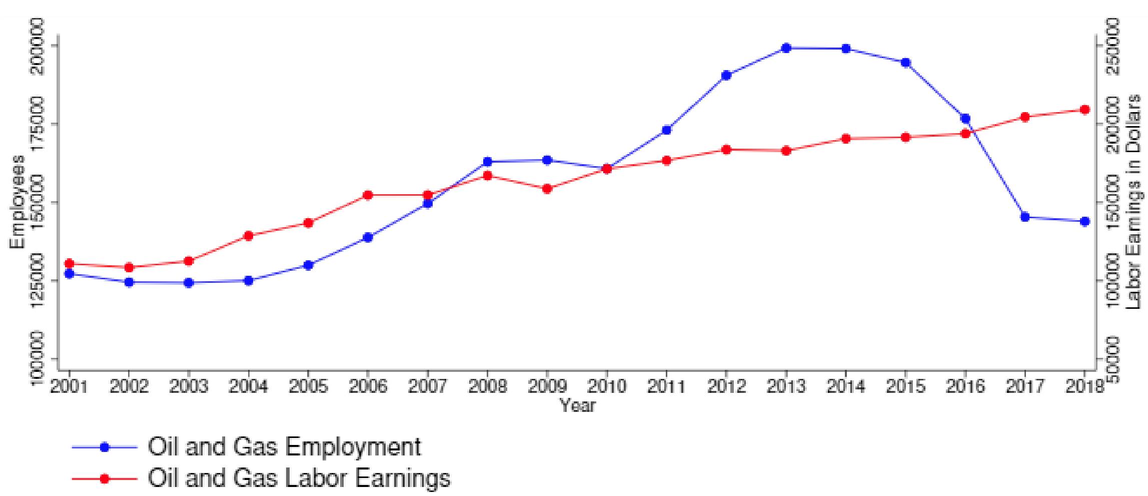
Oil and gas development can greatly shift the economics and demographics of local communities. The O&G industry creates many jobs both for extraction activities

Figure 1.1. *Major Shale Plays in the United States*



Source: U.S. Energy Information Administration

Figure 1.2. *Oil and Gas Production in the United States*



Source: Abboud and Betz (2020)

and within the community to support the increasing population (Abboud & Betz, 2020; Black, McKinnish, & Sanders, 2005; Brown, 2014; Haggerty, Gude, Delory, & Rasker, 2014; Jacobsen & Parker, 2016; Munasib & Rickman, 2015; Weinstein, 2014). The industry also raises per capita income during initial community extraction specialization (Haggerty, Gude, Delory, & Rasker, 2014; Jacobsen & Parker, 2016; Weinstein, 2014). The O&G industry also may bring in rising rates of migration, as workers move from place to place to establish mining infrastructure. The O&G industry is male dominated, as they make up 80% of the workforce[1]; these males are also largely young and unmarried. An influx of migrants and shifting economic prospects has the possibility of altering social capital, such as relationship rates and behaviors and community educational composition. First, I will describe long-term trends and issues surrounding social capital, such as changing family behaviors and "brain drain", followed by a discussion of theoretical frameworks that suggest how O&G development may alter these trends.

Social Changes over Time

Changing Family Behavior

Family formation trends have experienced a large shift in the past several decades. Since the mid-20th century, each successive decade has seen declines in average households with two-parents and children and increases in single-parent families, nonmarital cohabitation, and nonmarital childbearing (Cherlin, 2010; Manning, Brown, & Payne, 2014; McLaughlin & Coleman-Jensen, 2011; Snyder & McLaughlin, 2004; Stevenson & Wolfers, 2007). This trend is prevalent in metropolitan and nonmetropolitan

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[1] https://www.bls.gov/cps/cpsaat18.htm

counties (Snyder, 2006). These overarching trends have coincided with a noticeable drop in welfare for both adults and children, but especially so for child economic well-being (Brown & Lichter, 2004; McLaughlin & Coleman-Jensen, 2011; Nelson, 2011; Snyder, McLaughlin, & Findeis, 2006; Snyder & McLaughlin, 2006). The drop in welfare becomes a perpetual issue, as low economic well-being and family outcomes are passed to future generations (Cherlin, 2004). However, increasing economic opportunity may help break this cycle; higher employment and income are generally associated with more two-parent households, while lower levels of income and employment are associated with more diverse family forms (Blau & van der Klaauw, 2013; Charles & Stephens, 2004; Cherlin, Ribar, & Yasutake, 2016; Harknett & Kuperberg, 2011; Joshi, Quane, & Cherlin, 2009; Kotila, Snyder, & Quian, 2015; Nelson, 2011; Nunley & Seals, 2010; Oppenheimer, 2003; White & Rodgers, 2000).

Marriage Market Theory

One potential explanation for individual family formation and dissolution behavior is the Marriage Market Theory (Becker, 1973). Generally, the potential marriageable partners are restricted by geography and individuals evaluate these partners based on economic, social, and physical qualities (Becker, 1973). Within this evaluation process, individuals decide whether the potential partner brings enough positive qualities to outweigh remaining single (Becker, 1973). Couples generally follow a process known as assortative mating, referring to partners matching with someone who is relatively similar in economic standing, religious behavior, leisure preferences, among other things (Becker, 1973). However, an exception to assortative mating is the potential for household specialization, as couples may decide to have one person earn money while the other manages the household responsibilities (Becker, 1973).

Marriage markets may be influenced by the local economy, as better employment and income prospects can draw new potential mates to the area or increase the attractiveness of local residents. This is important for women, as the supply of economically attractive men play a role in their marital behavior (Lichter, LeClere, & McLaughlin, 1991) and especially for women in nonmetro areas, as the number of economically attractive men is limited due to fewer employment opportunities (Slack & Jensen, 2009). Improvements in the local economy may increase marital behavior, as individuals still aspire to marry and do so when there are sufficient economic resources and an attractive potential partner (Cherlin, 2020; Kuo & Raley, 2016).

Rural Brain Drain

Since the mid-20th century, rural populations nationwide have experienced a phenomenon known as "depopulation", which refers to chronic population loss through out-migration, declining fertility, and rising mortality through an aging population (Johnson, 2011; Johnson & Lichter, 2019). Rural areas experience a high number of young adults moving away in search of educational and economic opportunities in urban cores, leaving an aging population behind in many nonmetropolitan counties (Fuguitt & Heaton, 1995; Von Reichert, Cromartie, & Arthun, 2014). This is a concept known as "brain drain", which refers to a loss of the highest achieving residents fleeing to more economically advantageous locations (Artz, 2003; Waldorf, 2007). Brain drain can create a self-perpetuating cycle, as high levels of human capital (as measured by educational attainment) are associated with higher income levels, economic growth, and productivity, which are keys to drawing in and retaining residents (Artz, 2003). Without a shock to pull areas out of this cycle, many may remain with high percentages of poverty and an aging population.

Migration Theory

Migration Theory, first discussed by Lee (1966), suggested that individual migration decisions are based on a personalized equation of factors associated with the area of origin, factors associated with the destination, intervening obstacles, and personal factors. Although these equations may be complicated and personal, individuals generally migrate for economic opportunity and around certain milestones, such as high school or college graduation, a new job, a baby being born, retirement, among others (Lee, 1966). Migration decisions tend to occur based on "push" and "pull" factors between the areas of origin and destination (Greenwood Hunt, Rickman, & Treyz, 1991; Lee, 1966; Passaris, 1989). For example, rural counties that have experienced long trends of depopulation may experience heavy push factors, as individuals may want to leave to pursue a stronger dating market, educational opportunities, or a new job. Areas with a diverse economy and demographic makeup could experience strong pull factors that bring high levels of in-migration. Thus, an economy strengthened by O&G development may experience new pull factors that increase in-migration and help retain residents. However, chapter 4 will discuss whether these residents are bringing high levels of human capital and if the O&G industry is reducing push factors that would drive away individuals with high potential.

Dissertation Significance

Shale O&G development has quickly expanded over the last 15 years to many locations without previous mining experience. Many of these communities are in nonmetropolitan counties, which have faced depopulation for several decades due to a lack of economic prospects (Johnson, 2011; Johnson & Lichter, 2019). Shale O&G production can infuse these communities with relatively high-paying jobs, more employment opportunities, and in-migration that could serve as a shock to alter the depopulation trend (Abboud & Betz, 2020; Black, McKinnish, & Sanders, 2005; Brown, 2014; Haggerty, Gude, Delory, & Rasker, 2014; Jacobsen & Parker, 2016; Munasib & Rickman, 2015; Weinstein, 2014). Social life and behaviors may change with the infusion of new economic opportunities and in-migration. This dissertation will examine a few aspects of social trends, such as county marriage, divorce, and cohabitation rates, the decision to transition to marriage, and human capital accumulation in O&G communities. The goal of this work is to understand if O&G development can provide communities a chance to reverse depopulation trends, provide families an opportunity for more stable living situations, and to infuse communities with human capital that can promote long-term change.

Dissertation Structure

This dissertation project includes three studies that examine social change in O&G communities, each containing a literature review, methods, results, and conclusions section. Chapter 2 examines county-level marriage, divorce, cohabitation, and never married rates in a sample of 10-O&G states during the boom and bust periods. The expectation according to Marriage Market Theory would be that the boom period would bring strong economic prospects and promote marriage behaviors. However, Shepard, Betz, and Snyder (2020) in a similar study using a national sample during the boom found decreasing marital behaviors and an increase in divorces. This chapter will propose some possible mechanisms to explain changes in marital rates, lay out hypotheses, and provide some of the first estimates of relationship rates during the O&G bust.

Chapter 3 uses individual-level data to examine how O&G activity at the county-level influences the decision to transition to marriage in the previous 12 months. Again relying on Marriage Market Theory, I would expect that strong economic times will promote marriage while lean economic prospects during the bust could hinder these transitions. Chapter 3 will lay out hypotheses and results based on boom-bust and by age group to see if O&G development differentially influences individuals based on age-cohort.

Chapter 4 uses a sample of 10-O&G states to see how O&G development influences the flow of human capital to and from a county. Migration Theory would suggest that increased economic opportunity may draw individuals with higher education to an area; however, it is unknown if an extraction industry will provide that same draw. This section will again provide hypotheses and see if educated individuals are choosing to move to O&G counties and if out-migrants during the boom have more or less human capital. These analyses will also cover the bust to see if an economic downturn sends human capital away from the county or if O&G counties are able to retain some of the hypothesized gains. Last, in Chapter 5, I provide a cross-study conclusion of my findings and address limitations and future research directions.

Data

Economic Modeling Specialists International

Studies focusing on shale O&G development generally utilize one of two measures. The first is production data, which is beneficial for examining supplier and consumer prices (Bataa & Park, 2017) and to estimate the timing and magnitude of an energy boom or bust within the industry (Brown, 2014; Mayer, Malin, & Olson-Hazboun, 2018; Munasib & Rickman, 2015; Weber, 2012; Weber, 2013). The other measure that is generally utilized is employment data, which is useful when considering how employment and income influence behaviors among mining and other workers in the local economy Haggerty, Gude, Delorey, & Rasker, 2014; Kearney & Wilson, 2017; Maniloff & Mastromonaco, 2017; Marchand & Weber, 2018; Weber, 2013; Weinstein, 2014; Weinstein, Partridge, & Tsvetkova, 2018). Employment data capture the buildup activity, such as establishing wells and pipelines that are labor intensive, that are not reflected in production data. As wells begin to produce resources, employment numbers in an area significantly decrease as a relatively little work force is required for maintenance activities. As demographic studies are focused on human behavior, employment data are beneficial to capture the buildup activity that influences the largest number of people.

Economic Modeling Specialists International (EMSI) is a company that collects and aggregates labor market data to fill in withheld information from the publicly available economic data at the 4-digit North American Industry Classification (NAICS) level. They draw data from the U.S. Census Bureau's County Business Patterns form, The Bureau of Economic Analysis' (BEA) Regional Economic Accounts, and the Bureau of Labor Statistics' Quarterly Census of Employment and Wages (QCEW) to accomplish this. These EMSI data allow me to separate O&G employment (NAICS 2111) from other types of mining employment and includes initial exploration for petroleum and natural gas; drilling, completing, and equipping wells; operating separators, emulsion breakers, desiliting equipment, and field gathering lines; and other activities involved in O&G development to the point of when resources are shipped from the property[2]. These proprietary data are utilized in chapters 2, 3, and 4 to test the association of county-level O&G employment as a share of overall employment and several demographic indicators.

American Community Survey

The American Community Survey (ACS) is an annual survey conducted by the U.S. Census Bureau and is designed to capture information across a variety of social, economic, housing, and demographic topics. Chapter 2 utilizes county-level estimates from the ACS; importantly, the dependent variables of marriage, divorce, never married, and cohabitation rates are five-year rolling averages. In publicly available data, the ACS restricts access to yearly data for counties under 65,000 individuals[3]. As nonmetropolitan areas may be disproportionately influenced by O&G development, it is imperative to not leave these counties out. Although rolling averages may mask some rate changes, this

[2] https://www.bls.gov/iag/tgs/iag211.htm
[3] https://www.census.gov/programs-surveys/acs/geography-acs/areas-published.html

limitation is outweighed by the need to include both metro and nonmetro counties. County rolling averages are also included as controls in chapter 2, including population, education structure, racial composition, percent of foreign-born population, age structure, sex ratio, and female labor force participation.

While the Census Bureau makes some ACS estimates publicly available depending on geographic and population restrictions, they do not release individual-level respondent data in a public format. To access individual responses, researchers must apply to use a restricted sample of the ACS held in Census Bureau-run Research Data Centers. These restricted samples provide a wealth of information about respondents and as such, any analyses or tabulations completed with these data go through a strict disclosure review process (see Appendix B for research disclaimers for chapters 3 and 4). Chapter 3 uses the restricted ACS sample to calculate the odds of transitioning to marriage in the previous 12 months, as well as using individual-level controls for employment status, foreign-born status, sex, educational attainment, and race/ethnicity. Chapter 4 utilizes the restricted ACS sample to obtain the average education of migrants to and from O&G counties. These calculations required accessing individual-level educational attainment and information about whether an individual moved in the last 12 months and if so, which county they moved from and to where they relocated.

United States Census Bureau Intercensal Estimates

The United States Census Bureau houses a Population Estimates Program to produce annual estimates of demographic change between decennial censuses, known as

Intercensal Estimates[4]. These Intercensal Estimates provide state and county population by age, sex, race, and ethnicity annually. These estimates are vital for allocation of government funds and survey research. Chapters 3 and 4 utilize the county age structure, population, and racial and ethnic county estimates as control variables. This decision was made to have control data that covered the beginning of the O&G boom, which started in 2007.

Small Area Income and Poverty Estimates

The Small Area Income and Poverty Estimates (SAIPE) is a program conducted by the U.S. Census Bureau and provides yearly economic data at several different geographic levels. SAIPE utilizes ACS estimates to supplement their economic calculations[5]. Chapters 2, 3, and 4 utilize SAIPE's estimates of county-level poverty and median household income.

[4] https://www.census.gov/programs-surveys/popest/about.html

[5] https://www.census.gov/programs-surveys/saipe/technical-documentation/methodology.html

Chapter 2: Shale Development and Trends in County Relationship Rates

The landscape of energy production in the United States has shifted dramatically in the last 15 years as shale oil and gas extraction technology has evolved. This technology, utilizing hydraulic fracturing and horizontal drilling to extract oil and gas from shale plays (commonly known as “fracking”), has rapidly transformed towns and communities with shale beneath them. Energy production skyrocketed domestically; natural gas production increased by 35% between 2006 and 2015 while oil production has doubled from five to 10 million barrels per day, over half of which came from shale plays (Bataa & Park, 2017; Cook & Perrin, 2016; Perrin & Cook, 2016). The initial shale boom, lasting from 2007-2014, provided 550,000 jobs to local communities through mining and related support activities (Maniloff & Mastromonaco, 2017). As with other extraction industries, shale oil and gas production is subject to extraneous market forces, such as prices, supply, demand, and environmental regulation. A combination of these forces can cause sharp fluctuations for industry employment and production, leading to boom-bust cycles. The first shale oil and gas (hereafter O&G) bust occurred from 2015-2018 (Abboud & Betz, 2020).

At the height of the O&G boom, billions of dollars in market benefits were created through increased employment, royalty payments, and lower consumer energy prices. However, these benefits may be mitigated, as Loomis & Haefele (2017) estimate billions of dollars in costs from O&G production through impacts on air pollution, greenhouse gas emissions, water pollution, wildlife habitat fragmentation, and overall health outcomes. Further, communities who came to rely on employment and associated tax and royalty payments from O&G may be harmed as the industry went bust.

As O&G production become more prevalent, so too has the literature examining how the O&G industry has influenced many facets of life. Numerous studies have explored the environmental and economic impacts of O&G development (Joskow, 2013; Kelsey, Partridge, & White, 2016; Paredes, Komarek, & Loveridge, 2015; Tsvetkova & Partridge, 2015; White, 2012). Others have focused on health consequences of O&G production via fracking (Bunch et al., 2014; Colborn, Schultz, Herrick, & Kwiatkowski, 2012; Elliott et al., 2017; McKenzie, Witter, Newman, & Adgate, 2012; Mitka, 2012; Vengosh et al., 2014; Werner, Vink, Watt, & Jagals, 2015; Whitworth, Marshall, & Symanski, 2018). A few studies explored how resource extraction brings about social change in the U.S. (Brown, Dorius & Krannich, 2005; Komarek 2018; Ruddell, Ortiz, & Thomas, 2013; Schafft, Borlu, & Glenna, 2013; Smith, Krannich & Hunter, 2001). While these studies have greatly enhanced our understanding of many aspects of the O&G industry, very few studies have focused on specific family outcomes (Betz & Snyder, 2017; Kearney & Wilson, 2017; Shepard, Betz, & Snyder, 2020). This study uses a similar framework to Shepard, Betz, and Snyder (2020) and continues to explore how influxes of people and money brought into communities through O&G development can alter family behaviors in these O&G communities.

Based on the cyclical nature of extraction counties and previous family and economic literature, I would expect marriages to be stabilized, divorces to decrease, and fewer individuals to have never been married or be in cohabiting relationships during the O&G boom. However, Shepard, Betz, and Snyder (2020) provided an example of family outcomes trending away from stable marriages and toward relationship dissolution during the O&G boom for all 50 United States. These findings point to the independence effect possibly being in play, which allows individuals to leave unhappy relationships and seek alternatives in the growing marriage market. What is unclear is if the findings in Shepard, Betz, and Snyder (2020) hold within a 10 state sample of more highly concentrated O&G development. While it is useful to understand broad national trends with O&G development, narrowing the sample to 10 states with the large majority of shale O&G production and employment will better illustrate how the industry plays a role in shifting social dynamics. These 10 states have three times higher O&G employment as a share of overall employment compared to the 50 state sample during the boom (see Table 1; Shepard, Betz, & Snyder, 2020) and seven time higher O&G employment share than the 50 state sample during the bust (see Table 2; Appendix C, Table 25). This study will focus on a restricted sample during the O&G boom to determine if there is still evidence of the independence effect at play or if family outcomes behave differently when O&G development is a more prevalent part of the economy.

Prior literature is more clear about what to expect from family behavior as economic outlooks decrease. Families tend to be destabilized during economic downturns (Brown & Lichter, 2004; McLaughlin & Coleman-Jensen, 2011; Nelson, 2011; Snyder, McLaughlin, & Findeis, 2006; Snyder & McLaughlin, 2006); combined with the relatively new experience of extractive production cycles in many of these communities, I expect the percentage of currently married individuals would decrease, divorces would elevate, and the percentage of never married and cohabiting individuals would rise during the bust cycle as incomes and employment decrease and out-migration could become more prevalent, reversing the positive marriage market trends of the boom. As with the O&G boom, it is unclear how a subsample of states with higher concentrations of O&G development will follow the same pattern as the 50 state sample. This study will run analyses on both samples during the bust to see how findings may change based on industry concentration.

Understanding family formation behavior is important given trends in recent decades towards lower overall marriage rates, high divorce rates, and rising rates of nonmarital childbearing and cohabitation in both metro and nonmetro areas (Cherlin 2010; Manning, Brown, & Payne, 2014; McLaughlin & Coleman-Jensen, 2011; Snyder, 2006; Snyder & McLaughlin, 2004). These trends hold even as individuals still aspire to marriage; rather, limited resources may prevent more people from marrying and staying together (Cherlin, 2020; Kuo & Raley, 2016). Family behavior in O&G communities may differ from other nonmetro communities due to stabilizing influences of a strong local economy and increased resources, or destabilizing factors associated with demographic flux. Prior literature has noted that higher levels of employment and income provide resources for more stable family formation outcomes (Blau & van der Klaauw, 2013; Charles & Stephens, 2004; Cherlin, Ribar, & Yasutake, 2016; Harknett &

Kuperberg, 2011). Extraction communities may diverge from these findings as they follow the boom and bust cycles inherent in natural resource production, which lead to more volatile income and employment outlook (Betz & Snyder, 2017). There is evidence from the coal industry that extraction communities may be better able to withstand the volatility of the boom and bust economy; however, these coal communities have decades of experience in these types of economies (Betz & Snyder, 2017). As shale O&G communities generally are new to extraction industries, there are questions as to how they will respond to the inevitable swings of O&G production and demand.

Shepard, Betz, and Snyder (2020) utilized a stepwise approach to test the association of O&G employment on county marriage, divorce, never married, and cohabitation rates for all 50 states during the O&G boom from 2009-2014. The stepwise approach accounted for three other possible channels that could explain the variation in family behaviors; county sex ratio, female employment, and income. First, they suggest that sex ratios will shift substantially as the mining industry disproportionately employs men, which could influence family outcomes by shifting the local marriage market (Becker, 1973). Next, they hypothesize that jobs created during the O&G boom may increase employment for women specifically, leading to higher rates of female labor force participation. Marriage Market theory would suggest that increasing employment and income among women increases their partner selectivity and influences family formation decision and timing as they are less reliant on a potential mates' economic resources (Becker, 1973; Brewster & Rindfuss, 2000; Budig, 2003; Shepard, Betz, & Snyder, 2020; Wood & Neels, 2017). Last, they suggest incomes will be raised through higher salaries for workers and royalty payments, which in turn leads to job creation in the retail and service industry due to more disposable income. These incomes and related cash flows provide more employment opportunities for men and women, which could influence marital behavior (Cherlin, 2004).

Results showed that O&G employment was associated with lowered overall marriage rates and higher divorce rates at the county level beyond the other three hypothesized channels, which channels explained some but not all variation in marriage and divorce rates. Splitting the sample by metro status showed that the decreased marriage and higher divorce rates were driven by nonmetro counties, while also showing that nonmetro counties had more individuals reporting they had never been married (Shepard, Betz, & Snyder, 2020).

This study adds to Shepard, Betz, and Snyder (2020) in a few important ways. Since that paper was completed, data from 2015-2018 has been made available from the American Community Survey, allowing for examination of family outcomes in the bust period. This is an important next step as researchers begin to study if shale O&G communities follow the same cyclical patterns of more established extraction communities in other industries. As with Shepard, Betz, and Snyder (2020), I utilize O&G employment indicators rather than production data. O&G employment is intensive during the initial well drilling process and tails off after infrastructure is in place. Wells, once established, can produce for years with a fraction of the initial number of workers and require very little maintenance. I expect that family behaviors, such as marriage, divorce, and cohabitation, are more correlated with shifts in employment, sex ratios (the ratio of males to females in a community), and female labor force participation. These measures may be more closely related to O&G employment rather than production information.

I also utilize a more refined sample than the one used in Shepard, Betz, and Snyder (2020) from all counties in the 50 United States to a selection of 10 states in three regions that have the highest concentration of shale O&G employment and production in the United States (Abboud & Betz, 2020). Narrowing down the sample in this way will include counties and states most influenced by the shale O&G revolution and will illustrate how highly concentrated fracking activity influences local communities. I do this for both the boom (2009-2014) and bust (2015-2018) time periods to test whether the associations found in Shepard, Betz, and Snyder (2020) hold or were driven by other communities with less concentrated O&G extraction activities. These steps will give a clearer picture of how O&G drilling and extraction influences family behaviors at the county level in areas more influence by O&G extraction.

The Demographic and Economic Impact of Shale Energy Production

The evolution of the Shale O&G market has significantly shifted the balance of energy production and supply in the United States. Beginning in the early 2000's, a combination of horizontal drilling and hydraulic fracturing became more widely adopted and led to a boom period in O&G production from 2007-2014 (Rogers, 2011). Early shale O&G production began in the Marcellus Shale region in Pennsylvania and parts of Texas, but has since expanded to metro and nonmetropolitan areas in many states. Shale O&G development has led to the United States becoming the biggest oil producer in the world in 2015[6]. Subsequent demand for shale O&G declined as oil prices plummeted following this period, resulting in a bust period that lasted from 2015-2018 (Abbound & Betz, 2020). One focus of fracking activity is its environmental impact (see Jackson et. al, 2014 for a review). Aside from the environmental considerations, economists have generally found positive short-term economic impacts of O&G development in local communities. What is not known is whether shale O&G communities will experience the "natural resource curse", a phenomenon in resource extraction communities that leads to worse long-term economic outcomes (Betz et al., 2015; Haggerty, Gude, Delory, & Rasker, 2014; Jacobsen & Parker, 2016; James & Aadland, 2011; Measham and Fleming, 2014; Sachs & Warner, 1997; Weber, 2013; Weinstein, 2014;[7]).

Extractive industries have long followed a boom-bust cycle, alternating between periods of prosperity and production drought (see Betz & Snyder (2017) for an example in the coal industry). These cycles put long-term employment trends in flux, leading to workers who are frequently more transient than the typical workforce and will migrate to maintain full-time employment. Within the O&G industry, over 80% of employees are male[8], and the majority are young and unmarried. Communities experiencing and O&G boom may experience high levels of in-migration from young, unmarried males, shifting the male-to-female sex ratio. This could offset the community balance and influence family formation behavior. The population may not return to pre-boom levels, however, as some O&G workers could choose to relocate permanently to the community. The

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6 https://www.eia.gov/todayinenergy/detail.php?id=26352

7 See (Brown, 2014) for a notable disagreement.

8 https://www.bls.gov/cps/cpsaat18.htm

influx of permanent O&G workers could differentially influence family formation behaviors within the community when compared to temporary migrants.

The establishment of the O&G industry within a community appears to moderately influence overall employment rates within the county (Black, McKinnish, & Sanders, 2005; Brown, 2014; Haggerty, Gude, Delory, & Rasker, 2014; Jacobsen & Parker, 2016; Munasib & Rickman, 2015; Weinstein, 2014). Looking to the coal industry, there is evidence that industry support jobs (i.e. construction, service, and retail) are added to the local economy during resource boom cycles (Black, McKinnish, & Sanders, 2005; Abboud & Betz 2020). Local citizens also benefit from "spillover" effects (i.e. employment multipliers related to increased O&G mining employment), which has the potential to increase employment and income for non-mining workers (Brown, 2014; Munasib & Rickman, 2015). Women may experience more employment opportunities due to a stronger local economy; in particular, greater numbers of retail and service jobs may be available due to more local demand for services and more openings as men transition to working in the higher-paying O&G industry during the boom period.

Oil and gas extraction communities, as with other extraction communities, see per capita income increases when a county first begins specializing in extraction; however, the positive increases trail off over time (Haggerty, Gude, Delory, & Rasker, 2014; Jacobsen & Parker, 2016; Weinstein, 2014). As the shale O&G industry is still relatively new in the United States, I expect that incomes will be high during the boom and will trail off during the bust as industry jobs, along with demand for retail and services, trend downward.

Although individuals and communities see short-term economic benefits from O&G development and specialization, prior literature suggests that long-term environmental, economic, and social costs should steer politicians and developers to promote other types of employment in addition to fracking (Joskow, 2013; Kelsey, Partridge, & White, 2016; Paredes, Komarek, & Loveridge, 2015; Tsvetkova & Partridge, 2015; White, 2012). Despite the findings suggesting other sources of employment would be more beneficial long-term, both metro and nonmetro counties have experienced booms in migration, employment, and income from shale development and are now adjusting to this new reality. Although these trends have been underway for almost two decades, an understudied portion of the O&G revolution is how the industry has influenced family formation behaviors at the county level. Many of the counties that have come to rely on the O&G industry are nonmetro; therefore, this study will focus on metro and nonmetro differences in O&G employment and family formation behaviors.

Economic Trends and Family Outcomes

Family formation behaviors in America have dramatically shifted over the last half century. Whereas many families during the mid-20th century lived in two-parent with children households, recent trends show a diversification of family structures with increases in single-parent families, nonmarital cohabitation, and nonmarital childbearing (Cherlin, 2010; Manning, Brown, & Payne, 2014; McLaughlin & Coleman-Jensen, 2011; Snyder & McLaughlin, 2004; Stevenson & Wolfers, 2007). Despite the reputation of nonmetro areas holding to the nuclear family model, these trends are becoming prevalent in both metro and nonmetro counties (Snyder, 2006). As these trends have taken hold, a noticeable decrease in welfare has been found for both adults and children; the largest impact has been found for child economic well-being (Brown & Lichter, 2004; McLaughlin & Coleman-Jensen, 2011; Nelson, 2011; Snyder, McLaughlin, & Findeis, 2006; Snyder & McLaughlin, 2006). Low economic well-being and family outcomes share a cyclical, bidirectional relationship that can last for generations (Cherlin, 2004). The relationship between economic well-being and family outcomes can be explained using The Family Stress Model, which theorizes that families need financial and relational resources to respond to stressor events (Conger, Ge, Elder, Lorenz, & Simmons, 1994; Conger & Elder, 1994; Conger & Donnellan, 2007; Conger, 2011). Specifically, one of the biggest sources of chronic and acute stress are family finances; a lack of financial stability or disagreements in how to spend money often leads to conflict in relationships and families, which can destabilize marriages and family units through distancing or divorce.

Another framework to help explain how O&G employment may influence family formation and dissolution behavior is the Marriage Market Theory (Becker, 1973). Generally, the potential for marriageable partners is restricted to a pool of individuals in a given geographical area. Among individuals in these areas, a process then commences whereby potential mate evaluation occurs and each partner decides if the other brings enough resources to make marriage more advantageous than being alone (Becker, 1973). Within the mating process, couples generally match with someone who is relatively similar in financial earnings, religion, leisure preferences, and other categories in a process called assortative mating (Becker, 1973). The one exception to assortative mating is with financial resources, as couples may decide to specialize within marriage and have one partner work and the other maintain household responsibilities (Becker, 1973). The state of the local marriage market has been tied to marriage outcomes (Blau, Kahn, & Waldfogel, 2000), economic conditions (Autor, Dorn, & Hanson, 2017), men's employment (Oppenheimer, Kalmijn, & Lim, 1997), women's rising employment (Oppenheimer, 1997; Sweeney, 2002), and male incarceration (Charles & Luoh, 2010). The supply of economically attractive men in a geographic area plays a significant role in women's marital behavior (Licther, LeClere, & McLaughlin, 1991); however, the number of economically attractive men are restricted in nonmetro areas due to fewer employment opportunities (Slack & Jensen, 2009).

Increasing employment through the O&G industry can potentially alter the marriage markets within a community by providing relatively high-paying jobs and increased employment opportunities to individuals with lower levels of education and through in-migration of a large number of males. This may affect nonmetro communities more as they experience more than double the amount of O&G employment as a share of overall employment compared to metro counties (see Tables 1 and 2) and typically lack high paying employment options outside of the O&G industry. This influx of men, employment for marriage-age men, and income could encourage marriage among those who delayed marriage due to economic barriers or may destabilize existing marriages by providing potentially attractive alternatives within the local marriage market. This is important for nonmetro areas, as family behaviors in these locations display notable differences from their metro counterparts. Women in nonmetro areas are more likely to marry and have children at younger ages (Snyder, Brown, & Condo, 2004) and spend a larger portion of their lives in marital relationships (Snyder, 2011) due to marrying about one year earlier (Snyder, Brown, & Condo, 2004) and remarrying sooner after divorce (Snyder, 2011). Nonmetro women also transition from cohabiting relationships to either separation or marriage more quickly than women in metro areas (Brown & Snyder, 2006). Divorce is still prevalent in nonmetro areas, however, as there are no noted differences between metro and nonmetro women (Snyder, 2011).

Generally, higher levels of employment and income are associated with more two-parent married households, while lower levels of employment and income are tied to more diverse household forms (such as nonmarital cohabitation and childbirth) (Blau & van der Klaauw, 2013; Charles & Stephens, 2004; Cherlin, Ribar, & Yasutake, 2016; Harknett & Kuperberg, 2011; Joshi, Quane, & Cherlin, 2009; Kotila, Snyder, & Quian, 2015; Nelson, 2011; Nunley & Seals, 2010; Oppenheimer, 2003; White & Rodgers, 2000). However, better employment prospects can influence family behavior differently for men and women. Married men with lower income and employment see their marriages destabilized, while unmarried men in relationships and/or cohabiting are prevented from transitioning to marriage (Conger, 2011; Edin & Kafalas, 2005; Jensen & Jensen, 2011; Manning, Brown, & Payne, 2014; Nelson, 2011; Oppenheimer, Kalmjin, & Lin, 1997; Oppenheimer, 2003; Rowthorn & Webster, 2008). Women, however, can experience potentially stabilizing or destabilizing influences from better employment through the income effect and independence effect (Cherlin, 2004). The income effect can act to stabilize marriage by providing resources to an existing marital relationship or making a woman more attractive within the marriage market. The independence effect, however, destabilizes marriages as women may opt to use their higher incomes to leave an unfulfilling or unequitable marriage or abstain from marriage altogether (Nunley & Zietz, 2012; Sayer & Bianchi, 2000; Schoen, Astone, Rothert, Standish, & Kim, 2002).

Data and Methods

Sample

I utilize multiple sources of data to examine associations over time between county-level oil and gas (O&G) employment as a share of overall employment and county-level marriage, divorce, never married, and cohabitation rates. The county-level marriage, divorce, never married, and cohabitation dependent variables are all tabulated using the American Community Survey (ACS) 5-year estimates from 2009-2014 for the boom period and 2015-2018 for the bust. The ACS estimates are generated yearly through averaging the five previous year's data and aggregating at the county level. These decisions follow Shepard, Betz, and Snyder (2020) that focused on all 50 states in the U.S. during the O&G boom that occurred from 2007-2014.

Although the O&G boom started prior to 2009, ACS estimates for counties with less than 65,000 individuals are unavailable during this period[9]. However, by utilizing 5-year estimates, marriage rates from 2005 forward are included in these analyses. While these 5-year estimates are the best available for marital status in small counties, they are imperfect for the bust period as there will be overlap between boom and bust

[9] https://www.census.gov/programs-surveys/acs/geography-acs/areas-published.html

measurements (e.g. 4 of 5 years of marital rates in 2015 are from the boom). These rolling averages may mask behavior shifts during the bust.

These analyses build on Shepard, Betz, and Snyder (2020) in a few ways. First, I provide companion analyses using national 50 state data during the O&G bust (2015-2018) that have since become available. I also utilize a sample of 10 high O&G producing states in three regions[10] to see if national trends hold with higher concentration of O&G employment for both the boom and bust periods. These 10 states were chosen because they are the largest producers of shale O&G via fracking in the continental United States (Abboud & Betz, 2020).

Measures

Oil and Gas Employment Variable. The main explanatory variable is county-level O&G employment as a share of overall employment. Within the O&G literature, two main measures exist to determine the extent of O&G development within a community. The first is O&G production data, which is useful when estimating the timing and magnitude of an O&G boom or bust (Brown, 2014; Mayer, Malin, & Olson-Hazboun, 2018; Munasib & Rickman, 2015; Weber, 2012; Weber, 2013) or for examining supplier and consumer prices (Bataa & Park, 2017). The other main measure is employment data, which is useful for capturing the influence of O&G development on mining and other workers in related industries and how the industry influences the local economy through employment and income (Haggerty, Gude, Delorey, & Rasker, 2014; Kearney & Wilson, 2017; Maniloff & Mastromonaco, 2017; Marchand & Weber, 2018; Weber, 2013;

[10] Marcellus Region (OH, PA, WV); South Region (LA, OK, TX); West Region (CO, MT, ND, WY)

Weinstein, 2014; Weinstein, Partridge, & Tsvetkova, 2018). Establishing wells and pipelines is labor intensive; after the initial infrastructure is built and wells start producing, far fewer employees are required for maintenance activities. Employment data is useful to understand how workers with high-paying O&G jobs benefit the local economy through spillover effects (Haggerty, Gude, Delorey, & Rasker, 2014; Kearney & Wilson, 2017; Marchand & Weber, 2018; Maniloff & Mastromonaco, 2017; Weber, 2013; Weinstein, Partridge, & Tsvetkova, 2018). A focus on O&G employment data and the associated in-migration is important in policy and planning implications for local communities (Kelsey, Partridge, & White, 2016). Utilizing O&G employment data, rather than O&G production data, is useful in a demographic study as it captures the buildup activity that would otherwise be missed through production data.

The O&G employment variable is created from data purchased from Economic Modeling Specialists International (EMSI). EMSI uses the U.S. Census Bureau's County Business Patterns form, the Bureau of Labor Statistics' Quarterly Census of Employment and Wages (QCEW), and the Bureau of Economic Analysis' (BEA) Regional Economic Accounts to fill in withheld information in the publicly available economic data at the 4-digit North American Industry Classification System (NAICS) level. These EMSI data help me separate O&G employment (NAICS 2111) from other types of mining employment (coal, metal, gravel, etc.) that are combined in publicly available two-digit NAICS county-level data. O&G employment includes initial exploration for petroleum and natural gas; drilling, completing, and equipping wells; operating separators, emulsion breakers, desilting equipment, and field gathering lines; and other activities included in producing O&G up to when oil and gas is shipped from the property[11].

Control Variables. The data for control variables are drawn from three sources. Demographic variables, such as population, education structure, racial composition, percent foreign born, age structure, the percent male population over age 18, and female labor force participation, defined as the percentage of women between 20-64 currently engaged in the labor market, are taken from the ACS 5-year estimates. County poverty rate and median household income come from the Census Bureau's Small Area Income & Poverty Estimates (SAIPE) program while total county employment is drawn from EMSI.

Analytic Plan

I include county economic and demographic information in each model to control for possible sources of bias in the estimated relationship between marriage behaviors and O&G employment. Time and county fixed effects are included in the model to reduce potential bias from unobservable time-invariant differences between counties and year-specific trends. Each county in the equation is weighted by their population in 2009 for the boom and 2015 for the bust. The empirical models take the form:

$$OUTCOME_{it} = \beta 0 + \beta 1(OilAndGas_{it}) + \beta 2(X_{it}) + \sigma_i + \gamma_t + \varepsilon_{it} \quad (1)$$

The *OUTCOME* variable represents the percentage of each county's population that is currently married, divorced/separated, never married, or cohabiting, respectively for each year from 2009-2014 for the boom and 2015-2018 for the bust. The *OilAndGas* variable

[11] https://www.bls.gov/iag/tgs/iag211.htm

represents the O&G employment share of total county employment. X represents a vector of economic and demographic control variables shown in Tables 1-2. ε_{it} represents the error term, σ_i is the county-fixed effect, and γ_t is the year-fixed effect. Fixed effects are included to reduce time and place invariant confounding to better approximate within-unit change (Mummolo & Peterson, 2018). Equation 1 is estimated 12 times for the four outcome variables: the first four estimations are for counties in the 10 O&G states from 2009-2014 to add further insight to Shepard, Betz, and Snyder (2020); the next four estimations are for the 10 O&G states from 2015-2018; and the last four estimations are for the 50 state sample during the bust, which are included as an appendix for a robustness check. Robust standard errors are calculated.

First, I make estimations for the 10 O&G counties from 2009-2014. I start with a base model that includes all controls, but does not include potential key channels of O&G employment that may influence marital behaviors, namely population percent of males over age 18, female labor force participation, and median household income (Shepard, Betz, and Snyder, 2020). I then add each of these hypothesized mechanism variables one at a time to determine if the effect of O&G employment remains when accounting for other potential mediating variables. Last, I include all of the mechanism and control variables into one model that test whether O&G employment influences family behavior beyond county sex ratios, female labor force participation, and median household income. I utilize the U.S. Census Bureau's metro/nonmetro definitions of counties to test if there are differences in O&G employment by metro status for all counties in the United States. While there are several definitions of rural and urban, I utilize the metro/nonmetro

MSA measurement as it uses counties as the geographic unit of measurement and is the definition used within the ACS[12].

The next set of estimations uses the 10-state O&G sample from 2015-2018. I follow the same stepwise pattern described for the 50 state sample, testing whether O&G employment influences marital behavior beyond the percentage of population that is male over 18 years old, female labor force participation, and/or median household income. I also use a national 50-state sample and a similar stepwise approach for a robustness check during the O&G bust. Both sets of 10 state samples and the 50-state sample will further be split by metro status to examine whether O&G influences vary by metro status.

Results

Summary statistics for each sample are shown in Tables 1 and 2. Table 1 shows the descriptive statistics for all variables in the regression model for the 10-state sample during the O&G boom (2009-2014). Nearly 54% of the population is currently married, 13% are divorced or separated, and just over 25% have never been married. Cohabiting couples make up a little under 5% of the households in this sample. The share of O&G employment in this sample is 3%, with the maximum county being just under 48% (not shown). The O&G employment share in this 10-state sample is nearly two-percent higher than the nationwide sample during this same time period, when the average was nearly 1% (Shepard, Betz, & Snyder, 2020).

Table 1 also includes the descriptive statistics split by metro and nonmetro designation. The currently married population is 2% higher in nonmetro areas while

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[12] https://www.ruralhealthinfo.org/topics/what-is-rural#which-definition

metro areas have a 3% higher rate of never married individuals. The divorced population is slightly smaller in nonmetro areas while metro areas see a one-half percent higher level of cohabiting households.

Table 2 displays the descriptive statistics for the 10-state sample during the O&G bust. The currently married population is over 52%, nearly a half-percent higher than the 50-state bust sample (see Appendix C for 50-state bust sample). Over 13% of the population is divorced, nearly equal to the overall sample. The population of never married individuals is 27%, a 0.5% decrease from the 50-state sample. Cohabiting couples make up just over 5% of households in these 10 states. The average share of O&G employment is just under 3%, a marked increase compared to all 50 states.

Table 2 shows the descriptive statistics by metro and nonmetro area. The population of currently married individuals is nearly 2% higher in nonmetro areas, while the percentage of never married individuals is over 3% higher in metro counties. Divorce rates are roughly equal by metro status, whereas cohabitation rates are over a half-percent higher in metro areas.

O&G employment growth and marriage rates: 10-state sample, 2009-2014

Table 3 shows the regression coefficients and t-statistics for the models analyzing the currently married population in the 10 state sample from 2009-2014. Although better employment and income prospects are generally associated with higher marriage rates, Shepard, Betz, and Snyder (2020) found that county marriage rates *decreased* during the O&G boom. A restricted sample of 10 more-highly concentrated O&G employment states may yield different results given heavier industry influence in these areas.

The parsimonious model including only O&G employment share and no potential mediating channels suggests a similar negative relationship between higher O&G employment and county marriage rates. Specifically, a standard deviation increase in O&G employment's share of total employment was associated with a 0.51 percentage point decrease in the proportion of population currently married (Model 1). Nearly 80% of the O&G jobs nationwide are filled by males[13], which leads me to add a control for the county sex ratio (i.e. male-to-female proportion in the county). Adding county sex ratio removes the significant relationship between O&G employment and county marriage rates. Model 2 in Table 3 suggests that a higher population percentage of males is associated with lower marriage rates. It is important to note that this measure only captures the males that permanently relocate to a county and not transient workers who migrate frequently to follow O&G employment opportunities. This means a portion of the male population is not accounted for and could potentially influence the statistical model.

Model 3 replaces the population percent that is male with female labor force participation (FLFP). Becker's (1973) economic theory of marriage states that better employment and income opportunities for women leads to more selectivity in partner selection by removing reliance on a partner for economic resources. The O&G industry and the spillover employment effects could raise labor force opportunities for women and possibly influencing county marriage rates. Model 3 appears to show that Becker's (1973) independence effect is in play, as higher rates of FLFP are associated with lower

[13] https://www.bls.gov/cps/cpsaat18.htm

county marriage rates. However, the relationship between O&G employment share and marriage is significant in this model, such that a standard deviation increase in O&G employment share is associated with a .50 percent decrease in the proportion of the currently married population. This suggests that the relationship between O&G employment and county marriage rates is not fully explained by changes in FLFP.

Model 4 in Table 3 replaces FLFP with median household income and its squared term to test how income may related to O&G employment and marriage rates. Typically, income and employment are positively associated with marriage (Cherlin, 2004).The relationship between income and marriage rates is not significant in this model, though there appears to be evidence that county marriage rates are negatively associated with O&G employment share with income in the model.

Including all three potential mechanisms in model 5, in addition to O&G employment share, shows that the relationship between shale O&G employment share and county marriage rates may be explained through shifting county sex ratios and increasing FLFP. This null finding may be weighted by the metro counties in this sample, however, as the nonmetro population shows a significant negative relationship between O&G employment share and county marriage rates beyond the mechanism variables. A one standard deviation increase in O&G employment share in nonmetro counties is associated with a .57 percent decrease in the proportion of population currently married (Nonmetro, Table 3). This finding is consistent with Shepard, Betz, and Snyder (2020) that found a negative association between O&G employment and county marriage rates for nonmetro populations during the O&G boom. This is an important distinction as nonmetro counties have nearly two percent more of their employment made up of O&G jobs as compared to metro populations (Table 1).

O&G employment growth and marriage rates: 10-state sample, 2015-2018.

Table 4 includes the regression coefficients and t-statistics for the models of the currently married population in the 10-state sample during the O&G bust from 2015-2018. I test my hypothesis that slowed growth in the O&G employment share would decrease the proportion of currently married individuals. It is possible for marriage behaviors to decrease as the O&G industry busts, leading to less employment and resources for marriages to utilize. However, marriage rates are not associated with O&G employment in the parsimonious model.

The potential channels and reasoning are the same between models 2-5 in Table 3. The percent population that is male is not significantly associated with marriage rates within these 10 states. Model 3 in table 5 again provides some evidence of Becker's (1973) independence effect, as increasing FLFP is associated with lower marriage rates. Model 4 introduces income as a mechanism and shows a positive relationship with marriage, indicating that increasing income may be related to higher marriage rates.

In the fully saturated model, FLFP and income remained significant. However, O&G employment was not a significant predictor of the currently married population across any specification in this 10 state sample. This finding holds when the sample is split by metro status. My initial hypothesis was that the population of currently married individuals may be lower due to the O&G bust; these findings provide evidence that a downturn in the O&G industry may not influence the population of currently married individuals. This relationship between marriage and extractive industry downturn was found in the coal industry (Betz & Snyder, 2017), though one suggested reason was that the coal industry has a long history with the boom-bust cycle and may be able to withstand the shocks. The current findings with the O&G bust may provide an example of the relatively new shale O&G industry behaving in a similar fashion.

O&G employment growth and divorce rates: 10-state sample, 2009-2014

Table 9 displays the regression coefficients and t-statistics for the models looking at the divorced/separated population in the 10 state sample from 2009-2014. Divorce generally works through two channels; it may increase with O&G employment through the independence effect (i.e. rising FLFP) or decrease through the income effect (i.e. lowering financial stress in marital relationship). Another unknown factor is how an influx of largely male workers will influence current relationships. Although the expectation during strong economic periods could be fewer divorces due to stabilization through the income effect, Shepard, Betz, and Snyder (2020) in a similar sample found evidence of the independence effect possibly leading to higher divorce rates. They found that while an influx of males, rising FLFP, and higher income all occurred and were associated with shifts in divorce rates during the boom, O&G employment share remained a significant positive predictor of divorce across all specifications. The results appeared to be driven by nonmetro counties, as a one percentage increase in O&G employment share was associated with a .05 percent increase in the divorced population (Shepard, Betz, & Snyder, 2020). Following these findings, I expect O&G employment to be positively related to divorce through similar mechanisms in the higher-concentrated 10 state O&G sample.

The first model in Table 5 shows a positive relationship between O&G employment share and county divorce rates; a one standard deviation increase in O&G employment share is associated with a .27 percent increase in county divorce. This effect and relative magnitude remains in Model 2 when considering a shift in the county sex ratio due to an influx of males. Although it appears that an influx of males may destabilize marriages, possibly through increasing potentially attractive mates in the marriage market, O&G employment remains a significant predictor.

Replacing the county sex ratio with FLFP reveals a similar pattern. Although there is evidence of the independence effect for women through increased employment opportunities, it does not fully explain the relationship observed between O&G employment share and divorce rates. Somewhat surprising was that median income in model 4 was not associated with divorce rates; this may be because of the competing effects of the income and independence effects essentially cancelling each other out. Beyond income, the relationship between O&G employment share and divorce rates remained.

The fully saturated specification in model 5 shows that county sex ratio and FLFP remain important predictors in understanding county divorce rate in this restricted sample. O&G employment share remained a significant predictor of county divorce rates. However, two important things separate the models in Table 5 and the findings in Shepard, Betz, & Snyder (2020). First, the models in Table 9 show no significant effects of O&G employment in metro or nonmetro counties when considered independently, whereas Shepard, Betz, & Snyder (2020) found a positive relationship between O&G employment and divorce rates. Second, the r-squared for models in the restricted boom sample found in Table 5 show that these models are inefficient in explaining the variation observed in county divorce rates. This highlights that there may be other factors in play that are influencing divorce within these 10 states compared to the 50 state sample.

O&G employment growth and divorce rates: 10-state sample, 2015-2018.

Table 6 shows the results for divorce rates in the 10 high-concentration O&G bust sample. I expect that divorce rates in these states will be more highly influenced by the O&G bust in these areas, as they may be more reliant on the industry for economic well-being. Interestingly, in models 1-5, the relationships between nearly all mechanisms and O&G employment were removed by taking away the lower O&G concentrated states (see Appendix C, Table 27). Splitting the sample by metro status suggests that O&G employment share remains a significant positive predictor in metro counties, such that a one standard deviation increase in O&G employment share is associated with a .32 percent increase in county divorce rates. Although O&G employment typically is more concentrated in nonmetro counties, there are hubs – such as Fort Worth, Texas, and Pittsburgh, PA, among others – that have large amounts of O&G employees. This is an important distinction as it suggests that extraction industries may play a role in destabilizing marriages in different geographic contexts. However, the r-square for the metro model in table 6 is roughly half of the r-squared in Table 27, suggesting that this model is not as efficient at explaining variations in divorce in the restricted sample.

O&G employment growth and never married rates: 10-state sample, 2009-2014.

Table 7 contains the regression coefficients and t-statistics for never married rates in the restricted 10 O&G states from 2009-2014. Examining the rate of never married individuals is important to examine in conjunction with marriage and divorce rates to determine whether shifting marriage rates are due to more divorce or fewer couples transitioning to marriage. Based on my previous expectations that marriage rates would go up and divorce rates would go down, I would predict that the rate of never married individuals would decrease as more individuals transition to marriage. However, Shepard, Betz, and Snyder (2020) in their analyses found no effect of O&G employment share on the rate of never married individuals in all 50 states from 2009-2014. The results of models 1-5 in Table 7 found a similar pattern; although some mechanisms, such as sex ratio and FLFP are associated with the rate of never married individuals, O&G employment shares no relationship with the rate of never married individuals in this sample. Splitting the sample by metro status again yields null findings.

O&G employment growth and never married rates: 10-state sample, 2015-2018.

Table 8 contains the regression coefficients and t-statistics for the rate of never married individuals in the restricted 10 state sample from 2015-2018. I hypothesize that during the O&G bust, the economic downturn would lead to more individuals never being married as a lack of resources puts marriage out of reach. However, O&G employment share does not appear to be a significant predictor across models 1-5. When splitting the sample by metro status, O&G employment share is associated with lower rates of never married individuals in metro counties. Specifically, a one standard deviation increase in O&G employment share is associated with a .29 percent decrease in the rate of never married individuals. Median household income is also a significant predictor in the metro sample, indicating that increased employment and financial well-being may be helping metro individuals have the resources to achieve marriage.

O&G employment growth and cohabitation rates: 10-state sample, 2009-2014

Table 9 shows the regression coefficients and t-statistics for the models analyzing cohabitation rates in the 10 state sample during the O&G boom. Economic theory would lead me to hypothesize that cohabitation rates would go down during a time when individuals have more resources to transition to and stay in current marriages. Shepard, Betz, and Snyder (2020) found no evidence of O&G employment share influencing cohabitation rates during the boom in all 50 states. The findings in Table 9 show a similar pattern; models 1-5 yield no significant relationships between O&G employment and cohabitation rates. Similarly, there are no differences in these relationships based on metro status, indicating that O&G employment may not play a large role in the choice for couples to cohabit.

O&G employment growth and cohabitation rates: 10-state sample, 2015-2018.

Table 10 contains the regression coefficients and t-statistics for the models examining cohabitation rates in the 10 state sample from 2015-2018. Economic theory would predict that as marriages become destabilized through decreasing income and employment, cohabitation might increase as couples lack resources to transition to marriage. Models 1-5 in Table 10 go against this expectation, as there was not a significant relationship between O&G employment share and cohabitation rates within a county. Splitting the sample by metro status reveals that neither nonmetro nor metro areas show associations between O&G employment and cohabitation rates.

Conclusions

Shale oil and gas development has dramatically altered the energy landscape in the United States over the last 15 years. This shifting landscape has brought changes to many communities, but especially nonmetro areas that have come to rely on the O&G industry. Prior to the O&G boom and subsequent bust, many of the communities that are now reliant on the industry had little experience with the unique challenges tied to extractive activities. This study adds to the growing literature on family behavior in mining communities (Betz & Snyder, 2017; Kearney & Wilson, 2017; Shepard, Betz, & Snyder, 2020) that is helping to disentangle the social effects of O&G development and it becomes the dominant provider of energy resources in America.

This study sought to further explore these marriage trends to see if they held in different time and regional contexts. Utilizing Marriage Market theory (Becker, 1973), I would have initially expected that increasing employment and income through O&G development would have raised marriage rates, decreased divorce rates, rates of never married individuals, and cohabitation rates as partners became more attractive and resources were available to transition to marriage. I would expect this effect to be stronger in nonmetro areas, as prior literature documented the general preference for marriage in nonmetro counties (Albrecht & Albrecht, 2004; Snyder, 2006; Snyder, 2011).

However, Shepard, Betz, and Snyder (2020) found a negative association between county O&G employment and county marriage rates in a sample of 50 states during the O&G boom driven largely by nonmetro areas, showing that the nonmetro preference for marriage does not hold in all contexts. As O&G employment share was significantly higher in the 10-state sample, I would rely on these findings rather than Marriage Market theory to hypothesize that marriage would decrease, possibly due to the independence effect.

Restricting the sample from Shepard, Betz, and Snyder (2020) to 10 highly concentrated O&G employment states found that the association of lower marriage rates in counties with more O&G employment share held in nonmetro counties. However, when metro and nonmetro areas were considered together with county sex ratio, female labor force participation, and income, sex ratio and FLFP were the mechanisms by which county marriage rates fell. Further, the findings of this study are some of the first to shed light on how the O&G bust has influenced family outcomes. However, O&G employment rates were not associated with county marriage rates from 2015-2018.

The Family Stress Model (Conger, Ge, Elder, Lorenz, & Simmons, 1994; Conger & Elder, 1994; Conger & Donnellan, 2007; Conger, 2011) would suggest that divorce rates would go down during the O&G boom as increasing resources reduce stress on the relationship, thereby decreasing odds of separation. However, Shepard, Betz, and Snyder (2020) found that O&G employment shares were positively associated with county divorce rates in all 50 states during the O&G boom. This relationship held in the restricted 10-state sample but as opposed to the 50 state sample, there were no significant relationships by metro context. The O&G bust results showed a significant relationship between O&G employment and divorce in metro counties for the 10-state sample. A possible explanation for these findings is the independence effect, which hypothesizes that increased resources for women allow the dissolution of unsatisfying marriages and increase selectivity into marriage (Nunley & Zeitz, 2012; Sayer & Bianchi, 2000; Schoen et al., 2002). This phenomenon does not explain the geographic variation observed, however, that shows nonmetro counties drive divorce rates during the boom and metro counties drive significance during the bust. Further exploration into geographic variation may be necessary to better understand the observed divorce behavior.

Shale O&G development within the 10-state sample does not appear significantly related to cohabitation or never married rates. Overall, the shifting rates of never married individuals and cohabiting couples seems to be explained more accurately by focusing on county sex ratio, FLFP, and household income, all of which could be influenced in a small yet statistically insignificant way by O&G development. Generally speaking, marriage rates seem to go down during the boom while divorce rates go up in different geographic contexts across the boom-bust cycle. The rate of never married and cohabiting households seem not closely tied to O&G employment.

Marriage is associated to many desirable individual and community outcomes that are important for policy makers to consider when making the decision whether to pursue O&G development in their communities. It is important to contextualize the magnitude of the shifts in marriage and divorce rates within these states so that decision makers can be properly informed. As mentioned in the data section, the marriage, divorce, cohabitation, and never married rates are all calculated using rolling five-year averages. These measures, while the best available for county relationship rates, may understate year-over-year changes in rates. The true rate of change for these relationship variables may be much larger than is shown in these analyses. This is especially important when considering bust data; in 2015, the first year of the bust, four out of five years of relationship data are from the boom years. Even if partnering behaviors were shifting in the early years of the bust, these measures may mask the overall impact that O&G development is having on a community in real-time. This serious limitation could limit this paper from establishing accurate rates of marriage behavior during the bust. To address some of these concerns, I designed Chapter 3 using individual data during the bust that gives insight to marriage behavior on a yearly basis. Although I am unable to split the sample by metro status during this period due to Census Bureau disclosure restrictions (see Chapter 3 for more details), it will nevertheless provide insight to marriage behavior shifts that influence the largely nonmetro areas that experience O&G development.

Although the cumulative magnitude of these shifts in marriage and divorce are relatively small and non-reactive, understanding how energy development influences the social structure of a community is important nonetheless. What policies may be implemented are nuanced and should be carefully weighed before implementation. Though marriage in general is associated with positive benefits, the increased economic independence provided through increased labor force participation may allow women to leave abusive or unsupportive marriages and divorce could be considered a social good.

However, O&G development may lead to stress through several channels and could end up destabilizing otherwise successful families and marriages, leading to undesired relationship dissolution.

This study builds on Shepard, Betz, and Snyder (2020) in providing a better view of family outcomes during the O&G boom at the county level by limiting boom analyses to highly concentrated O&G states. Further, this study provides a first glimpse of family outcomes utilizing data from the O&G bust to see how families are reacting to industry downturn. The results of these analyses bring additional context to sample selection for examining relationship transitions. It appears that the results in Shepard, Betz, and Snyder (2020), which utilized a similar analytical framework, were more significant than the results in the 10-state sample for the O&G boom. This suggests either that the results were being strengthened by O&G counties outside of the 10 highest producing states or that the additional counties in the 50-state sample were infusing noise into the results. As these analyses are primarily interested in relationship rates within fracking communities, the 10-state sample proposed by Abboud and Betz (2020) appears to be beneficial in narrowing down the true effect of large O&G community development.

While these findings are beneficial, there are some limitations to the data and empirical approach. A key difficulty in utilizing ACS data for studies of the O&G industry is the inability to capture temporary in-migrant workers. It is common for workers to migrate to a county for a few months, live at a temporary address, and move after their work is complete. These workers are left out of ACS survey as the sampling frame relies on permanent addresses to select respondents. Capturing these migrant workers would undoubtedly increase data quality and would improve future studies of social outcomes in O&G communities.

I am also limited by the data quality on family outcomes in nonmetro areas. The ACS data used are based on 5-year rolling averages and may thus not capture nuanced yearly changes to family outcomes. As noted, O&G employment experiences high rates of migration and can quickly shift the demographics of a community; a 5-year rolling average may understate some of those shifts. This is especially important for the bust period, as some of the changes could be masked due to the bust occurring immediately following the boom. Being able to access higher quality nonmetropolitan data may influence some of the stated findings from this study, especially when considering results by geographic context.

Table 1. *Variable Means and Standard Deviations, 10 O&G States 2009-2014*

	Mean	SD	Nonmetro	SD	Metro	SD
Percent Now Married	53.96	6.68	54.41	6.67	52.47	6.49
Percent Divorced/Separated	13.10	2.80	13.04	2.98	13.30	2.10
Percent Never Married	25.56	6.25	24.83	6.09	27.95	6.20
Percent of Households Cohabiting	4.86	1.74	4.72	1.79	5.35	1.45
O&G Employment Share	2.98	5.77	3.40	6.30	1.56	3.09
Population Percent Male	50.39	2.81	50.58	3.00	49.76	1.93
Female Labor Force Participation	40.54	4.21	40.17	4.48	41.75	2.87
Median Household Income	44,302	10,362	42,612	9,220	49,890	11,865
Percent in Poverty	16.81	5.97	17.16	5.99	15.66	5.76
Percent Employed	41.26	14.89	41.00	14.71	42.10	15.44
Percent Foreign Born	4.63	5.38	4.32	5.18	5.65	5.91
County Population	82,977	236,843	44,641	127,826	209,734	408,327
Percent Under 20	26.23	3.96	25.85	4.08	27.49	3.23
Percent 20-24	6.13	2.43	5.94	2.35	6.75	2.56
Percent Over 64	16.02	4.42	16.91	4.35	13.08	3.18
Percent Hispanic	13.64	19.10	13.92	19.57	12.69	17.46
Percent African American	5.99	10.09	4.82	9.00	9.84	12.32
Percent All Other	4.72	8.12	4.84	8.49	4.31	6.76
Percent Some College	33.09	9.31	33.66	9.31	31.22	9.05
Percent Bachelors or More	19.75	6.82	19.08	6.45	21.98	7.51
N	4,806		3,690		1,116	

Table 2. *Variable Means and Standard Deviations, 10 O&G States 2015-2018*

	Mean	SD	Nonmetro	SD	Metro	SD
Percent Now Married	52.28	6.64	52.73	7.21	50.80	6.36
Percent Divorced/Separated	13.54	2.74	13.53	2.91	13.58	2.10
Percent Never Married	27.01	6.40	26.26	6.30	29.52	6.09
Percent of Households Cohabiting	5.33	1.80	5.19	1.85	5.78	1.55
O&G Employment Share	2.71	5.51	3.17	6.06	1.21	2.58
Population Percent Male	50.57	2.83	50.78	3.01	49.86	1.96
Female Labor Force Participation	40.58	4.34	40.20	4.60	41.80	3.07
Median Household Income	50,101	11,937	48,156	10,430	56,533	14,151
Percent in Poverty	15.78	5.89	16.18	5.92	14.43	5.59
Percent Employed	41.20	14.61	40.66	13.36	42.99	18.03
Percent Foreign Born	4.97	5.64	4.67	5.47	5.94	6.07
County Population	87,035	255,266	45,607	133,617	224,014	444,234
Percent Under 20	25.44	3.88	25.16	3.98	26.38	3.37
Percent 20-24	6.24	2.28	6.08	2.25	6.77	2.27
Percent Over 64	17.59	4.53	18.43	4.50	14.81	3.42
Percent Hispanic	14.89	19.72	15.20	20.24	13.86	17.87
Percent African American	6.01	10.08	4.82	8.98	9.96	12.29
Percent All Other	5.16	8.28	5.25	8.67	4.86	6.80
Percent Some College	29.44	5.40	29.47	5.55	29.32	4.87
Percent Bachelors or More	20.35	8.73	19.19	7.79	24.20	10.42
N	3,204		2,460		744	

Table 3. *Determinants of Percentage of Population Currently Married, 10 O&G States 2009-2014*

	Model 1	Model 2	Model 3	Model 4	Model 5	Nonmetro	Metro
O&G Employment Share	-0.088†	-0.076	-0.091*	-0.086†	-0.075	-0.091*	-0.012
	(-1.894)	(-1.634)	(-1.968)	(-1.852)	(-1.619)	(-1.994)	(-0.107)
Percent Population Male		-0.325**			-0.414***	-0.484***	-0.301
		(-3.194)			(-4.124)	(-5.240)	(-1.259)
Female LFP			-0.094**		-0.128***	-0.102***	-0.196*
			(-2.811)		(-3.760)	(-3.340)	(-2.482)
Median Household Income				-1.71e-05	-2.12e-05	-4.39e-05	4.15e-05
				(-0.270)	(-0.338)	(-0.828)	(0.479)
Median HH Income Squared				1.18e-10	1.54e-10	5.18e-10	-4.45e-10
				(0.210)	(0.280)	(1.078)	(-0.653)
N	4,805	4,805	4,805	4,805	4,805	3,689	1,116
R-squared	0.157	0.203	0.175	0.157	0.242	0.302	0.051

*** p<.001; ** p<.01; * p<.05; †p<.10

T-statistics are in parentheses under the coefficients

Controls were included for poverty, employment, foreign born status, county population, age, race/ethnicity, and education

Table 4. *Determinants of Percentage of Population Currently Married, 10 O&G States 2015-2018*

	Model 1	Model 2	Model 3	Model 4	Model 5	Nonmetro	Metro
O&G Employment Share	-0.003	-0.002	-3.82e-04	-0.010	-0.006	-0.041	0.024
	(-0.081)	(-0.062)	(-0.011)	(-0.272)	(-0.170)	(-1.052)	(0.363)
Percent Population Male		-0.101			-0.147	-0.176†	0.011
		(-1.134)			(-1.644)	(-1.771)	(0.047)
Female LFP			-0.062*		-0.073*	-0.083**	-0.069
			(-2.190)		(-2.523)	(-2.701)	(-1.001)
Median Household Income				5.70e-05†	6.24e-05*	3.43e-05	6.89e-05†
				(1.912)	(2.115)	(0.868)	(1.701)
Median HH Income Squared				-2.79e-10	-3.19e-10	-1.16e-10	-3.24e-10
				(-1.259)	(-1.455)	(-0.355)	(-1.189)
N	3,204	3,204	3,204	3,204	3,204	2,460	744
R-squared	0.239	0.237	0.278	0.239	0.276	0.262	0.279

*** p<.001; ** p<.01; * p<.05; †p<.10

T-statistics are in parentheses under the coefficients

Controls were included for poverty, employment, foreign born status, county population, age, race/ethnicity, and education

Table 5. *Determinants of Percentage of Population Divorced/Separated, 10 O&G States 2009-2014*

	Model 1	Model 2	Model 3	Model 4	Model 5	Nonmetro	Metro
O&G Employment Share	0.046†	0.041†	0.047†	0.047†	0.043†	0.033	0.037
	(1.857)	(1.698)	(1.910)	(1.943)	(1.790)	(1.214)	(0.747)
Percent Population Male		0.111*			0.150**	0.162**	0.118
		(2.425)			(3.154)	(3.233)	(1.214)
Female LFP			0.043**		0.055***	0.049**	0.068*
			(2.765)		(3.371)	(2.700)	(2.054)
Median Household Income				-2.33e-08	1.92e-06	1.00e-05	-1.81e-06
				(-0.001)	(0.062)	(0.301)	(-0.039)
Median HH Income Squared				-4.63e-11	-6.25e-11	-2.38e-10	5.01e-11
				(-0.171)	(-0.235)	(-0.740)	(0.140)
N	4,805	4,805	4,805	4,805	4,805	3,689	1,116
R-squared	3.00e-04	5.00e-04	0.000	2.00e-04	0.004	3.00e-04	0.002

*** p<.001; ** p<.01; * p<.05; †p<.10
T-statistics are in parentheses under the coefficients
Controls were included for poverty, employment, foreign born status, county population, age, race/ethnicity, and education

Table 6. *Determinants of Percentage of Population Divorced/Separated, 10 O&G States 2015-2018*

	Model 1	Model 2	Model 3	Model 4	Model 5	Nonmetro	Metro
O&G Employment Share	0.033	0.033	0.032	0.032	0.030	0.000	0.123*
	(1.383)	(1.378)	(1.344)	(1.324)	(1.279)	(0.001)	(2.508)
Percent Population Male		0.053			0.073	0.115†	-0.079
		(1.027)			(1.329)	(1.960)	(-0.502)
Female LFP			0.028†		0.031†	0.037†	0.030
			(1.673)		(1.761)	(1.847)	(0.836)
Median Household Income				2.03e-05	1.80e-05	-2.49e-05	3.77e-05
				(1.143)	(0.995)	(-1.179)	(1.507)
Median HH Income Squared				-1.47e-10	-1.30e-10	3.40e-10*	-3.31e-10†
				(-1.077)	(-0.934)	(2.040)	(-1.936)
N	3,204	3,204	3,204	3,204	3,204	2,460	744
R-squared	0.004	0.004	0.002	0.004	0.001	0.006	0.086

*** p<.001; ** p<.01; * p<.05; †p<.10

T-statistics are in parentheses under the coefficients

Controls were included for poverty, employment, foreign born status, county population, age, race/ethnicity, and education

Table 7. *Determinants of Percentage of Population Never Married, 10 O&G States 2009-2014*

	Model 1	Model 2	Model 3	Model 4	Model 5	Nonmetro	Metro
O&G Employment Share	0.024	0.014	0.025	0.020	0.010	0.028	-0.028
	(0.738)	(0.425)	(0.792)	(0.603)	(0.314)	(0.962)	(-0.345)
Percent Population Male		0.270**			0.317***	0.370***	0.230
		(2.978)			(3.456)	(4.383)	(1.170)
Female LFP			0.043†		0.069**	0.050*	0.117*
			(1.650)		(2.594)	(2.099)	(1.983)
Median Household Income				2.82e-05	2.97e-05	5.26e-05	-2.51e-05
				(0.775)	(0.828)	(1.359)	(-0.505)
Median HH Income Squared				-1.64e-10	-1.80e-10	-4.49e-10	2.68e-10
				(-0.534)	(-0.602)	(-1.215)	(0.717)
N	4,805	4,805	4,805	4,805	4,805	3,689	1,116
R-squared	0.389	0.419	0.396	0.389	0.437	0.404	0.267

*** p<.001; ** p<.01; * p<.05; †p<.10

T-statistics are in parentheses under the coefficients

Controls were included for poverty, employment, foreign born status, county population, age, race/ethnicity, and education

Table 8. *Determinants of Percentage of Population Never Married, 10 O&G States 2015-2018*

	Model 1	Model 2	Model 3	Model 4	Model 5	Nonmetro	Metro
O&G Employment Share	-0.010	-0.011	-0.011	-0.004	-0.006	0.050	-0.112*
	(-0.310)	(-0.330)	(-0.339)	(-0.117)	(-0.179)	(1.338)	(-2.460)
Percent Population Male		0.102			0.124†	0.118†	0.085
		(1.583)			(1.905)	(1.662)	(0.581)
Female LFP			0.026		0.035†	0.036	0.043
			(1.244)		(1.682)	(1.645)	(0.842)
Median Household Income				-5.53e-05†	-5.80e-05†	-1.71e-05	-6.76e-05*
				(-1.791)	(-1.892)	(-0.391)	(-1.978)
Median HH Income Squared				2.77e-10	2.97e-10	-1.05e-10	3.82e-10†
				(1.221)	(1.321)	(-0.293)	(1.693)
N	3,204	3,204	3,204	3,204	3,204	2,460	744
R-squared	0.428	0.436	0.436	0.423	0.442	0.364	0.363

*** p<.001; ** p<.01; * p<.05; †p<.10
T-statistics are in parentheses under the coefficients
Controls were included for poverty, employment, foreign born status, county population, age, race/ethnicity, and education

Table 9. *Determinants of Percentage of Population Cohabiting, 10 O&G States 2009-2014*

	Model 1	Model 2	Model 3	Model 4	Model 5	Nonmetro	Metro
O&G Employment Share	0.006	0.007	0.006	0.002	0.002	-0.005	0.038
	(0.325)	(0.358)	(0.338)	(0.097)	(0.132)	(-0.250)	(0.957)
Percent Population Male		-0.016			-0.013	0.015	-0.077
		(-0.456)			(-0.352)	(0.382)	(-0.937)
Female LFP			0.006		0.006	0.011	-0.005
			(0.496)		(0.481)	(0.816)	(-0.226)
Median Household Income				5.43e-05**	5.47e-05**	7.85e-05*	2.17e-05
				(3.186)	(3.193)	(2.565)	(0.999)
Median HH Income Squared				-4.47e-10**	-4.49e-10**	-5.75e-10*	-2.73e-10†
				(-3.238)	(-3.231)	(-2.048)	(-1.678)
N	4,805	4,805	4,805	4,805	4,805	3,689	1,116
R-squared	0.107	0.109	0.110	0.096	0.101	0.007	0.223

*** p<.001; ** p<.01; * p<.05; †p<.10
T-statistics are in parentheses under the coefficients
Controls were included for poverty, employment, foreign born status, county population, age, race/ethnicity, and education

Table 10. *Determinants of Percentage of Population Cohabiting, 10 O&G States 2015-2018*

	Model 1	Model 2	Model 3	Model 4	Model 5	Nonmetro	Metro
O&G Employment Share	-0.025	-0.024	-0.025	-0.028	-0.027	-0.005	-0.071
	(-0.949)	(-0.935)	(-0.953)	(-1.083)	(-1.058)	(-0.176)	(-1.289)
Percent Population Male		-0.083†			-0.088†	-0.128*	0.073
		(-1.746)			(-1.763)	(-2.526)	(0.620)
Female LFP			0.003		-0.005	-0.017	0.037
			(0.186)		(-0.299)	(-0.856)	(0.961)
Median Household Income				5.25e-05**	5.30e-05**	2.64e-05	5.55e-05*
				(3.205)	(3.221)	(1.097)	(2.157)
Median HH Income Squared				-3.79e-10**	-3.83e-10**	-1.42e-10	-3.97e-10*
				(-3.200)	(-3.216)	(-0.749)	(-2.269)
N	3,204	3,204	3,204	3,204	3,204	2,460	744
R-squared	0.036	0.040	0.037	0.041	0.044	0.020	0.069

*** p<.001; ** p<.01; * p<.05; †p<.10
T-statistics are in parentheses under the coefficients
Controls were included for poverty, employment, foreign born status, county population, age, race/ethnicity, and education

Chapter 3: Does Shale Development Encourage Transition to Marriage?

The energy production landscape in the United States has steadily been shifting over the last few decades towards a greater reliance on shale oil and gas production. Oil and gas reserves are extracted from shale rocks through a combination of hydraulic fracturing and horizontal drilling (i.e. "fracking"). This new production method gained popularity in the early 2000's and has spurred rapid change in communities located above underground shale plays. Energy production has skyrocketed within the United States as a result; oil production has doubled from five to 10 million barrels daily between 2006 and 2015, while natural gas production increased by 35% (Bataa & Park, 2017; Cook & Perrin, 2016; Perrin & Cook, 2016). As with other extractive industries, shale oil and gas (hereafter O&G) production experiences ebbs and flows based on supply and demand. The first shale O&G boom occurred from 2007-2014 and created roughly 550,000 jobs in mining communities through direct mining industry employment and support industries (Maniloff & Mastromonaco, 2017); however, the subsequent downturn lasting from 2015-2018 saw a number of those jobs disappear. The short-term benefits that occurred during the O&G boom included billions of dollars generated through increased employment, lower consumer energy prices, and royalty payments for landowners. These benefits may be outweighed by short- and long-term costs, such as billions of dollars of damage through greenhouse gas emissions, water pollution, air pollution, wildlife habitat fragmentation, and overall health outcomes (Loomis & Haefele, 2017). Local O&G communities, who quickly expanded infrastructure and paved the way for energy development, may be harmed as employment and associated tax and royalty payments from O&G production disappear during the bust.

Just as the O&G industry has exponentially grown over the last two decades, so to have studies examining its impact on all walks of life. A frequent topic of study is how O&G extraction influences the environment and economy in areas where development occurs (Joskow, 2013; Kelsey, Partridge, & White, 2016; Paredes, Komarek, & Loveridge, 2015; Tsvetkova & Partridge, 2015; White, 2012). Another extensively studied topic is how O&G production via fracking can influence health outcomes (Bunch et al., 2014; Colborn, Schultz, Herrick, & Kwiatkowski, 2012; Elliott et al., 2017; McKenzie, Witter, Newman, & Adgate, 2012; Mitka, 2012; Vengosh et al., 2014; Werner, Vink, Watt, & Jagals, 2015; Whitworth, Marshall, & Symanski, 2018). Others have focused on social change brought about through resource extraction (Brown, Dorius & Kranich, 2005; Komarek 2018; Ruddell & Ortiz, 2013; Schafft, Glenna, Creen & Barlu, 2013; Smith, Krannich & Hunter, 2001), while fewer still have focused specifically on family outcomes in O&G communities (Betz & Snyder, 2017; Kearney & Wilson, 2017; Shepard, Betz, & Snyder, 2020). To this point, papers focusing on family outcomes in extractive communities have utilized county- or PUMA-level measurements for family behavior outcomes. This study adds to the literature on family outcomes by using individual level data to examine how higher levels of O&G employment in an area relates to an individual's transition to marriage in the preceding 12 months.

Marriage behavior has shifted over the past several decades, with marriage and divorce rates trending lower, while nonmarital cohabitation and nonmarital childbearing saw increases in both metro and nonmetro areas (Cherlin 2010; Manning, Brown, & Payne, 2014; McLaughlin & Coleman-Jensen, 2011; Snyder, 2006; Snyder & McLaughlin, 2004). Although the prevailing trends have been away from steady marriage, individuals still largely aspire to get married; limited resources, rather than desire, may be preventing a subset of marriages (Cherlin, 2020; Kuo & Raley, 2016). O&G communities may experience shifting marital patterns due to stabilizing factors related to a strong economy or destabilizing factors related to population turnover (Betz & Snyder, 2017). The O&G industry provides high paying jobs to individuals (typically men) without requiring high levels of education. The Marriage Marketability hypothesis is a theory suggesting all individuals in a geographic area are potential partners and these individuals will seek an economically attractive partner (Becker, 1973). The O&G industry, with its associated high pay, large employment numbers, and draw for migrants, makes men seemingly more attractive mates and may promote marital behavior (Autor, Dorn, & Hanson, 2017; Becker, 1973; Conger, 2011; Edin & Kafalas, 2005; Jensen & Jensen, 2011; Manning, Brown, & Payne, 2014; Nelson, 2011; Oppenheimer, Kalmjin, & Lin, 1997; Oppenheimer, 2003; Rowthorn & Webster, 2008). Higher income reduces marital barriers for both women and men (Aassve, 2003; Cherlin, Ribar, & Yasutake, 2016; Lichter, Qian, & Mellott, 2006; Schmidt, 2008); the O&G mining and industry support jobs, combined with increased economic activity in the local community, could encourage marriage for working-aged individuals during the O&G boom (Cooke, 2011;

Harknett & Kuperberg, 2011; Schaller, 2013; Watson & McLanahan, 2011). However, job losses and decreased income, along with out-migration from mobile O&G workers, could reduce transitions to marriage during the O&G bust.

A few key studies have looked at marital outcomes in extraction communities. A study on marriage in the coal industry shows that nonmetropolitan mining communities are more resistant to economic fluctuations, which stabilizes marriage behaviors. This could be due to a longer history of coal extraction in the United States (Betz & Snyder, 2017). In the Shale O&G industry, Kearney and Wilson (2018) find no evidence for the Marriageable Men hypothesis at the PUMA-measurement level, highlighting that increasing incomes within the community did not lead to more marriages. Another study looking at the O&G boom from 2009-2014 found that marriages *decreased* in communities with higher levels of O&G employment and divorces and the percent of never-married individuals increased, driven largely by nonmetro populations; these findings were replicated in a concentrated 10 O&G state sample and extended to show no association between marriage and O&G employment during the bust in Chapter 2 of this dissertation (Shepard, Betz, & Snyder, 2020).

This paper builds on these studies in a few different ways. Though the aforementioned analyses provide conflicting evidence to the Marriageable Men hypothesis, they were conducted at either the county or PUMA (Public Use Microdata Area, a geographic measurement that generally consists of several counties) level and not examining individual marital behaviors. Performing analyses using these geographic units typically rely on rolling averages over several years to prevent identifying individuals that live in areas with small populations. These measurement techniques, while useful at providing trends over time within a community, may mask individual behaviors as they react to changing economic conditions. Further, these rolling marriage rates capture all marriages in a given geographic area; as the O&G industry is relatively new, many marriages captured in the rolling averages would have occurred prior to industry development. This study utilizes individual level data from the restricted sample of the American Community Survey (ACS) and respondent's answers to "Did you get married in the last 12 months?" This allows me to go beyond community trends to examine individual behaviors in light of higher levels of community O&G employment.

Previous studies on marriage behavior in O&G communities were conducted utilizing only data that cover the boom period from a nationwide sample, as bust data has only recently become available. This study encompasses data from both the boom and bust periods, allowing me to see if individuals changed their behavior based on industry performance. I also restrict my sample from nationwide to individuals in the 10 highest O&G concentrated states[14] in three regions to focus these analyses on areas more influenced by the O&G industry. This approach will produce useful knowledge as researchers continue to study the social outcomes of the relatively new Shale O&G industry.

Chapter 2 of this dissertation utilized the 10 O&G state sample over the boom and bust periods to establish marriage, divorce, never married, and cohabitation rates at the county level. This chapter will build on Chapter 2 by delving deeper into shifting

[14] Marcellus Region (OH, PA, WV); South Region (LA, OK, TX); West Region (CO, MT, ND, WY)

behavior by using individual level data to see how the O&G industry is influencing the decision to marry. This is done by taking yearly response data to the American Community Survey and using the question "did you get married in the last 12 months?" to see if higher levels of O&G in a county alter marriage patterns. Rather than relying on rolling county marriage rates, this measure is designed to capture individuals at the margins (i.e. those getting married instead of those married long before O&G) to see if the economic boom introduced by the O&G industry is changing people's decision to marry.

Using individual level data for both the boom and bust periods in highly concentrated O&G states will provide a clearer picture of how O&G employment may influence the decision to transition to marriage. Given the confounding results from other marriage studies in extractive industries, I rely on the Marriage Marketability hypothesis, which leads me to predict O&G boom periods will increase transitions to marriage while an O&G bust will lead to fewer marriages. I also predict that marriage behavior will be more influenced for younger adults (ages 18-40) than older adults (41-64) as transitions to marriage are more frequent for this age group.

Shale Energy Production's Impact on Economics and Demographics

Over the last two decades, Shale Oil and Gas (O&G) has captured an increasingly large portion of the energy supply chain in the United States. The technology to extract O&G from shale plays using a combination of horizontal drilling and hydraulic fracturing was refined in the early 2000's, leading to an O&G boom from 2007-2014 (Rogers, 2011). The advancements in fracking technology allowed the United States to become a significant force in the world energy market, becoming the world's biggest oil producer in 2015. Subsequent market forces, such as lower demand and prices, led to a bust in the O&G sector that ranged from 2015-2018. With the rise in O&G production via fracking, a robust literature has emerged focusing the economic influence of O&G development. Economists have generally found positive short-term economic impacts within communities; however, it is unclear whether O&G development will experience the "natural resource curse" found in other extraction industries that lead to poorer long-term economic outcomes (Betz et al., 2015; Haggerty, Gude, Delory, & Rasker, 2014; Jacobsen & Parker, 2016; James & Aadland, 2011; Measham and Fleming, 2014; Sachs & Warner, 1997; Weber, 2013; Weinstein, 2014;[15]).

Industries based on resource extraction follow boom-bust cycles as supply, demand, and prices rise and fall. These patterns lead to shifts in the demographic makeup of counties where production occurs through frequent migration of O&G workers and industry support workers (e.g. service, construction, retail) as they search for the next employment opportunity (Black, McKinnish, & Sanders, 2005). Extraction-related in- and out-migration is largely done by men, as over 80% of employees in the O&G industry are male[16] and a majority are young and unmarried. This influx of young, unmarried males to an area may alter the marriage market, providing new options for partners in the largely nonmetropolitan areas where O&G production occurs. The Marriage Market theory, first introduced by Becker (1973), hypothesizes that

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[15] See (Brown, 2014) for a notable disagreement.

[16] https://www.bls.gov/cps/cpsaat18.htm

marriageable partners are generally found within a restricted geographical area and that potential partners are compared to each other within this area. Even if a portion of the male influx is only temporary as O&G booms, relationships might be formed and potentially lead to marriages as the local marriage market grows.

Aside from migration patterns, the marriage market is also influenced by economic attractiveness of potential partners. While O&G production brings high paying jobs to those in the industry, longer-term residents in O&G counties may also see benefits through “spillover effects” (i.e. employment multipliers related to increased O&G mining employment), which could raise income and employment opportunities for workers outside of the mining industry (Brown, 2014; Munasib & Rickman, 2015). There is precedent in extractive communities that industry support jobs (i.e. construction, service, and retail) are added to the local economy during boom cycles and that per capita and household income increases for O&G and non-O&G workers during extraction specialization, at least initially (Black, McKinnish, & Sanders, 2005; Haggerty, Gude, Delory, & Rasker, 2014; Jacobsen & Parker, 2016; Weinstein, 2014). Economic conditions at the community level have also been associated with helping individuals transition to marriage (Cooke, 2011; Harknett & Kuperberg, 2011; Schaller, 2013; Watson & McLanahan, 2011); the O&G industry may therefore play a role in increasing individual marriage behavior in areas with high O&G employment.

Both individuals and communities see short-term economic benefits stemming from O&G development and specialization; however, a growing body of literature warns that fracking is associated with long-term economic, environmental, and social costs, including a decrease in marital rates during the O&G boom (Chapter 2; Joskow, 2013; Kelsey, Partridge, & White, 2016; Paredes, Komarek, & Loveridge, 2015; Shepard, Betz, & Snyder, 2020; Tsvetkova & Partridge, 2015; White, 2012). While long-term outcomes may be worse for communities that welcome O&G development, both metro and nonmetro counties across the U.S. have seen booms in migration, income, and employment and must now deal with the consequences of the industry. These trends have been ongoing for nearly two decades as the United States O&G market has completed a full boom-bust cycle. While many of the outcomes from O&G development have been written about, an understudied issue is how the industry has influenced individual's decisions to transition to marriage. This study aims to fill the gap in understanding how individuals within ever-specializing O&G communities adjust their marital behavior in light of shifting resources.

Economics and Family Formation Outcomes

Over the course of the last several decades, family formation behaviors in America have greatly diversified. The majority of families in the mid-20th century lived in two-parent with children households; however, subsequent decades have shown trends toward more single-parent families, nonmarital cohabitation, and nonmarital childbearing (Cherlin, 2010; Manning, Brown, & Payne, 2014; McLaughlin & Coleman-Jensen, 2011; Snyder & McLaughlin, 2004; Stevenson & Wolfers, 2007). Even as there has been a documented retreat from marriage within a nuclear family setting, a vast majority of individuals still aspire to marriage and see it as an achievement they hope to one day reach (Cherlin, 2020; Kuo & Raley, 2016).

As marriage rates have lowered and the number of single-parent families, cohabiting households, and children born to unmarried parents have increased, a noticeable decrease in welfare has been documented among both adults and children, especially child economic well-being (Brown & Lichter, 2004; McLaughlin & Coleman-Jensen, 2011; Nelson, 2011; Snyder, McLaughlin, & Findeis, 2006; Snyder & McLaughlin, 2006). Low economic well-being and family outcomes share a bidirectional relationship that can be difficult to break (Cherlin, 2004). The Family Stress Model, which hypothesizes that finances serve as a major source of stress and can lead to familial and relational conflict, can be useful in understanding how poor economic health can negatively influence family outcomes (Conger, Ge, Elder, Lorenz, & Simmons, 1994; Conger & Elder, 1994; Conger & Donnellan, 2007; Conger, 2011).

Another potential explanation for how O&G development may influence family formation behavior is through the Marriage Market Theory (Becker, 1973). Marriage markets typically consist of individuals living within the same georgraphic area. The state of the local marriage market is associated with economic conditions (Autor, Dorn, & Hanson, 2017), marriage outcomes (Blau, Kahn, & Waldfogel, 2000), men’s employment (Oppenheimer, Kalmijn, & Lim, 1997) and incarceration (Charles & Luoh, 2010), and increasing women’s employment (Oppenheimer, 1997; Sweeney, 2002). A supply of economically viable men within a marriage market plays a significant role in both men and women transitioning to and staying married (Autor, Dorn, & Hanson, 2017; Conger, 2011; Licther, LeClere, & McLaughlin, 1991; Nelson, 2011; Oppenheimer, 2003; Rowthorn & Webster, 2008). Rising O&G employment may bring high paying employment to largely nonmetro areas, increasing the number of economically attractive men and making marriage possible for more people (Slack & Jensen, 2002).

Higher levels of income and employment are generally associated with more two-parents married households, while lower levels of income and employment are associated with more diverse household forms (such as nonmarital cohabitation and childbirth) (Blau & van der Klaauw, 2013; Charles & Stephens, 2004; Cherlin, Ribar, & Yasutake, 2016; Harknett & Kuperberg, 2011; Joshi, Quane, & Cherlin, 2009; Kotila, Snyder, & Quian, 2015; Nelson, 2011; Nunley & Seals, 2010; Oppenheimer, 2003; White & Rodgers, 2000). While better economic prospects help all individuals appear more attractive within a marriage market, family formation behaviors may be different for men and women. Men with poor economic prospects may experience high multi-partner fertility and worse odds for getting married (Guzzo & Furstenberg, 2007; Ruggles, 2015). Lower income and employment among men in dating or cohabiting relationships prevent them from transitioning to marriage, while married men with worsening economic standing see their marriages destabilized (Carlson, McLanahan, & England, 2004; Conger, 2011; Cooke, 2011; Edin & Kafalas, 2005; Jensen & Jensen, 2011; Manning, Brown, & Payne, 2014; Nelson, 2011; Oppenheimer, Kalmjin, & Lin, 1997; Oppenheimer, 2003; Rowthorn & Webster, 2008; Shenhav, 2016; Watson & McLanahan, 2011; Xie et al. 2003).

Whereas men experience a relatively linear relationship between relational stability and income, women have more potential outcomes from increasing employment opportunities. The first outcome is relationship stabilization through the income effect, which acts to secure marriages (Cherlin, 2004) or provide an opportunity to transition to marriage (Aassve, 2003; Cherlin, Ribar, & Yasutake, 2016; Lichter, Qian, & Mellott, 2006; Schmidt, 2008) through more economic resources. Unique to women, however, is the independence effect (Cherlin, 2004), which destabilizes current marriages as women use their higher income to leave an unequitable or unfulfilling relationship or allows women to abstain from marriage altogether (Nunley & Zietz, 2012; Sayer & Bianchi, 2000; Schoen, Astone, Rothert, Standish, & Kim, 2002). The independence effect may increase the population of the local marriage market as more women become single and could potentially partner with the influx of males seeking O&G employment.

Marriage behavior can also be considered by whether this is a first marriage or remarriage for individuals. For all marriages, the median age of first marriage has risen over the past several decades, to 27.8 in 2017 (Eickmeyer, 2019). Most individuals who marry do so before age 45; 96% of first marriages occur before age 45 (Cruz, 2012). Those with higher levels of education transition to marriage more frequently than those with lower educational attainment (Cruz, 2012). Additionally, those with lower levels of education are also more likely to experience a remarriage (Cruz, 2012). Men also tend to remarry at higher rates than women (Lamidi & Cruz, 2014); however, this trend has converged over time due to lower remarriage rates among men (Schweizer, 2019).

Previous literature gives confounding evidence of what to expect regarding marriage behavior in extraction communities (Betz & Snyder, 2017; Kearney & Wilson, 2017; Shepard, Betz, & Snyder, 2020). However, those studies relied on county- or PUMA-level rolling marriage rate averages, which could mask trends towards marriage among individuals in O&G counties. This is the first study that I am aware of to study O&G communities utilizing individual-level data, which should help identify shifting marriage behavior based on industry expansion. Another advantage to this study is capturing individuals who were married within the previous year rather than relying on a county average. This measure should be more reactive to an infusion of migrants and income that comes along with O&G employment. I further restrict my sample to a selection of 10 highly concentrated O&G states to see how the industry is changing relationships in areas with high industry concentration. Thus, I rely on the Marriage Market Theory to hypothesize that increasing O&G share of overall county employment will increase marital transitions during the boom as it increases attractiveness of potential partners in the local marriage market or by providing resources to allow those already in a relationship to get married. I expect the opposite during the O&G bust and for marriage transitions to decrease as resources are reduced and partners become less economically attractive.

Data and Methods

Sample

I employ multiple sets of data to explore the relationship between county oil and gas (O&G) employment as a share of its total employment and individual's choosing to get married from 2006-2018. Data for the dependent variable is drawn from the restricted sample of the American Community Survey (ACS), which allows me to access data from all respondents to the ACS for each year from 2006-2018. Publicly available samples of the ACS, known as the Public Use Microdata Sample (PUMS), does not allow access to individual-response data in nonmetropolitan areas. Having access to individual data from individuals in both metro and nonmetro areas is key as shale O&G production and employment is typically more concentrated in nonmetropolitan areas. The dependent variable is created using the ACS question, "Did you get married in the last 12 months?" and restricting the sample to working aged (18-64) individuals who were not married more than one year prior to response. I also restrict the sample to 10 high-concentration O&G states[17] to better approximate the influence of O&G employment on marital decision-making. These 10 states were chosen due to their status as the largest producers of shale O&G via fracking in the continental United States (Abboud & Betz, 2020).

Measures

Oil and Gas Employment Variable. The independent variable of interest is county O&G employment as a share of overall employment. Two main measures within the O&G literature measure the influence of O&G development within communities. One is O&G production data, which is used to estimate the timing and magnitude of an O&G boom (Brown, 2014; Mayer, Malin, & Olson-Hazboun, 2018; Munasib & Rickman, 2015; Weber, 2012; Weber, 2013) or examine supplier and consumer prices (Bataa & Park, 2017). Employment data, on the other hand, is useful in capturing the influence on mining workers and employees in related industries and provides a better picture of the O&G industry's effect on the local economy through employment and income (Haggerty, Gude, Delorey, & Rasker, 2014; Kearney & Wilson, 2017; Maniloff & Mastromonaco, 2017; Marchand & Weber, 2018; Weber, 2013; Weinstein, 2014; Weinstein, Partridge, &

[17] Marcellus Region (OH, PA, WV); South Region (LA, OK, TX); West Region (CO, MT, ND, WY)

Tsvetkova, 2018). The work to establish initial infrastructure, such as wells and pipelines, is intensive and demands many employees. After wells and pipelines are operating, a large amount of O&G resources can be produced with a low number of employees. By the time noticeable amounts of O&G production are occurring, some of the temporary migrants who interacted with the community could have moved to the next project. Additionally, revenue from increased production largely flows to oil and gas companies outside of the local community, while employment data captures increasing wages and employment opportunities that directly influence the local community. This project is focusing on the demographic impact of O&G development; therefore, employment data is best suited to capture industry influence on the local marriage market.

The O&G employment variable is calculated using data purchased from Economic Modeling Specialists International (EMSI). EMSI utilizes the Bureau of Labor Statistics' Quarterly Census of Employment and Wages (QCEW), the Bureau of Economic Analysis' (BEA) Regional Economic Accounts, and the U.S. Census Bureau's County Business Patterns form to fill in withheld values from the publicly available economic data at the 4-digit North American Industry Classification System (NAICS) level. These data allow me to isolate O&G employment (NAICS 2111) from other categories of mining employment (metal, coal, gravel, etc.) that are only available in aggregate at the two-digit NAICS county-level from public sources. O&G employment includes initial exploration for natural gas and petroleum; drilling, completing, and equipping wells; operating separators, emulsion breakers, desilting equipment, and field gathering lines; and all activities involved in producing gas and oil up to shipment from the property[18].

Control Variables. The control variables consist of both individual- and county-level measures. Individual measures, such as age, whether the individual was born in the U.S., their employment status, total income, sex, education level, and race/ethnicity are all drawn from the restricted sample of the ACS. Table 1 shows how each variable is measured. County-level control measures include demographic variables, such as age structure, racial composition, county sex ratio, and population come from the U.S. Census Bureau's Intercensal Estimates. Total county employment estimates come from EMSI while county median household income and poverty rate are drawn from the Census Bureau's Small Area Income & Poverty Estimates (SAIPE) program.

Analytic Plan

The analytic model includes individual- and county-level economic and demographic characteristics to control for factors that may bias the estimated relationship between individual marital decisions and O&G employment. County and time fixed effects are included in the model to reduce potential bias from unobservable time-invariant differences between counties and year-specific national trends. The empirical models take the form:

$$OUTCOME_{it} = \beta_0 + \beta_1 (OilAndGas_{jt}) + \beta_2 (X_{it}) + \beta_3 (X_{jt}) + \sigma_j + \gamma_t + \varepsilon_{ijt} \qquad (1)$$

The *OUTCOME* variable represents whether or not an individual was married in the last 12 months. The *OilAndGas* variable is the O&G employment share of total

[18] https://www.bls.gov/iag/tgs/iag211.htm

county employment variable. X represents a vector of economic and demographic control variables split by individual- and county-level measurements as shown in Table 1. ε_{ijt} is the error term, σ_j represents the county fixed effect, and γ_t represents the year fixed effect. Equation 1 is estimated nine times; for the time period 2006-2018, 2006-2014 (O&G boom), 2015-2018 (O&G bust), 2006-2018 for those aged 40 and under, 2006-2018 for those aged 41 and over, 2006-2014 for those aged 40 and under, 2006-2014 aged 41 and over, 2015-2018 aged 40 and under, and 2015-2018 aged 41 and over. Robust standard errors are calculated.

First, I estimate linear probability models for marriage behavior of working aged (18-64) individuals from 2006-2018 in 10 highly concentrated O&G states to provide a baseline estimation of how the independent and control variables related to the dependent variable of interest. The LPM was chosen over probit and logit models due to computational restrictions in this large dataset and for ease of interpretation of the coefficients. I then separate the models into the O&G boom (2006-2014) and bust (2015-2018) to see how overall sector health influenced these behaviors. Following this, I run the models four times; for individuals 18-40 during the boom, for individuals 41-64 during the boom, for individuals 18-40 during the bust, and for individuals 41-64 during the bust. The age cutoffs were chosen as many marriages prior to age 40 are first marriages while marriages after 40 tend to be individuals remarrying (Eickmeyer, 2019). This allows me to test whether marriage behavior is influenced differentially among younger or older working aged adults in different economic climates.

Results

The summary statistics for all nine samples are shown in Tables 11-12. Table 11 shows the descriptive statistics for all individual and county level variables in the 10 O&G state sample from 2006-2018. Due to the regulations surrounding use of the restricted American Community Survey sample, the population and county sizes are rounded according to Census Bureau parameters to maintain respondent confidentiality. Of note, just under four percent of the sample over the course of the O&G boom and bust were married within the previous 12 months of survey response. This may cause some of the effect sizes in the regression tables to be small as transitioning to marriage was relatively unlikely for working-aged individuals. Oil and gas employment share was nearly three percent during this period. The sample majority were employed, male, high school educated, and non-Hispanic white. The breakdown of all individual and county control sample characteristics can be found in Table 1.

Table 11 also includes descriptive statistics split by the boom (2006-2018) and bust (2015-2018) periods. The sample size of the bust is roughly one-third of the boom for individual respondents, though the same number of counties are represented. Interestingly, marriage transitions increased from 3.63% during the boom to 4.41% during the bust. This happened as O&G employment share remained relatively static at just under three percent. As with the overall sample, respondents were a majority employed, male, high school educated, and non-Hispanic white. However, the bust period saw more individuals either employed or out of the labor force, more males, higher college attainment, and more racially and ethnically diverse compared to the boom sample. County population and income also increased during the bust and the percent of people in poverty dropped compared to the boom. All individual and county statistics for boom and bust are summarized in Table 11.

Table 12 similarly splits the sample by boom and bust period, but adds additional columns for younger adults (18-40) and older adults (41-64) for the overall observation period and split by boom-bust. The county control statistics are the same as the previously discussed overall boom and bust samples from Table 1. The percentage of individuals transitioning to marriage is roughly double for younger adults during both the boom and bust periods. Following previously discussed trends, the transition to marriage was more likely during the bust than boom (4.49% vs. 5.28% for younger adults; 2.11% vs. 2.92% for older adults). The percent of currently employed individuals hovers around 62% for all respondents and periods; however, younger adults have higher percentages of unemployment while older adults are out of the labor force. Younger adults in this sample are more likely to be male while the older sample has a higher percentage of females. Older adults have higher college completion rates while younger adults are still working their way through college. The 18-40 year old sample is also more racially and ethnically diverse and more likely to have been born outside the U.S. A full breakdown of individual and county characteristics by O&G boom-bust period and age is shown in Table 12.

Table 13 breaks down the percent of individuals who transitioned to marriage by whether they lived in a county with any shale oil or gas production. The majority of individuals in this sample lived in counties with oil and/or gas production, which could be expected with this sample being restricted to 10 highly concentrated O&G states. For the overall observation period, individuals living in counties with O&G production experienced more marital transitions compared to individuals in non-producing counties (3.94% vs. 3.63%). This pattern held during the boom and bust, as well as for individuals under 40 and 41 or older. A higher percent of individuals experienced marital transitions during the bust compared to the boom in O&G and non-O&G counties. Additionally, younger individuals across all periods were more likely to get married compared to those aged 41 or older. A complete breakdown of marital percentages by county is available in Table 13.

O&G employment share and transition to marriage, 2006-2018

Table 14 includes the regression coefficients and t-statistics for the models using O&G employment as a share of county population as a predictor for transitioning to marriage in the last 12 months. This period covers an entire O&G boom-bust cycle; therefore, I am using this model as a baseline for understanding the dynamics between O&G employment, transitioning to marriage, and a host of control variables. For the overall sample, a one standard deviation increase in O&G employment share is associated with a 0.02% increase in the probability of transitioning to marriage over the preceding 12 months. For context, 3.84% of individuals in this sample transitioned to marriage within 12 months of survey response, meaning that the effect of O&G employment share is very low for this model. As previously mentioned, the effect sizes may be small for individual predictors as transitioning to marriage is relatively infrequent. However, other factors associated with increasing O&G employment share appear to play a similar or larger role in predicting the transition to marriage.

The Marriage Market Theory would suggest that income and employment status are important for predicting marriage behavior by making potential partners more attractive (Becker, 1973; Cherlin, 2004); this was found to be the case. Each additional thousand dollars in income was associated with a 0.0002% higher chance of marrying, while being employed increased odds of marriage by 0.012% and 0.018% compared to being unemployed or out of the labor force, respectively. Generally, marital behavior also varies by education, as individuals with higher education follow more traditional marital patterns (Harknett & Kuperberg, 2011; Lundberg, Pollak & Sterns, 2016). The education pattern holds for this sample, as marital odds increase by 0.006% for individuals with some college experience and 0.029% for those with a bachelor's degree or higher compared to high school graduates. Other important individual predictors of marriage transitions that are correlated with increasing O&G employment include age and sex. Each additional year of age reduces the odds of transitioning to marriage by 0.0006%. Female respondents also had 0.001% higher odds of getting married compared to males. For a complete listing of all included individual and county variables in this model and their associated coefficients, see Table 26 in the appendix.

O&G employment share and transition to marriage, by industry cycle

O&G boom, 2006-2014

Table 14 displays the regression coefficients and t-statistics for the models estimating the relationship between O&G employment and transition to marriage during the industry boom. Utilizing Marriage Market theory (Becker, 1973), I hypothesize that transitions to marriage will increase within a 10 state sample with high O&G employment concentration. Potential marriage partners may become more attractive through high-income O&G jobs and related spillover employment benefits. Relatedly, increased resources helps individuals transition from dating and cohabiting relationships to marriage (Aassve, 2003; Cherlin, Ribar, & Yasutake, 2016; Lichter, Qian, & Mellott, 2006; Schmidt, 2008). The Marriage Market hypothesis was supported in this model, as a one standard deviation increase in O&G employment share was associated with a 0.004% increase in the odds of transitioning to marriage in the preceding 12 months. This relationship held even as a host of individual and control variables, along with county and time fixed effects, were implemented. However, the practical significance of this finding is minimal, as 3.63% of individuals in this sample transitioned to marriage in the 12 months prior to survey response.

As with the overall model, other potential economic and demographic influences were found to be significant. Each additional thousand dollars of individual income was associated with a 0.0002% increase in the odds of getting married. Relatedly, being employed was associated with a 0.011% and 0.017% increase in marriage compared to being unemployed or out of the labor force, respectively. Respondent age shared a negative relationship with marriage, as each additional year of age was related to a 0.0006% decrease in odds of getting married. Additionally, women had 0.001% higher odds of getting married compared to men. For a complete listing of all variables and related coefficients in this model, see Table 27 in the appendix.

O&G bust, 2015-2018

Table 14 also includes the regression coefficients and t-statistics for the models of transitioning to marriage during the O&G bust. A sampling of 10 more highly concentrated O&G employment states may feel the effect of an industry downturn more acutely than a national sample during this same time. Thus, I rely on the Marriage Market hypothesis (Becker, 1973) to predict that transitions to marriage may decrease as the O&G bust occurs. Some potential reasons for this may be that marriage partners become less economically attractive or some individuals may move away in search of employment, leaving fewer potential mates from which to choose. Interestingly, although industry boom was associated with increased odds of transitioning to marriage, O&G employment during the bust was not related to odds of getting married. As with previous models, other individual and county-level factors appear to play a role in shifting marital odds.

Employment status was significantly associated with odds of getting married. Compared to employed individuals, unemployed individuals had 0.016% lower odds of transitioning to marriage, while being out of the labor force was associated with 0.021% worse odds. Unlike the previous models covering the entire boom-bust cycle and only the boom, income was not significantly related to marriage during the O&G bust. Respondent age was again important for this model, as each additional year of age was related to a 0.0006% decrease in the odds of getting married. Females had 0.002% higher odds of transitioning to marriage in the 12 months prior to survey response compared to male respondents. For other variables included in this model outside of channels highly correlated with both marriage and increasing O&G employment share, see Table 28 in the appendix.

O&G employment and marriage, by industry cycle and age

O&G boom, ages 18-40

Another consideration to the previously discussed mechanisms of how O&G boom-bust cycles may influence transition to marriage is whether respondents are younger or older adults. Median age at first marriage in 2020 was 30.5 for males and 28.1 for females[19]. As workers within the O&G industry are typically young males and median age at marriage shows that individuals typically marry as younger adults, I split the sample by age to see how marital behavior is influenced for both younger and older adults. Table 15 includes baseline estimates for the overall period for young adults (under age 40) and older adults (over age 41). As directionality, significance, and relative magnitude are all similar between this overall period and when the samples are split by boom and bust, I will focus the results discussion by industry cycle to highlight how the overall trends are formed by shale O&G performance (see Appendix Tables 29 and 30 for overall models split by age).

Table 15 includes the analytic sample separated by age during the O&G boom and bust. Using the Marriage Marketability theory, I hypothesize that younger adults will be more influenced by an increase in O&G extraction employment as more in-migrants will be their age and incomes rise for individuals in their peer age group. During the boom period, I hypothesize that young adults aged 18-40 will see a significant and higher

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[19] https://www.census.gov/data/tables/time-series/demo/families/marital.html

magnitude shift in transitions to marriage compared to the overall boom sample. My hypothesis showed evidence of being correct, as the model in Table 15 for young adults during the boom shows that a one-percentage increase in O&G employment share was associated with a 0.0009% increase in odds of transitioning to marriage in the previous 12 months. This effect size was nearly double what was found for the entire working aged sample during the boom period displayed in Table 4, though the relative magnitude of the effect could still be considered small as young adults transitioned to marriage 4.71% of the time.

Table 15 also includes regression coefficients and t-statistics for other individual and county variables contained in the model estimating the relationship between O&G employment and marriage for young adults during the boom. Economic and demographic factors continued to be related to marital behavior, similar to the overall boom model. Each additional thousand dollars of income was associated with 0.0004% higher odds of transitioning to marriage. Compared to employed individuals, unemployed respondents had 0.008% lower odds of marrying while those not in the labor force had 0.012% lower marital odds. Unlike other specifications that included all working-aged respondents during different industry cycles, age shared a positive relationship with marital transition odds for young adults aged 18-40 during the O&G boom. Specifically, each additional year of age was associated with a 0.001% higher likelihood of getting married. Females continued to have higher odds of getting married than males, though the effect size increased to 0.007% when considering only young adults. Other variables included in this model can be found in appendix Table 31.

O&G boom, ages 41-64

Table 15 also displays the regression coefficients and t-statistics for the models estimating the association between O&G employment and transition to marriage among older adults during the boom. As previous hypotheses suggested younger adults may see the biggest shifts in marital behavior due to O&G development, I am unsure how an analytical sample of older adults (ages 41-64) will perform. On the one hand, the Marriage Marketability hypothesis would suggest that older adults could potentially become more attractive partners through O&G employment and associated spillover effects, thereby increasing their resources and aiding in transition to marriage. Conversely, older adults may have fewer potential partners to select from as many attractive partners have already chosen to marry at this stage. O&G development may not help bring in new entrants to the marriage market for older adults as extraction employment typically goes to young males. The analytic model in Table 15 shows no significant relationship between O&G employment share and transitions to marriage, suggesting that a few of the possible explanations could be confounding effects or something else is affecting this altogether.

Other individual economic and demographic influences were found to be significantly associated with odds of transitioning to marriage, though most had lower effect sizes when compared to the young adult boom sample. Each additional thousand dollars of income increased odds of getting married by 0.00008%. Being employed was associated with 0.003% and 0.008% higher odds of transitioning to marriage compared to being unemployed or out of the labor force, respectively. Age was again related to odds of marital transition, but had the opposite effect of the young adult group; each additional year of age was associated with a 0.001% decrease in odds of transitioning to marriage. Women in this sample experienced a similar inverse relationship compared to the young adult sample, such that their odds of marriage decreased by 0.005%. For a complete listing of coefficients in this model, see Appendix Table 32.

O&G bust, ages 18-40

Table 15 shows the regression coefficients and t-statistics for the models estimating the relationship between O&G employment and the transition to marriage among young adults during the industry bust. Relying on the Marriage Market theory, I hypothesized that marital odds would trend downwards as O&G industry employment lowered and potential marriage partners lost their employment and income. I also expect this effect to be more pronounced among young adults, as the industry is more likely to employ young males. However, there is no statistically significant relationship between O&G employment share and transitioning to marriage for young adults during the bust, providing some evidence against my initial hypothesis.

Additional individual and county factors were also significantly related to transitioning to marriage in the preceding 12 months. Economic and demographic variables correlated with O&G employment that increased marital odds among the young adult sample during the bust were increasing income, being older, and being female. For a complete breakdown of relationships between individual and county-level variables and transitioning to marriage in this sample, see Appendix Table 33.

O&G bust, ages 41-64

Table 15 shows the regression coefficients and t-statistics for the models examining the relationship between O&G employment share and getting married among older adults during the bust. Again relying on the Marriage Marketability theory, I hypothesize that marital behavior may decrease during industry downturn, though to a smaller degree than young adults in these 10 high O&G concentration states. As with young adults during the bust, O&G employment share is not significantly related to getting married in the preceding 12 months.

Economic and demographic factors additionally were significantly related to odds of transitioning to marriage in the preceding 12 months. Variables that increased marital odds among the older adult sample were increasing income, while changes from the younger adult bust model are that being younger and male increase marital odds, rather than being older and female in Table 15. For a complete breakdown of relationships between all variables and odds of transitioning to marriage, see Appendix Table 34.

Conclusions

The landscape of the natural resource extraction industry has shifted dramatically in the last two decades, as shale O&G development has become more commonplace. Shale O&G production occurs in many communities with little or no experience with the boom-bust nature and other challenges brought in through resource extraction. This study adds to existing work about marriage behavior in mining communities (Betz & Snyder, 2017; Kearney & Wilson, 2017; Shepard, Betz, & Snyder, 2020) that is helping to clarify how O&G development influences social change, as it becomes the predominant source of energy in the United States.

The results of this study are some of the first to examine how the O&G boom and bust influenced marital behavior, and the first that I am aware of to use individual-level marital data in conjunction with county-level O&G employment share. In general, marriage behavior has been shifting for decades, with marriage rates lowering and divorce, nonmarital cohabitation, and nonmarital childbearing all increasing to new, steady heights (Cherlin 2010; Manning, Brown, & Payne, 2014; McLaughlin & Coleman-Jensen, 2011; Snyder, 2006; Snyder & McLaughlin, 2004). Despite these trends, individuals still aspire to marry and do so when sufficient resources allow them to do so (Cherlin, 2020; Kuo & Raley, 2016). Increasing O&G employment may raise income for individuals who would otherwise be earning less; this may make them more attractive potential partners and increase their standing in the local marriage market while also giving them resources to transition to marriage. Decreasing O&G employment during the bust may have the opposite effect.

Utilizing Marriage Market theory (Becker, 1973), I hypothesized that individual marriage odds would increase during the O&G boom and decrease as the industry busted. I predicted this effect would be more substantial in young adults rather than older adults as individuals under 40 are generally more likely to transition to marriage. There was evidence given that O&G employment increase odds of transitioning to marriage during the boom; further investigation found that individuals aged 18-40 primarily drove this effect. There were no significant associations for older adults during the boom or any significant effects of O&G employment on marital odds during the bust. While Marriage Market theory seems to be in play during the boom, – that is, increasing resources could aid in transitions to marriage for young adults – it does not seem to be decreasing marriages during the bust. A possible explanation is that individuals are still forming relationships and transitioning to marriage when possible, but the resulting decrease in marital odds is not significant. Another possible explanation is that extractive communities are more resistant to downturns occurring within industry cycles (Betz & Snyder, 2017). This phenomenon is known as “rural resilience” and could provide some evidence for a reversal of the Marriageable Men Hypothesis (see Kearney & Wilson, 2017 for a full discussion of Marriageable Men in extraction areas). This hypothesis suggests that lower earnings of men has led to lower marriage rates for men with lower educational attainment. The findings in this chapter suggest that O&G could increase earnings and bring more marriages during the boom while not seeing a decrease of marriages during the bust. This trend, if continued, could bring about a return to marriage among lower-educated men in O&G communities.

Marriage is generally associated with many desirable individual and community outcomes that should be considered by policy makers when deciding whether to open their communities to O&G development. The relative magnitude of the findings in this paper could be considered small; however, it is important to understand how the O&G industry shifts odds in the complex decision to marry to best understand how it influences social change in the community. These findings also add to Kearney and Wilson (2017), who found no association between marriage behavior and O&G development when aggregated at the PUMA level. Using these rich individual-level data may show how behavior is shifting at the grassroots level, which could be masked through aggregated rolling averages such as the ones used in their analyses. Though marriage is generally considered a social good and was found to increase in certain demographics in this paper, increasing income through O&G employment could also allow decoupling among partners who were only still together due to a lack of resources. Further investigation into individual divorce odd shifts may be an important piece in understanding how individuals shift relational transitions in the face of O&G development.

This paper expands on previous studies of marriage during O&G development in several ways. First, rather than PUMA- or county-level data, I utilize individual data to assess odds of transitioning to marriage. This measure is more reactive and assess behavioral change at a finer level, rather than relying on small changes in overall rates. Relatedly, prior studies analyzed rolling county average marriage rates, which account lack nuance and may mask changing behavior. This may particularly become an issue during the bust, which would rely on yearly averages mostly occurring during the boom and mask change occurring as the O&G industry experiences downturn. I also limit my sample to a selection of 10 highly concentrated O&G states that should further capture the influence of O&G employment on marital behavior. Last, this study also utilizes bust data, which only recently became available. Understanding the bust is a key component in providing a better picture of how the O&G industry is related to social and behavioral change.

Although this study improves on past publications, there are still limitations that must be considered. The decision to marry is complex and many factors play a role in who decides to marry and when. Despite a host of variables being considered, the explanatory power of the models found in Tables 3-9 remains low. Undoubtedly, there are considerations outside of measurable demographic and economic data that influence the decision to marry and cannot be capture within an analytical study. Future studies may consider a qualitative or mixed-methods approach to examine how a booming (or busting) industry influences couples as they decide whether and when to make a marital commitment.

Another limitation is the number of respondents in nonmetro areas within the 10 state sample was low, preventing me from splitting the sample by metro status. As part of the regulations for use of the restricted ACS, I am unable to report the exact number of nonmetro respondents. Although I was unable to provide exact counts of nonmetro respondents, Table 13 was created to show respondents by O&G county production status to show how the industry may influence local populations. Nonmetro counties play a key role in the O&G industry, as many shale plays are found in these areas and a booming O&G industry may play a larger role in the local economy. Higher quality data from nonmetropolitan areas would better capture how the O&G industry is influencing the rural population, where there are documented differences in marital behavior (Brown & Snyder, 2006; Snyder, Brown, & Condo, 2004; Snyder, 2011).

Table 11. *Variable Means and Types, Transition to Marriage Ages 18-64, 2006-2018*

	2006-2018	2006-2014	2015-2018	Type of Variable
Percent married, last 12 months	3.84	3.63	4.41	Binary dummy
O&G employment share	2.81	2.84	2.73	County mean
Percent foreign-born	8.38	8.25	8.73	Binary dummy
Employment status				Categorical variable
Employed	61.90	61.63	62.62	
Unemployed	6.82	7.36	5.38	
Not in labor force	31.28	31.00	32.01	
Sex (Female)	49.23	49.49	48.54	Binary dummy
Education				Categorical variable
High school or less	47.76	48.44	45.95	
Some college	33.92	33.72	34.47	
Bachelor's degree or more	18.31	17.84	19.58	
Race/Ethnicity				Categorical variable
Non-Hispanic White	67.33	67.69	66.35	
Non-Hispanic Black	13.84	13.97	13.51	
Non-Hispanic Asian	2.31	2.18	2.66	
Non-Hispanic Other	2.09	2.10	2.05	
Hispanic	14.43	14.06	15.42	
County employment rate	41.07	41.10	41.01	County mean
County percent under age 20	25.86	26.16	25.19	County mean
County percent ages 20-24	6.18	6.18	6.20	County mean
County percent ages 25-64	51.12	51.50	50.26	County mean
County percent ages 65+	16.83	16.16	18.35	County mean
County percent White	74.90	75.56	73.40	County mean
County percent Black	6.00	5.96	6.08	County mean
County percent other race	4.82	4.63	5.26	County mean
County percent Hispanic	14.29	13.85	15.27	County mean
County median household income	44,766	43,197	49,473	County mean
County percent in poverty	16.36	16.52	15.89	County mean
County mean population	84,976	83,384	88,560	County mean
County sex ratio	100.34	100.12	100.85	
N (Individuals)	3,884,000	2,828,000	1,056,000	
N (Counties)	800	800	800	

Table 12. *Variable Means and Types, Transition to Marriage by Age Group, 2006-2018*

	2006-2018 ages 18-40	2006-2018 ages 41-64	2006-2014 ages 18-40	2006-2014 ages 41-64	2015-2018 ages 18-40	2015-2018 ages 41-64
Percent married, last 12 months	4.71	2.40	4.49	2.11	5.28	2.92
O&G employment share	2.81	2.81	2.84	2.84	2.73	2.73
Percent foreign-born	8.94	7.45	8.91	7.05	9.00	8.27
Employment status						
Employed	61.58	62.44	61.08	62.68	62.89	62.14
Unemployed	7.94	4.95	8.58	5.47	6.25	3.88
Not in labor force	30.48	32.61	30.34	31.85	30.86	33.98
Sex (Female)	47.06	52.87	47.19	53.49	46.72	51.66
Education						
High school or less	47.57	48.08	48.46	48.54	45.23	47.19
Some college	35.75	30.86	35.51	30.63	36.69	31.19
Bachelor's degree or more	16.68	21.06	16.03	20.83	18.39	21.62
Race/Ethnicity						
Non-Hispanic White	65.07	71.12	65.36	71.80	64.30	69.88
Non-Hispanic Black	13.04	15.19	13.24	15.14	12.52	15.22
Non-Hispanic Asian	2.97	1.20	2.82	1.10	3.38	1.42
Non-Hispanic Other	2.11	2.04	2.12	2.02	2.09	1.99
Hispanic	16.81	10.44	16.47	9.93	17.71	11.49
County employment rate	41.07	41.07	41.10	41.10	41.01	41.01
County percent under age 20	25.86	25.86	26.16	26.16	25.19	25.19
County percent ages 20-24	6.18	6.18	6.18	6.18	6.20	6.20

Continued

Table 12 Continued

County percent ages 25-64	51.12	51.12	51.50	51.50	50.26	50.26
County percent ages 65+	16.83	16.83	16.16	16.16	18.35	18.35
County percent White	74.90	74.90	75.56	75.56	73.40	73.40
County percent Black	6.00	6.00	5.96	5.96	6.08	6.08
County percent other race	4.82	4.82	4.63	4.63	5.26	5.26
County percent Hispanic	14.29	14.29	13.85	13.85	15.27	15.27
County median household income	44,766	44,766	43,197	43,197	49,473	49,473
County percent in poverty	16.36	16.36	16.52	16.52	15.89	15.89
County mean population	84,976	84,976	83,384	83,384	88,560	88,560
County sex ratio	100.34	100.34	100.12	100.12	100.85	100.85
N (Individuals)	2,434,000	1,450,000	1,766,000	1,061,000	667,000	389,000
N (Counties)	800	800	800	800	800	800

Table 13. Percent Married in Previous 12 Months, by O&G County Status

	Non-O&G Counties	Population	O&G Counties	Population
2006-2018	3.63	1,169,000	3.94	2,715,000
2006-2014	3.42	847,000	3.72	1,981,000
2015-2018	4.18	322,000	4.52	734,000
2006-2018 under 40	4.44	737,000	4.82	1,697,000
2006-2018 41+	2.25	433,000	2.46	1,018,000
2006-2014 under 40	4.24	533,000	4.60	1,234,000
2006-2014 41+	2.03	315,000	2.28	747,000
2015-2018 under 40	4.94	204,000	5.43	463,000
2015-2018 41+	2.86	118,000	2.95	271,000

Table 14. Determinants of Transitioning to Marriage in the Last 12 Months, by Time Period and Age

	2006-2018	2006-2014	2015-2018
O&G employment share	4.80e-04**	5.32e-04**	6.52e-04
	3.18	3.00	1.12
Age	-6.83e-04***	-6.87e-04***	-6.63e-04***
	-97.31	-85.37	-46.62
Employment status			
Unemployed	-0.012***	-0.011***	-0.016***
	-30.06	-24.85	-17.36
Not in labor force	-0.018***	-0.017***	-0.021***
	-77.98	-62.99	-45.95
Income	2.04e-07***	2.03e-07***	2.01e-07
	71.63	58.66	39.60
Sex (Female)	0.001***	0.001***	0.002***
	7.51	5.22	5.48
County Sex Ratio	2.57e-05	1.06e-04	-4.88e-05
	0.63	1.58	-0.40
Constant	-0.04**	-0.09***	-0.04
	-2.91	-5.02	-0.37
N (Individuals)	3,884,000	2,828,000	1,056,000
N (Counties)	800	800	800
R-squared	0.021	0.022	0.019

*** p<.001; ** p<.01; * p<.05

T-statistics under beta coefficients in parentheses.

Table 15. Determinants of Transitioning to Marriage in the Last 12 Months, by Time Period and Age

	2006-2018 under 40	2006-2018 41+	2006-2014 under 40	2006-2014 41+	2015-2018 under 40	2015-2018 41+
O&G employment share	8.15e-04***	-9.22e-05	8.92e-04***	-8.59e-05	8.15e-04	5.66e-04
	3.84	-0.48	3.55	-0.39	1.01	0.74
Age	0.001***	-0.001***	0.001***	-0.001***	0.002***	-0.002***
	58.26	-65.42	44.29	-52.37	38.99	-38.75
Employment status						
Unemployed	-0.009***	-0.004***	-0.008***	-0.003***	-0.013***	-0.007***
	-17.67	-6.14	-14.27	-3.98	-10.97	-5.24
Not in labor force	-0.013***	-0.009***	-0.012***	-0.008***	-0.015***	-0.012***
	-38.24	-28.76	-30.87	-22.35	-22.42	-18.31
Income	4.84e-07***	8.23e-08***	4.93e-07***	8.12e-08***	4.60e-07***	8.19e-08***
	86.28	29.53	71.46	24.33	47.02	15.92
Sex (Female)	0.008***	-0.005***	0.007***	-0.005***	0.010***	-0.005***
	28.43	-19.74	22.33	-17.55	17.81	-9.73
County Sex Ratio	1.77-05	-1.17e-05	1.19e-04	1.67e-05	-6.42e-05	1.55e-06
	0.31	-0.22	1.27	0.19	-0.39	0.01
Constant	-0.09***	0.00	-0.15***	-0.06**	-0.08	-0.02
	-5.11	-0.11	-5.59	-2.59	-0.72	-0.21
N (Individuals)	2,434,000	1,450,000	1,766,000	1,061,000	667,000	389,000
N (Counties)	800	800	800	800	800	800
R-squared	0.032	0.013	0.034	0.014	0.031	0.014

*** p<.001; ** p<.01; * p<.05

T-statistics under beta coefficients in parentheses.

Chapter 4: Shale Development and Trends in Migration of Human Capital

Nonmetropolitan counties have faced declining human capital, dubbed “rural brain drain”, that has seen young adults with the brightest future prospects flee in search of economic opportunity (Artz, 2003; Petrin, Schafft, & Meece, 2014; Roscigno & Crowley, 2001). Human capital, here measured by the cumulative educational attainment of the local population, is associated with income levels, productivity, and economic growth; these factors are keys to retaining and attracting new residents (Artz, 2003). Rural locations have long faced declining populations and fewer educational and economic opportunities compared to urban cores (Dewees, Lobao, & Swanson, 2003; Roscigno & Crowley, 2001; Von Reichert, Cromartie, & Arthun, 2014). Migration theory would suggest that individuals are being positively selected and drawn to urban cores that provide economic and lifestyle benefits not found in rural locations (Lee, 1966). The choice to migrate is two-sided; there are factors that “push” individuals to move from a location and factors that “pull” people to a new location (Greenwood, Hunt, Rickman, & Treyz, 1991; Lee, 1966; Passaris, 1989). These push/pull factors play a large role in determining how human capital is spatially distributed.

One push/pull factor that has sprung up in recent decades is shale oil and gas (hereafter O&G) development, which disproportionately influences nonmetro counties and could disrupt the long-term human capital and population decline in rural areas by bringing in high paying jobs and a large number of young males[20]. Shale plays sit beneath many communities across the U.S. and hold vast amounts of oil and natural gas reserves. New production methods have spurred rapid change in areas on top of shale plays and provided extensive new domestic energy sources. Oil production doubled between 2006 and 2015, from five to 10 million barrels per day; natural gas production increased 35% during the same period (Bataa & Park, 2017; Cook & Perrin, 2016; Perrin & Cook, 2016). The first shale boom, occurring from 2007-2014, provided 550,000 jobs to local communities through mining and related support activities (Maniloff & Mastromonaco, 2017). As with other extractive industries, market forces (e.g. supply, demand, and prices) cause boom and bust periods; the O&G industry experienced a downturn between 2015 and 2018 that saw O&G employment decrease. In the short term, certain pull factors associated with O&G development are increased employment, lower consumer energy prices, and landowner royalty penalties. However, there are also push factors that could drive people away, as O&G development has also been associated with billions of dollars in damage through water pollution, greenhouse gas emissions, air pollution, wildlife habitat fragmentation, and overall health outcomes (Loomis & Haefele, 2017). There is an open question as to how long lasting these O&G trends are and if the influx of people, jobs, and income seen during industry booms can provide long-term change through increasing human capital (Dewees, Lobao, & Swanson, 2003; Mayer, Malin, & Olson-Hazboun, 2018; Schafft & Biddle, 2015; Schafft, Glenna, Green, & Borlu, 2014).

[20] https://www.bls.gov/cps/cpsaat18.htm

There have been several studies that examine how O&G development influences the educational outcomes of the local population (Cascio & Narayan, 2015; Emery, Ferrer, & Green, 2012; Kumar, 2017; Rickman, Wang, & Winters, 2017) and in-migrants combined with local population (Carpenter, Anderson, & Dudensing, 2019; Weber, 2014). The studies that focused on only the local population found a modest decrease in education due to high paying O&G employment swaying young adults to drop out of school and seek lucrative mining salaries. Weber (2014) found that overall education increased in several O&G heavy states when considering migrants and native populations together, suggesting that a strong local economy may draw educated individuals and could help reverse brain drain. However, Mayer, Malin, and Olson-Hazboun (2018) explicitly sought to understand the relationship of O&G development and the reversal of rural brain drain. Using the 2000 and 2010 decennial census' and O&G production data provided by the USDA-ERS to identify "boom" counties, these authors found that the O&G boom was associated with increased proportions of those with a high school degree or less and decreases in the proportion of individuals with a college education.

I build on these studies in several ways. First, prior research on this topic focuses on local populations or a combination of local residents and in-migrants. My study will fill a gap by focusing only on educational attainment of migrants moving to and leaving O&G counties to determine how O&G activity influences these migration decisions. Relatedly, I utilize O&G employment as a share of overall county employment rather than production, which can provide nuance to migration decisions. O&G employment is largest early in the process of mining a shale play when wells are being drilled. After this initial employment surge, wells can produce for years with low maintenance and significantly fewer employees on-site. Many of the employees moved in to establish infrastructure will relocate in search of the next opportunity. As mining industries tend to have a transitive workforce, employment data will capture the fluctuations of workers and could be better suited to catch these migration decisions than production data.

Second, using proprietary employment data, I can separate out O&G employment at the county level from other mining sources. Prior studies utilize higher-level geographies (such as PUMAs) or rely on data from a small collection of states. Utilizing county measures from all 10 states on top of shale plays will provide a more comprehensive picture of human capital fluctuations due to migration. Additionally, this study uses individual-level data through the restricted Census Bureau American Community Survey (ACS) program, which allows detailed access to individual-level migration and educational attainment data for individuals in both metro and nonmetro areas. This study is novel in being able to capture individual responses from rural individuals, providing unprecedented access to migration behavior across the geographic spectrum. These data can give a fine-grained, reactive view of changes happening within the boom, rather than rolling averages over several years that could mask shifting behavior. Again, this reflects that mining employment may be transitive and influencing multiple counties over time.

Last, this study is the first to consider educational outcomes during the O&G bust, which data only recently became available. While educational results appeared to be mixed during the boom, individuals could be making different migration decisions when the O&G industry has a downturn. I examine data for 2015-2018, providing several years of migration patterns that could show how responsive individuals are to a downturn in O&G extraction.

Migration theory suggests that higher educated individuals may experience pull factors to O&G counties during the boom as the economy grows and the population demands more goods and services (Lee, 1966). Previous findings support this idea, as the education level of in-migrants is positively associated with that of the local population, suggesting a concentration of human capital across space (Waldorf, 2007). However, extractive industries may be unique as there is evidence that increases in mining activity may not reverse rural brain drain and population decline (Brown & Schafft, 2011; Brown & Swanson 2004; Jensen, McLaughlin, & Slack, 2003), possibly due to push factors such as negative environmental and health externalities driving individuals with high human capital to relocate. These studies, combined with evidence from O&G literature, lead me to hypothesize that O&G employment may be unique and attract lower-educated migrants during a boom period as O&G field work and the associated high salary serve as a pull factor. The current study also considers the average education level of out-migrants; higher educated individuals may stay due to spillover effects or move to avoid the environmental or other factors that come with O&G development, while lower educated individuals may experience “crowding out” as relative prices of goods and services rise due to a more robust economy (Lee, 1966). I also consider the average level of education of both in- and out-migrants during the bust period to determine how lowering O&G employment influences migration behavior.

How Shale Energy Production Influences Economics and Demographics

Shale Oil and Gas (O&G) development has become an increasingly important part of the energy landscape in the United States. The combination of horizontal drilling and hydraulic fracturing became widespread in the early 2000s and led to a boom period in oil and natural gas production from early 2007-2014 (Rogers, 2011). The refinement of fracking technology spurred unprecedented growth in domestic energy production, allowing the U.S. to become the world's biggest oil producer in 2015. This extended boom period was followed by a collapse of oil prices, which sent O&G into a downturn that lasted through 2018. Communities generally experience positive short-term economic benefits through O&G production. However, it is currently unknown whether areas with heavy O&G development will experience the "natural resource curse", a phenomenon leading to poor long-term economic outcomes in resource extraction communities (Betz et al., 2015; Haggerty, Gude, Delory, & Rasker, 2014; Jacobsen & Parker, 2016; James & Aadland, 2011; Measham & Fleming, 2014; Sachs & Warner, 1997; Weber, 2014; Weinstein, 2014;[21]).

With a rise in O&G production in the United States, numerous studies have begun to examine its impact on the local economy and environment (Joskow, 2013; Kelsey, Partridge, & White, 2016; Paredes, Komarek, & Loveridge, 2015; Tsvetkova & Partridge, 2015; White, 2012). Another topic of frequent study is how fracking influences health outcomes (Bunch et al., 2014; Colborn, Schultz, Herrick, & Kwiatkowski, 2012; Elliott et al., 2017; McKenzie, Witter, Newman, & Adgate, 2012; Mitka, 2012; Vengosh

[21] See (Brown, 2014) for a notable disagreement.

et al., 2014; Werner, Vink, Watt, & Jagals, 2015; Whitworth, Marshall, & Symanski, 2018). Some studies have focused on social change brought about by resource extraction (Betz & Snyder, 2017; Brown, Dorius & Kranich, 2005; Kearney & Wilson, 2017; Komarek 2018; Ruddell & Ortiz, 2013; Schafft, Glenna, Creen & Barlu, 2013; Shepard, Betz, & Snyder, 2020; Smith, Krannich & Hunter, 2001). Others still have focused on how O&G production influences human capital at the county level (Carpenter, Anderson, & Dudensing, 2019; Cascio & Narayan, 2015; Emery, Ferrer, & Green, 2012; Kumar, 2017; Marchand & Weber, 2018; Mayer, Malin, & Olson-Hazboun, 2018; Rickman, Wang, & Winters, 2017; Schafft & Biddle, 2015; Weber, 2014). To this point, studies of human capital in shale O&G counties have considered only the local population or a combination of human capital accumulation for in-migrants and the local population. This study adds to the literature of human capital accumulation by isolating in- and out-migrants to determine if O&G development attracts or drives away higher educated individuals.

Due to the cyclical nature of extractive industries, both short- and longer-term migration occurs and can alter the demographic makeup of a community. This may happen when O&G workers relocating for work, through industry support jobs (e.g. construction, service, retail), or jobs not unrelated to O&G that are created through demands of a higher population being added to the local economy through increased community resources (Black, McKinnish, & Sanders, 2005). The O&G industry may disproportionately encourage migration of males to work directly in the industry, as over

80% of workers are male[22] and a majority are young and unmarried. However, economic shifts within a county may influence both male and female migration as the O&G industry raises demand for support jobs. Migration theory suggests that a strong economy would be a 'pull' factor that could draw individuals to a county; however, not all strong economies offer the same opportunities to every would-be migrant. For example, individuals looking to relocate to Silicon Valley in the U.S. would need substantial financial and personal resources to make such a move attractive. Other areas may offer lower barriers to entry and attract individuals with more modest resources. Further, the theory would posit that educated individuals may be more likely to move due to greater resource access (Greenwood, Hunt, Rickman, & Treyz, 1991; Lee, 1966; Passaris, 1989). What is unknown is whether the volatile O&G sector draws highly educated individuals due to new community opportunities or lower-educated migrants who want high-paying O&G jobs and if these people move on when the industry busts.

Migration patterns are heavily influenced by economic opportunity. While O&G jobs bring high paying jobs to workers in the industry, other jobs are created through "spillover" effects. Spillover effects (i.e. employment multipliers resulting from increased O&G mining employment) may increase income and employment for non-mining workers (Brown, 2014; Munasib & Rickman, 2015). Extractive communities have generally experienced employment gains through industry support jobs (i.e. retail, construction, and service) and per capita income rises for both O&G and non-O&G workers as resource specialization begins, at least initially (Black, McKinnish, &

[22] https://www.bls.gov/cps/cpsaat18.htm

Sanders, 2005; Haggerty, Gude, Delory, & Rasker, 2014; Jacobsen & Parker, 2016; Weinstein, 2014). This may be a boon to local counties through in-migration of workers and former residents returning to their childhood communities, who bring with them spouses, children, and human capital. These return migrants could be key to reversing population decline and "brain drain" as they establish community roots and productive business ventures (Von Reichert, Cromartie, & Arthun, 2014).

Individuals and communities alike realize short-term benefits from O&G development and specialization. However, studies from recent years are pointing to long-term environmental, economic, and social costs (Joskow, 2013; Kelsey, Partridge, & White, 2016; Paredes, Komarek, & Loveridge, 2015; Tsvetkova & Partridge, 2015; White, 2012). Despite the evidence of negative long-term outcomes, many communities nationwide have already accepted O&G development and may experience unintended negative consequences in the long run. Many outcomes have been written about in the two decades since fracking has become more widespread, including human capital fluctuation among local residents and a combination of residents and in-migrants (Carpenter, Anderson, & Dudensing, 2019; Cascio & Narayan, 2015; Emery, Ferrer, & Green, 2012; Kumar, 2017; Rickman, Wang, & Winters, 2017; Weber, 2014). An understudied phenomenon is what role the O&G industry plays in attracting or deterring human capital through migration patterns in O&G communities. This study aims to fills this gap by focusing on migration patterns during the O&G boom and bust to see what role the industry plays in influencing human capital accumulation.

Economic Trends in Rural Areas and Human Capital Accumulation

Rural populations across the country have faced decades of decline from their peak in the mid-20th century. This phenomenon is called "depopulation", which refers to chronic population loss through out-migration, declining fertility, and rising mortality as the population ages (Johnson, 2011; Johnson & Lichter, 2019). Rural areas experience a disproportionately high number of young adults out-migrating in search of economic and educational opportunities in urban centers, leaving an aging population in many nonmetropolitan counties (Fuguitt & Heaton, 1995; Von Reichert, Cromartie, & Arthun, 2014). Adding to this effect is a dearth of in-migrants to rural locales due to a lack of economic opportunity or attractive natural amenities, such as recreational opportunities (Rupasingha, Liu, & Partridge, 2015; Von Reichert, Cromartie, & Arthun, 2014). These selective out-migration patterns among motivated and capable young adults can be particularly harmful for farming- and mining-dependent communities as they lose human, financial, and social capitals due to a lack of economic opportunity and job diversity (Corbett, 2005; Winkler, Cheng, & Golding, 2012).

Migration theory suggests that people move more frequently at given life stages, such as high school graduation, marriage, childbirth, and retirement, among others (Lee, 1966). At these stages, individuals examine their options to determine whether remaining or migrating would be more advantageous to their new life circumstances. Certain "push" or "pull" factors are weighed against obstacles of moving, creating a personalized equation of migration (Lee, 1966). A major consideration at all life stages is employment possibilities in the area of origin or possible destination (Rupasingha, Liu, & Partridge, 2015). As work in America has become bimodal (i.e. increasing numbers of high-skill and low-skill jobs while middle-skill jobs are lost) in the past few decades, rural areas have fallen behind due to lack of opportunities and have experienced large periods of out-migration and declining human capital (Gibbs, Kusmin, & Cromartie, 2005).

Human capital has several major components: education, training, and health (Goldin, 2016). Human capital increases both personal and community productivity, encouraging economic growth as more is accumulated (Goldin, 2016). The focus of this essay is cumulative educational attainment, a key component of human capital within communities (Goldin, 2016). Local communities can increase their cumulative educational attainment in two ways; through increasing education among local residents, or by attracting in-migrants with high levels of education. The O&G industry may encourage local citizens to forego educational opportunities by offering high-paying fieldwork jobs. However, in-migrants could have low or high educational attainment, depending on the type of work for which they are relocating. Within the O&G industry, individuals with lower educational attainment may work the fields to extract resources; however, highly educated individuals may relocate to serve as engineers that help design and maintain critical infrastructure. Additionally, a strong local economy may draw individuals outside of the O&G employment field with any level of educational attainment. This essay isolates the effect of in-migration on the accumulation of human capital at the county level.

Rural areas, which have seen selective depopulation of higher educated individuals, are experiencing a trend called “brain drain” that sees the highest achieving residents flee to more economically advantageous locations (Artz, 2003; Waldorf, 2007). This is problematic, as high levels of human capital are associated with higher levels of income, productivity, and economic growth, which are keys to attracting and retaining residents (Artz, 2003). As residents flee and human capital declines, rural locations are left with fewer resources to help the remaining population, perpetuating the cycle of out-migration to succeed elsewhere or remaining economically insecure in the same town (Dewees, Lobao, & Swanson, 2003; Sherman & Sage, 2011). This lack of resources is particularly evident in family and school settings, which play a large role in determining whether a youth out-migrates after graduation or stays in the area (Dewees, Lobao, & Swanson, 2003; Petrin, Schafft, & Meece, 2014; Roscigno & Crowley, 2001; Sherman & Sage, 2011). However, an influx of capital investment, employment, and income through shale O&G development may serve to reverse these fortunes. There is evidence that communities see large employment gains in all sectors when O&G development occurs (Weber, 2014); this may play a key role in return migration where individuals who moved out after high school graduation reevaluate at different life stages and return with spouses, children, and accumulated human capital, possibly rejuvenating rural communities (Von Reichert, Cromartie, & Arthun, 2014).

Prior literature has sought to understand how O&G activity influences human capital within the community (Cascio & Narayan, 2015; Emery, Ferrer, & Green, 2012; Kumar, 2017; Rickman, Wang, & Winters, 2017) and a combination of the local population and in-migrants (Carpenter, Anderson, & Dudensing, 2019; Weber, 2014). There is evidence that local citizens will leave educational opportunities to pursue high paying jobs within the O&G field, while the literature on in-migrants and the local population combined is less conclusive. This paper is unique in its focus on only migrants in and out of O&G heavy counties. Utilizing a sample of 10 high-concentration O&G states, this study examines human capital flows in and out of counties during both the boom and bust to determine how O&G development influences migration behavior. Migration theory would hypothesize that a strong local economy may attract higher educated individuals (Lee, 1966); however, extractive communities have yet to show evidence of brain drain reversal and population decline (Brown & Schafft, 2011; Brown & Swanson 2004; Jensen, McLaughlin, & Slack, 2003). Prior evidence leads me to hypothesize that O&G communities may be unique and draw lower-educated migrants in search of O&G employment during the boom. Higher educated individuals may either stay due to positive spillover effects from the O&G industry or out-migrate due to negative externalities from O&G development. This is the first study that I am aware of utilizing O&G bust data, which will also highlight in- and out-migration patterns during the bust from 2015-2018.

Data and Methods

Sample

The focus of this paper is to assess how O&G development is influencing the migration of human capital to and from counties with high levels of industry employment and how this differs during the boom and bust period. I combine several data sources to investigate the association between county oil and gas (O&G) employment as a share of its total employment and the in- and out-migration of human capital, as measured by level of education from 2006-2018. The first dependent variable is created by calculating the average level of education of out-migrants over the age of 18 from each county for each year from 2006-2014. The second dependent variable is created by calculating the average level of education of in-migrants to each county for each year from 2006-2014. This process is repeated for both in- and out-migrants during the O&G bust from 2015-2018.

All dependent variables are created utilizing the American Community Survey (ACS) individual-level PUMS data from 2006-2018 and restricting the sample to those who have moved in the last year and are over the age of 18. This paper utilizes the restricted sample of the ACS, which are housed in federal research data centers and provide access to confidential information from all respondents to the ACS. Accessing these restricted data are essential to this project as the publicly available samples are aggregated at different geographical levels and only utilize rolling averages in nonmetro areas to protect respondent identification. Using the restricted sample allows me to assess county of origin and destination among individual migrants and education levels in both metro and nonmetro areas, providing a level of detail not widely available in previous research. Following the findings of Abboud & Betz (2020), I also restrict the sample to 10 highly concentrated O&G states[23] where the majority of shale O&G development has occurred to better approximate how O&G development influences the flow of human capital.

[23] Marcellus Region (OH, PA, WV); South Region (LA, OK, TX); West Region (CO, MT, ND, WY)

Measures

Oil and Gas Employment Variable. The key explanatory variable is county O&G employment as a share of overall county employment. Within the O&G literature, two main measures are used to capture the influence of O&G development within local communities. The first is O&G production data, which is utilized in estimating the timing and overall magnitude of an O&G boom or bust (Brown, 2014; Mayer, Malin, & Olson-Hazboun, 2018; Munasib & Rickman, 2015; Weber, 2012; Weber, 2014) or examine supplier prices (Bataa & Park, 2017). The other measure is employment data, which is beneficial in capturing the influence on both mining workers and employees in related industries to better assess how the O&G industry influences the local economy through income and employment (Haggerty, Gude, Delorey, & Rasker, 2014; Kearney & Wilson, 2017; Maniloff & Mastromonaco, 2017; Marchand & Weber, 2018; Weber, 2014; Weinstein, 2014; Weinstein, Partridge, & Tsvetkova, 2018). Initial O&G development in an area requires intensive infrastructure investment to establish wells and pipelines and demands many employees. The required number of employees drops as wells and pipelines are operational, leaving a small crew to perform extraction and maintenance activities.

When considered chronologically, employment numbers are heavily right-skewed, while production levels often skew more to the left. Capturing the lead-up activity that precedes documented resource production is essential to understanding how the O&G industry specifically influences migration decisions. The industry may draw lower-skill workers to work the fields and perform manual labor to establish infrastructure or higher-skill workers, such as engineers, that influence the demographic composition of the county before any O&G is extracted. With some overlap in the employment and production data, I rely on employment measures to better capture the demographic influence of O&G development at a community level.

Data to create the O&G employment variable were purchased from Economic Modeling Specialists International (EMSI). EMSI uses the Bureau of Economic Analysis' (BEA) Regional Economic Accounts, the US Census Bureau's County Business Patterns form, and the Bureau of Labor Statistics' Quarterly Census of Employment and Wages (QCEW) to fill in withheld values in publicly available economic data at the 4-digit North American Industry Classification System (NAICS) level. These proprietary data allow me to distinguish O&G employment (NAICS 2111) from all other mining employment (gravel, metal, coal, and other types of mining) that are aggregated in publicly available two-digit NAICS county-level data. O&G employment includes exploration for natural gas and petroleum; drilling, completing, and equipping wells; operating separators, emulsion breakers, desilting equipment, and field gathering lines; and all other activities involved in producing oil and gas up to the point of shipment from the property[24].

Control Variables. Data for control variables come from three sources. Demographic variables, such as county age structure (county percent under age 20, 20-24, 25-64, 65+) racial composition (county percent non-Hispanic White, non-Hispanic Black, non-Hispanic other, Hispanic), and population, come from the U.S. Census

[24] https://www.bls.gov/iag/tgs/iag211.htm

Bureau's Intercensal Estimates. County median household income and poverty rate come from the Census Bureau's Small Area Income & Poverty Estimates (SAIPE) program and total percent employed, as measured by the percent of county population currently employed, comes from EMSI.

Analytic Plan

I include county demographic and economic characteristics in each model to control for important factors that may bias the estimated relationship between educational level of migrants and shale employment. County and time fixed effects are included in the model to minimize potential bias from unobservable time-invariant differences between counties and year-specific national trends. The empirical models take the form:

$$OUTCOME_{it} = \beta_0 + \beta_1 (OilAndGas_{it}) + \beta_2 (X_{it}) + \sigma_i + \gamma_t + \varepsilon_{it} \quad (1)$$

The *OUTCOME* variable represents the average level of education of county in- or out-migrants separately from 2006-2014 (boom period) and 2015-2018 (bust period). The *OilAndGas* variable is the O&G employment share of total county employment variable. X represents a vector of county-level demographic and economic control variables previously listed. ε_{it} is the error term, σ_i represents the county fixed effect, and γ_t represents the year fixed effect. Equation 1 is estimated for the two outcome variables that accounts for the educational in- and out-flow of migrants at the county level for the O&G boom and bust periods of the last decade. Robust standard errors are calculated.

First, I estimate models for the United States' O&G boom period, which encompasses 2006-2014. I run two separate regression models to test the effect of county-level O&G employment on average educational attainment of in- and out-migrants, respectively. I then create the same models for the O&G bust period that occurred from 2015-2018. Separating the models into boom and bust categories will allow me to see what role the industry plays in gains and losses of human capital, as measured by average level of educational attainment in states with high O&G development.

Results

Summary statistics for the boom and bust samples are shown in Table 16. The first column displays the average education of in-migrants, out-migrants, and average county values for the 10 state O&G sample from 2006-2014. Due to confidentiality regulations involved in using the restricted American Community Survey sample, the sample size is rounded to maintain respondent confidentiality. The average years of completed education by migrants into counties in the 10 highly concentrated O&G states was 12.43, while the average years of completed education for out-migrants was 12.98. Oil and gas employment as a share of total employment was just under three percent. The employment percentage during this period was just over 41 percent, while the average population size in these counties was over 83,000 individuals. Nearly three-fourths of the sample during the boom was non-Hispanic White. The median household income for these counties was just over $43,000, while the percent of population in poverty was over 16%.

Also included in Table 16 are summary statistics for the O&G bust that occurred from 2015-2018. The average education of in-migrants during this period was 12.63, while average years of completed education among out-migrants was 13.17. O&G

employment share and the total county employment rate marginally declined during this period. The county age structure skewed slightly older during the bust, as the population over age 65 increased by two percent. Counties in this sample became slightly more racially diverse compared to the boom. Median household income was over $49,000, while the percent in poverty dropped below 16%. The average population in these counties increased by nearly 5,000 residents, to a new mean of over 88,000.

O&G employment share and in-migration, 2006-2014

Table 17 includes the regression coefficients and t-statistics for the models using O&G employment as a share of total employment as a predictor for the education level of in-migrants during the O&G boom. My initial hypothesis was that human capital would flow out of O&G counties with increased industry development during the boom due to prior findings from extractive industries (Brown & Schafft, 2011; Brown & Swanson 2004; Jensen, McLaughlin, & Slack, 2003). This goes against Migration theory, which would predict that higher educated individuals would flow into O&G counties with high industry development to support the booming population and increase economic opportunity (Lee, 1966). The findings for the models of in-migration during the boom lend support to Migration theory; a one standard deviation increase in O&G employment share was associated with an additional 0.09 average years of education among in-migrants.

Other county-level factors were considered in this model, as shown in Table 17. An additional percent of the population being over age 65 was associated with a 0.042 percent increase for average years of in-migrant education. Racial and ethnic diversity are critical components of understanding human capital accumulation (Taylor, Gillborn, & Ladson-Billings, 2009). Ethnicity was important in this model, as a one-percentage increase in the Hispanic population of a county was associated with a 0.078 decrease for in-migrant education. Another important predictor of educational attainment is poverty, which can prevent individuals from succeeding in school and set a lower economic trajectory overall (Van der Berg, 2008). County poverty level was a significant predictor in this model, as an additional percent of individuals living in poverty was correlated with a 0.020 decrease among in-migrant years of completed education.

O&G employment share and out-migration, 2006-2014

Table 18 displays the regression coefficients and t-statistics for the models estimating the relationship between O&G employment and average education level of out-migrants during the boom. The relationship between these two variables may be positive if educated individuals stay due to positive spillover effects or be negative if people move to avoid negative externalities (e.g. environmental damage, population shifts, etc.) resulting from O&G development. Migration theory would suggest that individuals could be "crowded out" due to higher costs of goods and services, real estate, and other consumer goods resulting from a strong economy (Lee, 1966). The association between O&G employment and education level of people moving away is negative, such that a one standard deviation increase in O&G employment share is correlated with a 0.11 decrease in the average education level of out-migrants during the boom. This finding lends support to the crowding out principle of Migration theory as lower educated individuals leave in the face of O&G development.

Additional county-level variables were included in this model and are displayed in Table 18. County age structure variables show that, on average, higher levels of the county population being under 20 is associated with lower out-migrant education while increases in the population of above 20 is related with higher out-migrant education. This relationship is particularly strong among 20-24 year olds, suggesting that these individuals may be moving for new opportunities in different locations. Race again played a significant role in this model, as an additional percent of the population identifying as non-Hispanic Black was associated with a 0.009 increase in out-migrant education. Higher median income with a county was associated with higher out-migrant education; an additional $1,000 in median household income was correlated with a 0.003 increase in years of out-migrant education.

O&G employment share and in-migration, 2015-2018

Table 19 includes the regression coefficients and t-statistics for the models showing the relationship between O&G employment share and average level of education of in-migrants during the O&G bust. No prior literature that I am aware of covers human capital flow during this time period; the bust and resulting economic downturn may be felt more acutely in this sample of 10 highly concentrated O&G states. Thus, I rely on Migration theory and expect that a bust in the O&G industry would weaken the local economy and lead to potential in-migrants with higher more education to look elsewhere (Lee, 1966). However, this expectation did not come to fruition, as there was not a significant relationship between O&G employment share and the average education of in-migrants. Of note, the coefficient for education of in-migrants changed between the boom and bust; this suggests there may be a change in average education of in-migrants even though it is statistically insignificant.

O&G employment share and out-migration, 2015-2018

Table 20 displays the regression coefficients and t-statistics for the models displaying the relationship between O&G employment and average education level of out-migrants during the bust. As with in-migration during the bust, there are no studies currently available detailing O&G industry bust and the resulting influence on human capital outflow. Migration theory would suggest that a downturn in the local economy would cause individuals with available resources, such as higher education, to move to a more promising location (Lee, 1966). However, this did not turn out to be the case, as the relationship between O&G employment share and the education level among out-migrants was insignificant.

Other variables were significant when considering the average education level of move-outs. An additional percent increase in the population under age 20 was associated with a 0.073 decrease in average education level of out-migrants. This relationship was also present during the O&G boom, although the magnitude was nearly double in this model covering the O&G bust. Median household income was a significant predictor of human capital out-flow, as an additional thousand dollars of median household income was associated with a 0.002 increase in education level of out-migrants. This relationship and magnitude was similar to the O&G boom model found in Table 18.

Conclusions

The last two decades has seen a large shift and uptick in domestic energy production as shale O&G technology and development has taken hold. Shale plays tend to be located under communities with little experience in the volatile boom-bust nature of natural resource extraction and its associated challenges. This study adds to the body of literature focusing on human capital accumulation in O&G communities, which tend to be rural and facing long-term “brain drain” and population decline (Artz, 2003; Carpenter, Anderson, & Dudensing, 2019; Cascio & Narayan, 2015; Emery, Ferrer, & Green, 2012; Kumar, 2017; Petrin, Schafft, & Meece, 2014; Rickman, Wang, & Winters, 2017; Roscigno & Crowley, 2001; Weber, 2014). There is an open question as to how O&G development may influence human capital in these communities, which will only become more important with growth in the shale O&G sector.

The results of this study add to the body of literature of how O&G development influences human capital accumulation; however, it is the first that I am aware of to isolate the effect of in- and out-migration at the county level. Additionally, this study is among the first to utilize O&G bust data, which gives a picture of how human capital flows change with fluctuations in the industry. Rural communities have been losing population and human capital for decades as people relocate to urban centers in search of economic and lifestyle opportunity. Shale O&G development may stimulate the local economy during the boom, possibly drawing an influx of residents in search of high-paying industry employment or through jobs created from industry spillover.

Utilizing Migration theory (Lee, 1966) would suggest that the incoming residents during an O&G boom would have higher educational attainment as they respond to economic opportunity. However, prior literature from other extractive industries suggests that the incoming residents may have low educational attainment (Brown & Schafft, 2011; Brown & Swanson 2004; Jensen, McLaughlin, & Slack, 2003), which led me to hypothesize that higher O&G employment share would be associated with lower incoming human capital. The results, found in Table 2, suggest that Migration theory may be at play here as increasing O&G employment share in a county was associated with an increase in the average level of education among in-migrants.

Each individual who decides to move has a personalized equation of migration, with certain factors acting to "push" them away or "pull" them to a new location (Lee, 1966). Out-migrants during the boom may be more highly educated and leave due to negative community changes from the O&G industry or could be "crowded out", which would drive individuals with low educational attainment away as the community becomes more expensive (Lee, 1966). Results for the model testing the relationship between O&G employment share and out-migration during the bust found evidence of "crowding-out", as higher O&G employment was associated with lower average educational attainment among out-migrants.

Migration theory would further suggest that the O&G bust may drive away individuals with high education and attract lower educated individuals due to low economic opportunity, as the community becomes a less economically attractive destination (Lee, 1966). The effects of O&G employment share on human capital in- and out-migration during the bust was insignificant. Shale O&G communities may be following the patterns of other extractive communities that are more resistant to downturns occurring within industry cycles (Betz & Snyder, 2017).

Overall, the results of this paper suggest that O&G communities are attracting better educated in-migrants, thus increasing local human capital levels, as measured by average educational attainment, in high-concentration O&G states during the boom. Out-migrants, on the other hand, show evidence of being crowded out during the boom as higher O&G employment share was associated with lower educational attainment among those moving away. These results add to the previous study of human capital in O&G communities that focused on only the local population (Cascio & Narayan, 2015; Emery, Ferrer, & Green, 2012; Kumar, 2017; Rickman, Wang, & Winters, 2017) and a combination of in-migrants and the local population (Carpenter, Anderson, & Dudensing, 2019; Mayer, Malin, & Olson-Hazboun, 2018; Weber, 2014). These prior studies suggest that educational attainment among the local population drops when O&G development occurs and studies on migrants and the local population are mixed. I fill a gap in the research by focusing only on in- and out-migration, finding evidence of brain drain reversal during the O&G boom and that these gains are not lost during the bust. This migration flow could possibly revitalize local communities that were previously experiencing population and human capital decline.

This paper also expands on previous studies in a few other ways. All migration data was aggregated using individual-level data from the restricted American Community Survey, allowing me to see the education level of each migrant rather than relying on county aggregates. Having these data, as well as county of origin and destination, allowed me to test how O&G development changed human capital flow within this sample. Further, I included data from 2006-2018, which captures the duration of the first O&G boom-bust cycle and provides a better picture of migration during different industry cycles.

While this study adds to the literature in new ways, some inherent limitations should be considered. The county demographic control variables included in these models were drawn from the Census Bureau’s Intercensal estimates. While they include quality data about county age structure and racial/ethnic composition, they do not have estimates for county educational attainment. The models in this study would have been strengthened by considering the human capital structure within the county, as educational attainment at the county level is associated with migration decisions (Waldorf, 2007). Further, this lack of education data prevented the possibility of examining the net effects of migration on the composite education structure of the county. The education structure is influenced by migrants but also by local citizens altering their behavior based on employment possibilities (e.g. dropping out of high school to work in O&G fields). Future studies would be stronger by finding a source of educational data to utilize as control variables for migration analyses and to calculate net effects to provide a more complete picture of human capital fluctuation in O&G communities.

Another limitation is that the number of migrants within the 10 state sample from nonmetro counties was low, which prevented me from splitting this sample by metro status. Oil and gas development plays an outsized role in rural locations and has the potential to reverse long-term brain drain patterns in these areas. While the evidence in this paper is promising, higher quality data from nonmetropolitan areas would strengthen the associations found in this paper and allow for stronger conclusions as to how shale O&G development stalls or reverses rural brain drain.

This chapter chose to utilize a continuous education measurement and stated findings in terms of grade levels gained or lost. Another possibility for measurement is categorical educational attainment (i.e. high school vs. some college vs. bachelor's or higher). There is a qualitative difference between gaining years of education compared to a higher degree attainment and that could influence the industry composition in the communities under analysis. Although I chose to utilize grade-level due to a high proportion of individuals with a high school education migrating in for O&G work (and thus could skew results lower), a categorical measurement could show different results and could be a future direction of study to better understand how human capital is changing in extraction communities.

A question posed in the introduction of this essay was how O&G activity would influence the medium and long-term trajectories of O&G communities and if industry development could reverse brain drain. This paper considers the first O&G boom-bust cycle, which encompassed over a decade of time. The results of these analyses suggest that the boom cycle attracts individuals with higher levels of education and maintains this gain as the industry went into a downturn. The noted gains could serve as a catalyst for longer-term growth in rural areas, as higher levels of human capital are associated with higher income, productivity, and economic growth (Artz, 2003). Policy makers can utilize these findings as a consideration when deciding whether to allow O&G development in their communities, possibly using this as a way to revitalize communities in a cycle of depopulation. A key consideration for decision makers would be how to utilize gains observed from the industry, such as increased tax revenue and infrastructure. One focus should be on investing in local educational systems, as the shock of the O&G industry on depopulation may serve to draw in a younger generation in search of opportunity. Local education investment could raise human capital within the community, continuing an upward trend of mobility for communities previously in a cycle of decline. These results could also serve to inform other communities that have experienced long-term decline, as an economic such (such as O&G development) could draw in human capital that could reverse the brain drain found in rural communities. This paper provides evidence that an economic shock could draw individuals with educational value, which in turn could draw new industries and services and promote a reciprocal cycle that benefits the community long-term.

Table 16. *Variable Means and Standard Deviations, 2006-2018*

	2006-2014	SD	2015-2018	SD
Average education of in-migrants	12.43	1.02	12.63	1.02
Average education of out-migrants	12.98	1.73	13.17	1.73
O&G employment share	2.84	5.54	2.73	5.51
County employment rate	41.10	13.89	41.01	14.38
County percent under age 20	26.16	3.63	25.19	3.76
County percent ages 20-24	6.18	2.34	6.20	2.10
County percent ages 25-64	51.50	3.40	50.26	3.18
County percent ages 65+	16.16	4.26	18.35	4.53
County percent non-Hispanic White	75.56	20.78	73.40	21.19
County percent non-Hispanic Black	5.96	10.08	6.08	9.97
County percent non-Hispanic other race	4.63	8.15	5.26	8.21
County percent Hispanic	13.85	19.21	15.27	19.77
County median household income	43,197	10,297	49,473	11,742
County percent in poverty	16.52	6.00	15.89	5.92
County mean population	83,384	238,634	88,560	262,735
N	7,100		2,400	

Table 17. *Determinants of Average Education of In-Migrants, 2006-2014*

	Beta	T-statistic
O&G employment share	0.017*	2.48
County employment rate	4.85e-08	0.02
County percent under age 20	0.016	0.76
County percent ages 20-24	-0.027	-0.91
County percent ages 65+	0.042*	2.33
County percent non-Hispanic Black	-0.046	-1.30
County percent non-Hispanic other race	0.060	1.68
County percent Hispanic	-0.078*	-2.11
County median household income	-7.66e-06	-1.56
County percent in poverty	-0.020**	-2.79
County mean population	7.11e-07	0.53
Constant	12.28***	13.06
N	1,028,000	
R-squared	0.060	

*** p<.001; ** p<.01; * p<.05

Table 18. *Determinants of Average Education of Out-Migrants, 2006-2014*

	Beta	T-statistic
O&G employment share	-0.020***	-3.62
County employment rate	-5.76e-07	1.79
County percent under age 20	-0.031**	-2.93
County percent ages 20-24	0.051***	5.49
County percent ages 65+	0.026*	2.40
County percent non-Hispanic Black	0.009**	3.42
County percent non-Hispanic other race	0.005	1.30
County percent Hispanic	8.20e-04	-0.23
County median household income	3.77e-05***	9.65
County percent in poverty	-0.011	-1.47
County mean population	-1.08e-07	-0.58
Constant	11.36***	21.39
N	1,028,000	
R-squared	0.115	

*** p<.001; ** p<.01; * p<.05

Table 19. *Determinants of Average Education of In-Migrants, 2015-2018*

	Beta	T-statistic
O&G employment share	-0.018	-0.91
County employment rate	-6.13e-07	-0.07
County percent under age 20	0.064	0.91
County percent ages 20-24	0.400***	4.34
County percent ages 65+	-0.028	-0.37
County percent non-Hispanic Black	-0.058	-0.42
County percent non-Hispanic other race	0.065	0.51
County percent Hispanic	-0.039	-0.29
County median household income	1.11e-06	0.12
County percent in poverty	-0.018	-1.10
County mean population	9.27e-07	0.14
Constant	8.76*	2.55
N	499,000	
R-squared	0.0002	

*** p<.001; ** p<.01; * p<.05

Table 20. *Determinants of Average Education of Out-Migrants, 2015-2018*

	Beta	T-statistic
O&G employment share	-0.013	-1.07
County employment rate	1.03e-06	1.90
County percent under age 20	-0.073**	-3.40
County percent ages 20-24	-0.018	-0.86
County percent ages 65+	-0.042	-1.93
County percent non-Hispanic Black	0.009	1.56
County percent non-Hispanic other race	-0.002	-0.22
County percent Hispanic	0.006	0.80
County median household income	2.16e-05**	3.23
County percent in poverty	0.002	0.11
County mean population	-5.06e-07	-1.61
Constant	14.51***	12.87
N	499,000	
R-squared	0.105	

*** p<.001; ** p<.01; * p<.05

Chapter 5: Conclusion

Shale O&G development has dramatically increased over the past few decades as new technology has allowed previously unattainable stores of energy to be accessed. This has led to large scale growth in both domestic gas and oil production that has made the United States a major force in the global energy sector (Bataa & Park, 2017; Cook & Perrin, 2016; Perrin & Cook, 2016). As with other extractive industries, shale O&G experiences a boom-bust cycle of production due to changes in supply, demand, and pricing. During the boom, many jobs are created for industry and support workers, which raises per capita income, employment rates, and in-migration (Abboud & Betz, 2020; Black, McKinnish, & Sanders, 2005; Brown, 2014; Haggerty, Gude, Delorey, & Rasker, 2014; Jacobsen & Parker, 2016; Maniloff & Mastromonaco, 2017; Munasib & Rickman, 2015; Weinstein, 2014). Conversely, the bust cycle may lead to declines in employment, income, and an uptick in out-migration (Abboud & Betz, 2020).

The shifting economics in O&G areas can alter family formation behaviors, as hypothesized in the Marriage Market Theory (Becker, 1973). Individuals weigh potential partners on economic, social, and physical qualities and match to someone relatively similar to their own standing in a process known as assortative mating. These qualities must outweigh the possibility of remaining single and looking for a more attractive partner (Becker, 1973). Improvements in the local marriage market through increasing economic prosperity brought on by the O&G industry may promote marriage behaviors, as individuals still generally aspire to marriage and will transition when a potential partner is economically viable (Cherlin, 2020; Kuo & Raley, 2016). Higher economic viability may also promote stability within an existing relationship (Cherlin, 2004). However, it is important to note that increasing economic opportunity may lead to relationship dissolution through the independence effect, allowing partners to separate from an unfulfilling relationship and re-enter the marriage market to search for a more suitable partner or remain single (Nunley & Zietz, 2012; Sayer & Bianchi, 2000; Schoen, Astone, Rothert, Standish, & Kim, 2002).

In Chapter 2, I considered how the O&G boom and bust would influence family formation behaviors in a sample of 10 highly concentrated O&G states. I found that there were changes in marriage and divorce rates, but these varied by metro status and industry cycle. Marriage rates decreased as O&G employment share increased during the boom, but this result only held in nonmetro counties. Marriage rates were not significantly related to O&G employment share in the full 10 state boom sample or in any context during the bust. Divorce also increased during both the boom and bust in the 10 state sample, suggesting that the independence effect is in play and allowing dissolution of unsatisfying marriages and increasing selectivity in future marriages (Nunley & Zeitz, 2012; Sayer & Bianchi, 2000; Schoen et al., 2002).

The results of Chapter 2 build on the findings of Shepard, Betz, and Snyder (2020) by considering family formation behaviors over an entire boom-bust cycle and in counties within highly concentrated O&G states. A consistent theme between Shepard, Betz, and Snyder (2020) and Chapter 2 is that marriage rates decreased during the boom while there was evidence of the independence effect in boom times for both samples. The current study used a sample of 10 O&G states, proposed by Abboud & Betz (2020); this sample reduced the effect sizes and some statistical significance found in Shepard, Betz, and Snyder (2020), suggesting that some of the findings were driven by O&G communities outside of the 10 main fracking states. These findings are in contrast to Marriage Market theory and suggest that extraction communities could be unique in their influence on marriage rates. Due to noted limitations (see Chapter 2 conclusions for a more thorough discussion on rolling averages, especially during the bust), further study is necessary to see if county relationship rates are the best tool to understand change at the margins that would be brought about due to industry expansion. Chapter 3 set out to address some of those concerns.

In Chapter 3, I designed a complementary set of analyses for Chapter 2 to see how the O&G industry was changing the decision to transition to marriage in the preceding year. This is the first study to utilize individual level data to understand how marriage behavior is changing in shale O&G communities. Utilizing Marriage Market Theory (Becker, 1973), I hypothesized that increasing resources during the boom would aid in transitions to marriage while a bust would decrease marital transition odds. I also predicted that these effects would be larger for adults under 40, as most marital behavior occurs in young- to mid-adulthood. While my hypotheses were supported for the boom – that is, increased community resources aid in odds of transitioning to marriage for adults under 40 – there did not appear to be a significant effect for any age group during the bust. There is evidence that extraction communities are more resistant to downturns within industry cycles (Betz & Snyder, 2017); this study may provide evidence of resistance during the bust for O&G communities specifically. This is known as "rural resilience" and specifically could show a reversal of the Marriageable Men hypothesis. Overall, individual marriage odds seem to follow the trajectory of Marriage Market theory when considered in these analyses.

Considering Chapters 2 and 3 together provides a broader picture of family formation behaviors in shale O&G communities. On the one hand, county averages used in Chapter 2 suggest that marriage rates are decreasing while divorce is increasing at the county level during the boom. These findings are juxtaposed with Chapter 3, which finds that odds of transitioning to marriage during the boom increase at the individual level among young adults. While these results may seem to contradict one another, there are explanations for how they can simultaneously be true. Chapter 2 utilizes rolling 5-year county averages for county rates of marriage, divorce, and cohabitation. These data provide the only way to access data for nonmetro counties in the publicly available ACS database. While this information is valuable, the 5-year averages also are non-reactive to sudden change and can mask fine-grained shifts in behavior. Chapter 3, which utilizes individual-data, aims to fill some of the gaps by showing how marital odds change year-over-year. This measure is better for capturing nuanced change, but may also mask long-term trends, as these data from the restricted ACS are cross-sectional. While data restrictions impose limits on these analyses, they provide a multi-faceted view of family formation behaviors in O&G communities and can allow a glimpse into how fracking activity is influencing family change.

Another facet of social change considered in this dissertation is the migration of human capital to and from O&G counties. Migration Theory (Lee, 1966) proposes an equation of migration that considers factors associated with the area of origin, the destination, intervening obstacles, and personal factors. Individuals are more likely to move for employment opportunities and at certain life milestones, such as graduation or childbirth (Lee, 1966). For several decades, nonmetropolitan areas have faced a decline in human capital as high-potential individuals leave due to a lack of economic and educational opportunity. This leaves a declining population that can lead to worse outcomes for those who are left behind (Johnson, 2011; Johnson & Licther, 2009). Shale O&G development may spur economic advancement in areas that have experienced population decline and may attract new residents and bring new human capital that will revitalize a community.

In Chapter 4, I examine how human capital flow, as measured by educational attainment of migrants, has shifted during the O&G boom and bust. On the one hand, Migration Theory (Lee, 1966) would suggest that human capital would increase during the O&G boom as migrants respond to increased economic opportunity. However, there is evidence that incoming residents to extraction community have low educational attainment (Brown & Schafft, 2011; Brown & Swanson 2004; Jensen, McLaughlin, & Slack, 2003), which led me to hypothesize that in-migration would lower human capital during the boom as counties began specializing in O&G extraction. The results of this study suggest that O&G communities may differ from other extraction communities as human capital increased during the boom, following the pattern suggested by Migration Theory (Lee, 1966). Another consideration was out-migration during the boom, as individuals with higher education could choose to leave due to negative industry externalities or be “crowded out” due to rising costs of goods and services brought on by a robust economy (Lee, 1966). The results suggest that individuals may experience crowding-out, as higher O&G employment was associated with lower educational attainment among out-migrants. Results were insignificant for both in- and out-migration during the bust, possibly due to extraction communities being resilient to economic downturns (Betz & Snyder, 2017).

The results of Chapter 2-4 suggest a few trends of social change within O&G communities. During the boom, rising O&G employment was associated with the independence effect within family life as marital rates lowered and divorces rose (Nunley & Zeitz, 2012; Sayer & Bianchi, 2000; Schoen et al., 2002). There is also evidence of a more robust marriage market, as the odds of transitioning to marriage increased for young adults. The local marriage market may be strengthened through O&G employment, as Chapter 4 highlighted an increase of human capital among in-migrants during this period; increased individual educational attainment is associated with higher marriage rates, which could possibly explain the increased marital odds observed in Chapter 3 (Harknett & Kuperberg, 2011). The findings in Chapters 2-4 were also much weaker during the bust, often losing statistical significance. There is evidence from the coal industry that extraction communities are more resilient to economic downturns (Betz & Snyder, 2017);

however, this phenomenon has yet to be documented in O&G communities as the industry just completed the first full boom-bust cycle. This dissertation may provide initial evidence of this resilience phenomenon holding for O&G communities.

This dissertation introduced several high quality datasets to examine how O&G development has influenced social change. Despite having access to valuable data, there were still some limitations to the analyses. In Chapter 2, a county-level analyses was conducted using publicly available ACS data relied on 5-year rolling averages to include all counties, rather than just counties with populations above 50,000 respondents. However, these rolling averages mask small changes year-over-year, but particularly during the bust. For example, marriage rates in 2015 are composed of four years of boom and one year of bust data. As noted, the bust results were insignificant or severely diminished in Chapter 2, and the rolling average data may play a role in that. Future studies could build on these analyses by finding better quality data for nonmetropolitan areas that better reflects changes over time.

This dissertation benefited from having access to the restricted individual response ACS data and proprietary O&G employment data, which goes beyond many previous studies, which are aggregated at higher geographic levels. However, due to disclosure restrictions through the U.S. Census Bureau, I was unable to split the restricted ACS sample by metro status, as there were not enough respondents in nonmetropolitan areas. While much of the O&G development occurs in nonmetro areas, there are still metro strongholds that have large amounts of O&G employment that could bias results. Future studies should consider using the 10 state O&G sample proposed by Abboud &

Betz (2020) in nonmetro settings to explore individual level outcomes, such as the ones used in Chapters 3 and 4.

Chapters 3 and 4 utilized the Census Bureau's Intercensal Estimates for demographic control variables. This decision was made to have controls that encompassed the entirety of the boom and bust periods, as the O&G boom predates publicly available ACS estimates. One benefit of these data is that they are yearly estimates for both metro and nonmetro counties, which removes the issue of rolling averages previously described. However, a key omission is that the Intercensal Estimates do not have educational attainment estimates at the county level. These data would enhance the analyses in Chapter 3 but especially the study on human capital in Chapter 4, as the educational attainment of residents within a county is associated with migration decisions (Waldorf, 2007). Future studies considering demographic change during the initial O&G boom will need to consider how best to handle the lack of quality data for control variables that covers the entirety of the 2007-2014 period.

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Appendix A: Additional Figures from Chapter 1

The following figures are drawn from Abboud & Betz (2020) and show the geographic distribution of oil and gas production in the pre-boom (2000) era, early boom (2008), peak boom (2014), and mid-bust (2016). All figures are created using Enverus production data. The three regions are Marcellus (PA, OH, WV); South (LA, OK, TX); and West (CO, MT, ND, WY).

Figure A.1. *Regional Distribution of Gas Production Over Time - Marcellus*

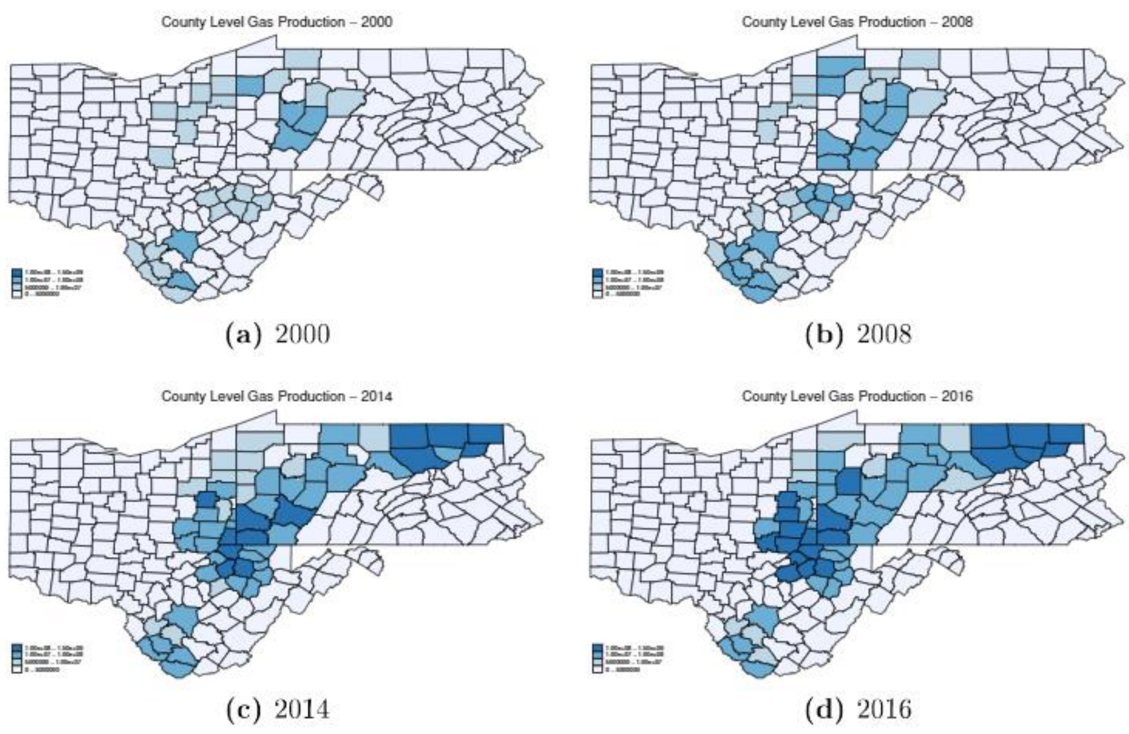
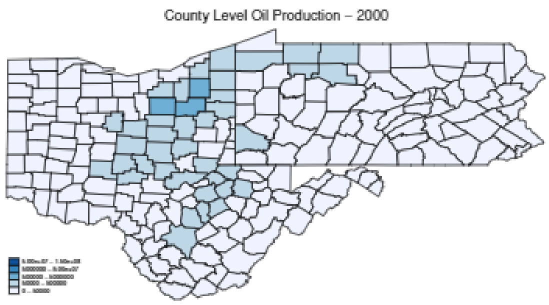
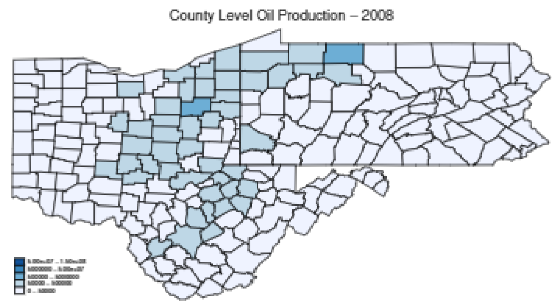


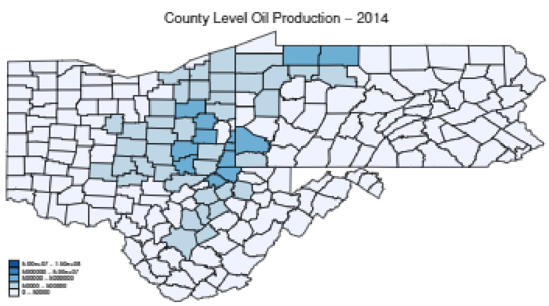
Figure A.2. *Regional Distribution of Oil Production Over Time - Marcellus*



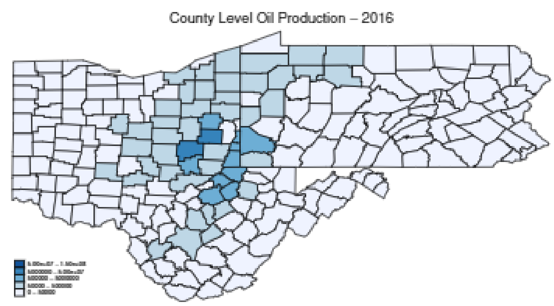
(a) 2000



(b) 2008

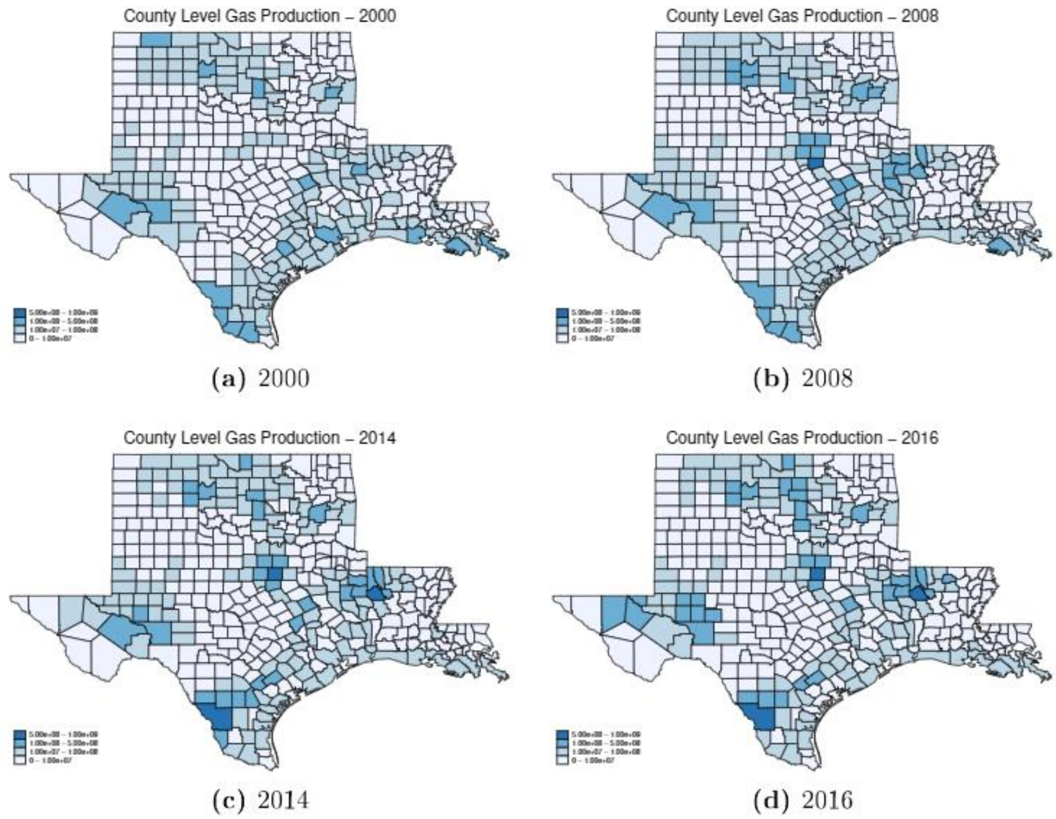


(c) 2014



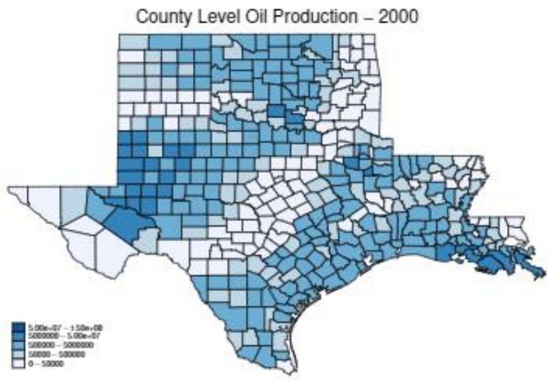
(d) 2016

Figure A.3. *Regional Distribution of Gas Production Over Time - South*

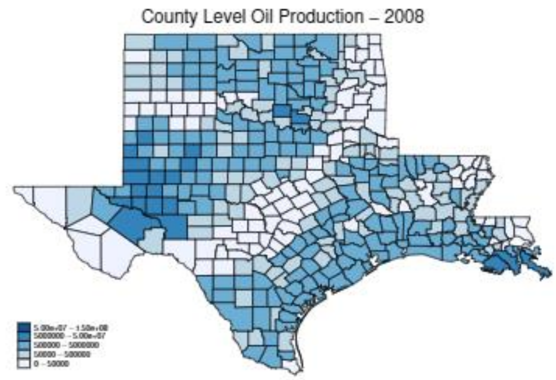


(a) 2000 **(b)** 2008 **(c)** 2014 **(d)** 2016

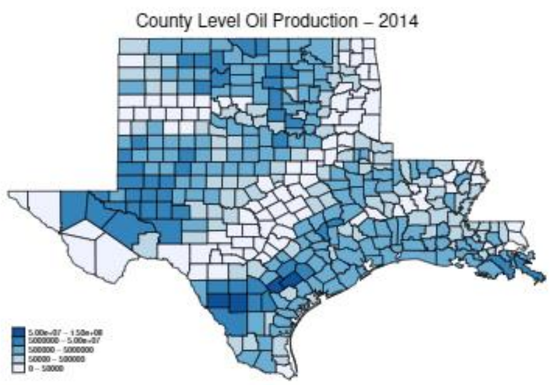
Figure A.4. *Regional Distribution of Oil Production Over Time - South*



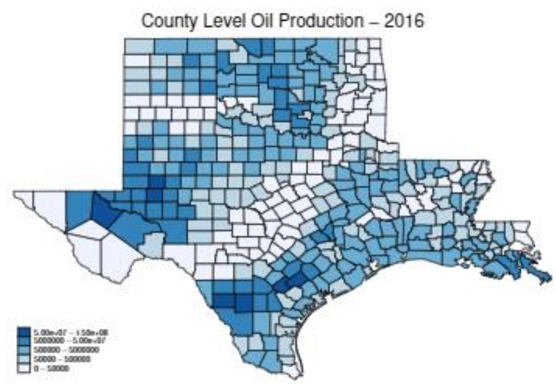
(a) 2000



(b) 2008



(c) 2014



(d) 2016

Figure A.5. *Regional Distribution of Gas Production Over Time - West*

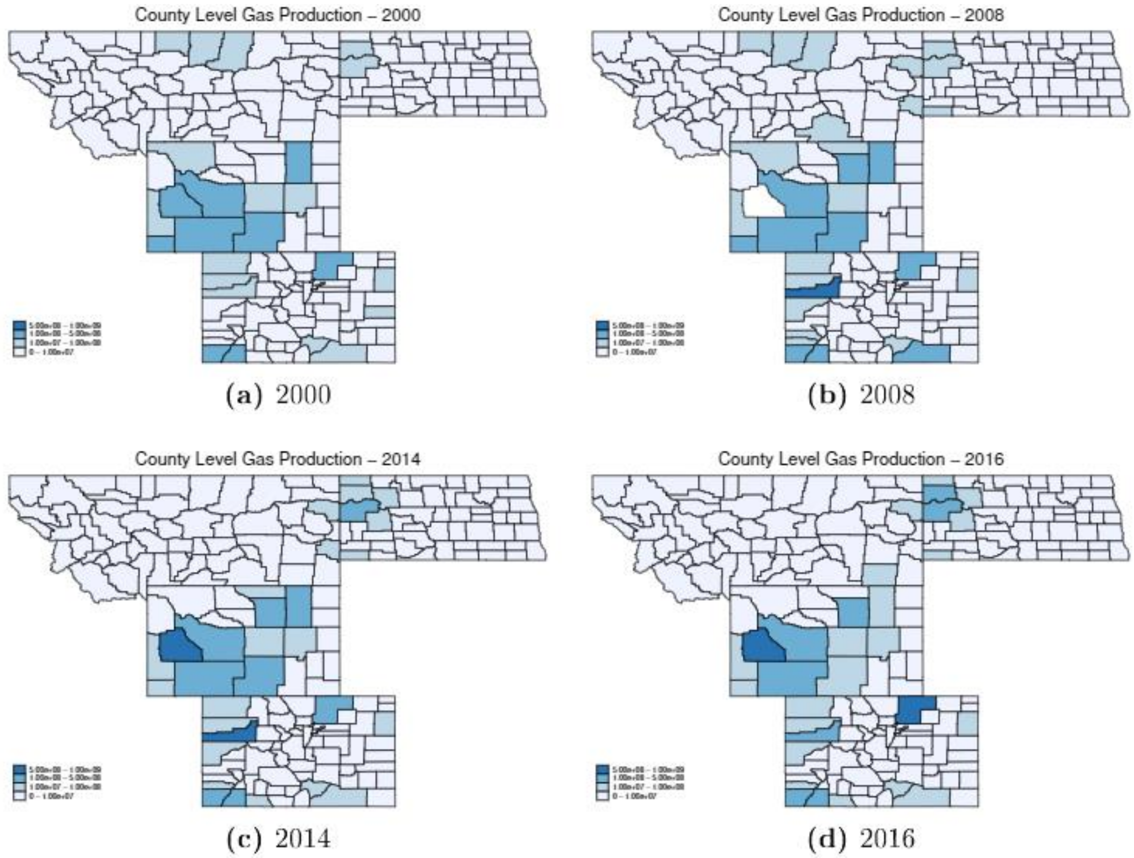
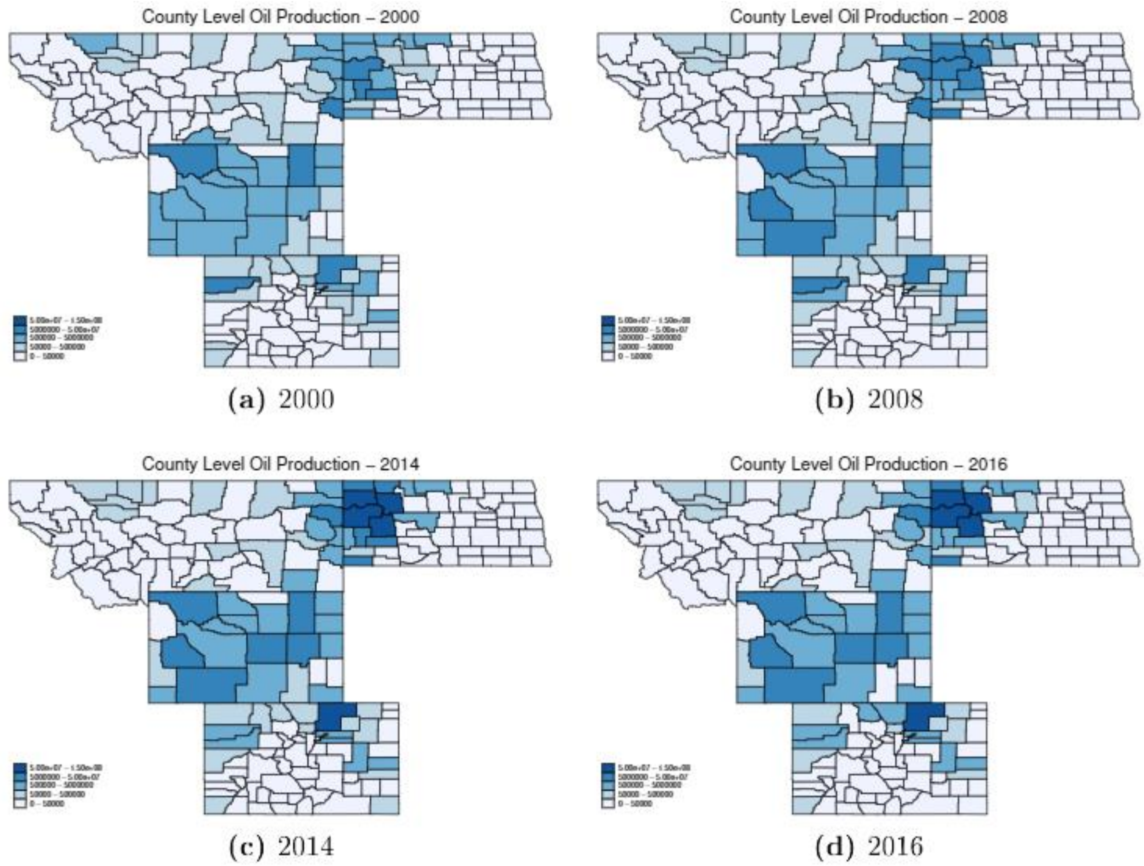


Figure A.6. *Regional Distribution of Oil Production Over Time - West*



(a) 2000 **(b)** 2008

(c) 2014 **(d)** 2016

Appendix B: Research Disclaimers for Chapters 3 and 4

Disclaimer for Chapter 3

Any views expressed are those of the authors and not those of the U.S. Census Bureau. The Census Bureau's Disclosure Review Board and Disclosure Avoidance Officers have reviewed this information product for unauthorized disclosure of confidential information and have approved the disclosure avoidance practices applied to this release. This research was performed at a Federal Statistical Research Data Center under FSRDC Project Number 1619. (CBDRB-FY21-P1619-R8872).

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Appendix C: Additional Tables for Chapter 2

Table 21. *Variable Means and Standard Deviations, 50 States 2015-2018*

	Mean	SD	Nonmetro	SD	Metro	SD
Percent Now Married	51.73	6.98	52.02	7.13	50.86	6.40
Percent Divorced/Separated	13.61	2.74	13.67	2.85	13.43	2.36
Percent Never Married	27.54	6.81	26.88	6.77	29.51	6.55
Percent of Households Cohabiting	5.61	1.84	5.55	1.93	5.77	1.53
O&G Employment Share	0.44	1.64	1.05	3.69	0.33	1.40
Population Percent Male	50.08	2.37	50.28	2.55	49.50	1.62
Female Labor Force Participation	41.84	4.08	41.61	4.36	42.53	3.01
Median Household Income	50,421	13,067	48,269	13,353	56,909	14,636
Percent in Poverty	15.68	6.29	16.25	6.48	13.99	5.32
Percent Employed	40.64	16.09	40.26	15.04	41.83	18.86
Percent Foreign Born	4.64	5.63	4.11	5.11	6.22	6.72
County Population	102,845	328,504	59,942	193,957	232,052	545,395
Percent Under 20	25.14	3.64	24.90	3.78	25.85	3.10
Percent 20-24	6.34	2.36	6.14	2.24	6.88	2.62
Percent Over 64	17.77	4.53	18.55	4.52	15.41	3.66
Percent Hispanic	9.06	13.69	8.96	14.01	9.34	12.70
Percent African American	8.78	14.33	8.04	14.51	11.04	13.53
Percent All Other	5.15	8.89	5.19	9.73	5.03	5.67
Percent Some College	30.53	5.15	30.66	5.31	30.13	4.60
Percent Bachelors or More	20.90	9.08	19.42	7.94	25.36	10.70
N	12,436		9,336		3,100	

Table 22. *Determinants of Percentage of Population Currently Married, 50 States 2015-2018*

	Model 1	Model 2	Model 3	Model 4	Model 5	Nonmetro	Metro
O&G Employment Share	-0.017	-0.016	-0.014	-0.028	-0.023	-0.001	-0.080
	(-0.510)	(-0.476)	(-0.430)	(-0.866)	(-0.715)	(-0.039)	(-1.185)
Percent Population Male		-0.088			-0.145*	-0.134*	-0.183
		(-1.420)			(-2.436)	(-2.402)	(-1.040)
Female LFP			-0.100***		-0.104***	-0.086***	-0.152***
			(-6.827)		(-7.079)	(-5.299)	(-4.868)
Median Household Income				1.68e-05	1.43e-05	3.61e-05†	-2.57e-05
				(0.936)	(0.795)	(1.722)	(-1.060)
Median HH Income Squared				8.35e-11	9.893-11	-4.54e-11	3.73e-10*
				(0.663)	(0.785)	(-0.308)	(2.279)
N	12,436	12,436	12,436	12,436	12,436	9,336	3,100
R-squared	0.340	0.336	0.364	0.407	0.433	0.401	0.376

*** p<.001; ** p<.01; * p<.05; †p<.10

T-statistics are in parentheses under the coefficients

Controls were included for poverty, employment, foreign born status, county population, age, race/ethnicity, and education

Table 23. *Determinants of Percentage of Population Divorced/Separated, 50 States 2015-2018*

	Model 1	Model 2	Model 3	Model 4	Model 5	Nonmetro	Metro
O&G Employment Share	0.038†	0.038†	0.037†	0.041†	0.040†	-3.52e-04	0.126**
	(1.799)	(1.798)	(1.767)	(1.958)	(1.911)	(-0.017)	(3.191)
Percent Population Male		0.005			0.020	0.032	-0.019
		(0.138)			(0.598)	(0.936)	(-0.210)
Female LFP			0.038***		0.038***	0.026*	0.078***
			(4.081)		(4.077)	(2.464)	(4.056)
Median Household Income				-1.48e-05*	-1.41e-05†	-1.28e-05	-1.71e-05
				(-1.998)	(-1.906)	(-1.415)	(-1.262)
Median HH Income Squared				6.34e-11	5.95e-11	2.44e-11	1.04e-10
				(1.470)	(1.380)	(0.450)	(1.270)
N	12,436	12,436	12,436	12,436	12,436	9,336	3,100
R-squared	0.049	0.048	0.057	0.051	0.057	0.013	0.161

*** p<.001; ** p<.01; * p<.05; †p<.10

T-statistics are in parentheses under the coefficients

Controls were included for poverty, employment, foreign born status, county population, age, race/ethnicity, and education

Table 24. *Determinants of Percentage of Population Never Married, 50 States 2015-2018*

	Model 1	Model 2	Model 3	Model 4	Model 5	Nonmetro	Metro
O&G Employment Share	0.001	-0.001	-0.001	0.006	0.001	0.016	-0.013
	(0.027)	(-0.038)	(-0.046)	(0.198)	(0.028)	(0.477)	(-0.234)
Percent Population Male		0.143*			0.184***	0.162***	0.253
		(2.568)			(3.512)	(3.399)	(1.629)
Female LFP			0.057***		0.062***	0.057***	0.073**
			(4.842)		(5.324)	(4.354)	(2.959)
Median Household Income				9.06e-06	1.12e-05	-8.32e-06	5.46e-05*
				(0.544)	(0.674)	(-0.457)	(2.534)
Median HH Income Squared				-1.93e-10	-2.07e-10†	-4.35e-11	-5.39e-10***
				(-1.619)	(-1.732)	(-0.332)	(-3.705)
N	12,436	12,436	12,436	12,436	12,436	9,336	3,100
R-squared	0.470	0.471	0.483	0.520	0.541	0.535	0.458

*** p<.001; ** p<.01; * p<.05; †p<.10
T-statistics are in parentheses under the coefficients
Controls were included for poverty, employment, foreign born status, county population, age, race/ethnicity, and education

Table 25. *Determinants of Percentage of Population Cohabiting, 50 States 2015-2018*

	Model 1	Model 2	Model 3	Model 4	Model 5	Nonmetro	Metro
O&G Employment Share	-0.022	-0.021	-0.021	-0.027	-0.026	0.002	-0.095*
	(-0.934)	(-0.902)	(-0.918)	(-1.175)	(-1.133)	(0.089)	(-2.133)
Population Percent Male		-0.064†			-0.050	-0.031	-0.107
		(-1.914)			(-1.635)	(-0.948)	(-1.394)
Female LFP			0.001		0.001	-0.001	0.005
			(0.172)		(0.097)	(-0.073)	(0.323)
Median Household Income				4.76e-05***	4.73e-05***	4.77e-05***	4.90e-05***
				(6.829)	(6.864)	(5.275)	(4.489)
Median HH Income Squared				-3.36e-10***	-3.33e-10***	-3.41e-10***	-3.35e-10***
				(-7.943)	(-8.060)	(-6.330)	(-5.163)
N	12,436	12,436	12,436	12,436	12,436	9,336	3,100
R-squared	0.012	0.011	0.012	0.040	0.038	0.047	0.004

*** p<.001; ** p<.01; * p<.05; †p<.10
T-statistics are in parentheses under the coefficients
Controls were included for poverty, employment, foreign born status, county population, age, race/ethnicity, and education

Appendix D: Additional Tables for Chapter 3

Table 26. Determinants of Transitioning to Marriage in the Last 12 Months, 2006-2018

	Beta	T-Statistic	Beta	T-statistic
O&G employment share	8.07e-04***	5.59	4.80e-04**	3.18
Age			-6.83e-04***	-97.31
Foreign-born status			0.019***	46.86
Employment status				
Unemployed			-0.012***	-30.06
Not in labor force			-0.018***	-77.98
Income			2.04e-07***	71.63
Sex (Female)			0.001***	7.51
Education				
Some college			0.006***	25.56
Bachelor's degree or more			0.029***	98.09
Race/Ethnicity				
Non-Hispanic Black			-0.011***	-36.46
Non-Hispanic Asian			-0.001	-1.71
Non-Hispanic Other			-0.005***	-6.49
Hispanic			-0.003***	-8.63
County employment rate			2.22e-08**	3.07
County percent under age 20			0.002***	5.03
County percent ages 20-24			-1.82e-04	-0.69
County percent ages 65+			0.002***	6.78
County percent Black			-1.56e-04	-0.52
County percent other race			8.01e-04*	2.25

Continued

Table 26 continued

County percent Hispanic			1.61e-05	0.04
County median household income			2.03e-07***	3.49
County percent in poverty			-5.08e-04***	-5.40
County mean population			-9.21e-011	-0.02
County sex ratio			2.57e-05	0.63
Constant	0.04***	192.40	-0.04**	-2.91
N (Individuals)	3,884,000		3,884,000	
N (Counties)	800		800	
R-squared	0.009		0.021	

*** p<.001; ** p<.01; * p<.05

Table 27. *Determinants of Transitioning to Marriage in Last 12 Months, 2006-2014*

	Beta	T-statistic	Beta	T-statistic
O&G employment share	8.12e-04***	4.87	5.32e-04**	3.00
Age			-6.87e-04***	-85.37
Foreign-born status			0.017***	37.69
Unemployed			-0.011***	-24.85
Not in labor force			-0.017***	-62.99
Income			2.03e-07***	58.66
Sex (Female)			0.001***	5.22
Some college			0.005***	21.40
Bachelor's degree or more			0.026***	77.05
Non-Hispanic Black			-0.011***	-30.73
Non-Hispanic Asian			-9.87e-04	-1.20
Non-Hispanic Other			-0.004***	-4.55
Hispanic			-0.003***	-7.39
County employment rate			1.97e-08*	2.08
County percent under age 20			0.003***	6.67
County percent ages 20-24			-7.63e-04	-1.99
County percent ages 65+			0.003***	7.61
County percent Black			1.02e-04	0.24
County percent other race			0.002***	2.93
County percent Hispanic			-4.94e-04	-0.86
County median household income			7.30e-08	0.91
County percent in poverty			-6.22e-04***	-5.57
County mean population			-8.27e-10	-0.17
County sex ratio			1.06e-04	1.58
Constant	0.04***	154.70	-0.09***	-5.02
N (Individuals)	2,828,000		2,828,000	
N (Counties)	800		800	
R-squared	0.011		0.022	

*** p<.001; ** p<.01; * p<.05

Table 28. *Determinants of Transitioning to Marriage in Last 12 Months, 2015-2018*

	Beta	T-statistic	Beta	T-statistic
O&G employment share	0.001	1.81	6.52e-04	1.12
Age			-6.63e-04***	-46.62
Foreign-born status			0.022***	27.76
Unemployed			-0.016***	-17.36
Not in labor force			-0.021***	-45.95
Income			2.01e-07	39.60
Sex (Female)			0.002***	5.48
Some college			0.007***	14.31
Bachelor's degree or more			0.036***	60.72
Non-Hispanic Black			-0.013***	-19.95
Non-Hispanic Asian			-0.002	-1.47
Non-Hispanic Other			-0.008***	-5.08
Hispanic			-0.003***	-4.36
County employment rate			1.50e-08	0.50
County percent under age 20			0.003	1.45
County percent ages 20-24			0.002	0.72
County percent ages 65+			0.003	1.38
County percent Black			-0.005*	-2.23
County percent other race			-0.003	-1.18
County percent Hispanic			1.92e-04	0.08
County median household income			2.57e-07	1.57
County percent in poverty			-4.45e-04	-1.61
County mean population			9.24e-08***	4.49
County sex ratio			-4.88e-05	-0.40
Constant	0.04***	66.10	-0.04	-0.37
N (Individuals)	1,056,000		1,056,000	
N (Counties)	800		800	
R-squared	0.004		0.019	

*** p<.001; ** p<.01; * p<.05

Table 29. *Determinants of Transitioning to Marriage in Last 12 Months, Ages 18-40 from 2006-2018*

	Beta	T-statistic	Beta	T-statistic
O&G employment share	0.001***	6.02	8.15e-04***	3.84
Age			0.001***	58.26
Foreign-born status			0.021***	39.93
Unemployed			-0.009***	-17.67
Not in labor force			-0.013***	-38.24
Income			4.84e-07***	86.28
Sex (Female)			0.008***	28.43
Some college			0.006***	20.01
Bachelor's degree or more			0.037***	85.72
Non-Hispanic Black			-0.019***	-42.82
Non-Hispanic Asian			-0.004***	-5.20
Non-Hispanic Other			-0.010***	-9.74
Hispanic			-0.006***	-12.41
County employment rate			1.03e-08	1.04
County percent under age 20			0.002***	3.64
County percent ages 20-24			3.68e-04	1.05
County percent ages 65+			0.002***	4.29
County percent Black			-3.39e-05	-0.08
County percent other race			7.87e-04	1.61
County percent Hispanic			2.67e-04	0.5
County median household income			7.17e-08	0.89
County percent in poverty			-6.82e-04***	-5.23
County mean population			5.85e-09	1.16
County sex ratio			1.77-05	0.31
Constant	0.05***	167.50	-0.09***	-5.11
N (Individuals)	2,434,000		2,434,000	
N (Counties)	800		800	
R-squared	0.011		0.032	

*** p<.001; ** p<.01; * p<.05

Table 30. *Determinants of Transitioning to Marriage in Last 12 Months, Ages 41-64 from 2006-2018*

	Beta	T-statistic	Beta	T-statistic
O&G employment share	1.80e-04	0.97	-9.22e-05	-0.48
Age			-0.001***	-65.42
Foreign-born status			0.009***	15.65
Unemployed			-0.004***	-6.14
Not in labor force			-0.009***	-28.76
Income			8.23e-08***	29.53
Sex (Female)			-0.005***	-19.74
Some college			0.003***	9.25
Bachelor's degree or more			0.004***	10.45
Non-Hispanic Black			-0.005***	-13.52
Non-Hispanic Asian			0.004***	3.30
Non-Hispanic Other			-4.46e-04	-0.47
Hispanic			-0.001**	-2.76
County employment rate			4.02e-08***	4.18
County percent under age 20			0.001**	2.91
County percent ages 20-24			-7.99e-04*	-2.18
County percent ages 65+			0.002***	7.25
County percent Black			1.49e-04	0.38
County percent other race			0.001*	2.36
County percent Hispanic			-7.39e-04	-1.46
County median household income			3.92e-07***	5.12
County percent in poverty			-2.93e-04*	-2.37
County mean population			-1.12e-08*	-2.27
County sex ratio			-1.17e-05	-0.22
Constant	0.02***	94.22	0.00	-0.11
N (Individuals)	1,450,000		1,450,000	
N (Counties)	800		800	
R-squared	0.006		0.013	

*** p<.001; ** p<.01; * p<.05

Table 31. *Determinants of Transitioning to Marriage in Last 12 Months, Ages 18-40 from 2006-2014*

	Beta	T-statistic	Beta	T-statistic
O&G employment share	0.001***	5.35	8.92e-04***	3.55
Age			0.001***	44.29
Foreign-born status			0.020***	31.92
Unemployed			-0.008***	-14.27
Not in labor force			-0.012***	-30.87
Income			4.93e-07***	71.46
Sex (Female)			0.007***	22.33
Some college			0.006***	17.19
Bachelor's degree or more			0.034***	69.20
Non-Hispanic Black			-0.018***	-36.26
Non-Hispanic Asian			-0.005***	-4.70
Non-Hispanic Other			-0.009***	-7.70
Hispanic			-0.006***	-10.36
County employment rate			8.84e-09	0.68
County percent under age 20			0.003***	5.18
County percent ages 20-24			2.46e-04	-0.48
County percent ages 65+			0.002***	4.71
County percent Black			1.40e-04	0.02
County percent other race			0.002*	2.65
County percent Hispanic			-6.75e-04	-0.84
County median household income			-1.51e-07	-1.36
County percent in poverty			-9.09e-04***	-5.85
County mean population			8.58e-09	1.27
County sex ratio			1.19e-04	1.27
Constant	0.04***	134.90	-0.15***	-5.59
N (Individuals)	1,766,000		1,766,000	
N (Counties)	800		800	
R-squared	0.014		0.034	

*** p<.001; ** p<.01; * p<.05

Table 32. *Determinants of Transitioning to Marriage in Last 12 Months, Ages 41-64 from 2006-2014*

	Beta	T-statistic	Beta	T-statistic
O&G employment share	1.39e-04	0.66	-8.59e-05	-0.39
Age			-0.001***	-52.37
Foreign-born status			0.009***	13.18
Unemployed			-0.003***	-3.98
Not in labor force			-0.008***	-22.35
Income			8.12e-08***	24.33
Sex (Female)			-0.005***	-17.55
Some college			0.002***	6.00
Bachelor's degree or more			0.002***	4.22
Non-Hispanic Black			-0.005***	-10.85
Non-Hispanic Asian			0.004**	2.66
Non-Hispanic Other			9.17e-04	0.86
Hispanic			-0.002**	-3.43
County employment rate			4.05e-08**	3.26
County percent under age 20			0.002***	4.01
County percent ages 20-24			-0.001	-1.97
County percent ages 65+			0.004***	8.41
County percent Black			6.55e-04	1.19
County percent other race			1.00e-03	1.44
County percent Hispanic			-5.37e-04	-0.72
County median household income			4.08e-07***	3.95
County percent in poverty			-1.76e-04	-1.22
County mean population			-1.70e-08**	-2.64
County sex ratio			1.67e-05	0.19
Constant	0.02***	75.21	-0.06**	-2.59
N (Individuals)	1,061,000		1,061,000	
N (Counties)	800		800	
R-squared	0.008		0.014	

*** p<.001; ** p<.01; * p<.05

Table 33. *Determinants of Transitioning to Marriage in Last 12 Months, Ages 18-40 from 2015-2018*

	Beta	T-statistic	Beta	T-statistic
O&G employment share	0.001	1.71	8.15e-04	1.01
Age			0.002***	38.99
Foreign-born status			0.026***	24.00
Unemployed			-0.013***	-10.97
Not in labor force			-0.015***	-22.42
Income			4.60e-07***	47.02
Sex (Female)			0.010***	17.81
Some college			0.007***	10.55
Bachelor's degree or more			0.043***	49.93
Non-Hispanic Black			-0.021***	-22.93
Non-Hispanic Asian			-0.004*	-2.34
Non-Hispanic Other			-0.013***	-6.13
Hispanic			-0.006***	-6.52
County employment rate			1.08e-08	0.27
County percent under age 20			0.003	0.93
County percent ages 20-24			0.005	1.67
County percent ages 65+			5.81e-05	0.02
County percent Black			-0.006*	-2.23
County percent other race			-0.004	1.25
County percent Hispanic			0.004	1.03
County median household income			2.35e-07	1.05
County percent in poverty			-3.99e-04	-1.05
County mean population			8.96e-08**	3.25
County sex ratio			-6.42e-05	-0.39
Constant	0.05***	56.91	-0.08	-0.72
N (Individuals)	667,000		667,000	
N (Counties)	800		800	
R-squared	0.006		0.031	

*** p<.001; ** p<.01; * p<.05

Table 34. *Determinants of Transitioning to Marriage in Last 12 Months, Ages 41-64 from 2015-2018*

	Beta	T-statistic	Beta	T-statistic
O&G employment share	7.00e-04	0.94	5.66e-04	0.74
Age			-0.002***	-38.75
Foreign-born status			0.010***	8.41
Unemployed			-0.007***	-5.24
Not in labor force			-0.012***	-18.31
Income			8.19e-08***	15.92
Sex (Female)			-0.005***	-9.73
Some college			0.005***	7.50
Bachelor's degree or more			0.009***	11.94
Non-Hispanic Black			-0.007***	-8.13
Non-Hispanic Asian			0.004	1.72
Non-Hispanic Other			-0.004*	-2.15
Hispanic			-3.02e-04	-0.27
County employment rate			2.80e-08	0.68
County percent under age 20			0.004	1.38
County percent ages 20-24			-0.005	-1.64
County percent ages 65+			0.007*	2.59
County percent Black			-0.001	-0.40
County percent other race			-2.61e-04	-0.08
County percent Hispanic			-0.006	-1.64
County median household income			2.62e-07	1.18
County percent in poverty			-6.70e-04	-1.82
County mean population			9.31e-08**	3.24
County sex ratio			1.55e-06	0.01
Constant	0.03***	32.83	-0.02	-0.21
N (Individuals)	389,000		389,000	
N (Counties)	800		800	
R-squared	0.005		0.014	

*** p<.001; ** p<.01; * p<.05