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Jason P. Brown

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Federal Reserve Bank of Kansas City

Response of Consumer Debt to Income Shocks: The Case of Energy Booms and Busts*

Jason P. Brown†

Federal Reserve Bank of Kansas City

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Abstract

Local shocks in oil and gas development may lead consumers to increase their spending. Using quarterly information on consumer debt and oil and gas activity between 2000 and 2016, I find that consumer debt increased at a peak of $840 per capita, equivalent to 1.7 percent of median household income in counties with shale endowment and increased drilling. Shocks to local wages via drilling revealed a marginal propensity to consume from debt of 0.45. Relative to areas with oil and gas development experience, the marginal propensity to consume was 70 percent larger in previously undeveloped areas.

Keywords: oil and gas; income shock; consumer debt

JEL Classification Numbers: D12, R11, Q32, Q33

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†jason.brown@kc.frb.org

1 Introduction

Economic theory indicates that consumers spend gains in income differently depending on whether they view increases as permanent or transitory in order to smooth consumption. A survey of the literature by Jappelli and Pistaferri (2010) shows that economists have often used abrupt changes in income to estimate changes in consumption. One of the challenges noted in the literature is the difficulty in identifying income shocks that are genuinely exogenous and can be used to follow consumption after a shock (Agarwal and Qian, 2014; Jappelli and Pistaferri, 2014). Assuming exogenous shocks are in hand, researchers may use quasi-natural experiments that allow for the estimation of differential effects of responses across space and time. One such natural experiment is the recent boom and modest bust in oil and gas development in various portions of the United States. These shocks are plausibly exogenous because they are largely driven by the fixed location of oil and gas formations.

Domestic oil and gas production began to increase rapidly in the mid-2000s. By 2014, oil and gas production combined increased 40 percent compared to a decade earlier (EIA, 2015). However, the price of oil peaked in mid-2014 and dropped precipitously throughout 2015 and remained low through the first half of 2016. Even though production continued to increase in the near term, exploration and drilling companies responded by significantly reducing their capital expenditures for drilling new wells, leading to massive layoffs of workers in the sector.

Development largely occurred in rural areas of the country representing potentially different levels of shocks to the local economy that may be less economically diverse. The large increase in development translated into labor market shocks with increased demand directly and indirectly from the extraction sector. This shock led to increases in wage and salary income in these areas, especially in the development and drilling phase (Marchand and Weber, 2017). At the same time, extraction may have translated into large income streams from royalty payments paid to local mineral rights owners. For the average U.S. county that experienced an increase in oil and gas production from 2010 to 2014, increased royalty income and its associated economic stimulus increased nearly all portions of the local income distribution (Brown et al., 2016a).

It is unclear how consumers living in areas which experienced the boom reacted. Consumers may have used increases in income or expected future income to borrow money towards the purchase of a new home or car, make home improvements, pay for college education, or use it for general spending. The extent to which consumption patterns changed largely depends on how their income and expectations of income were directly or indirectly effected by the boom via wages or royalty income. Following the initial bust in drilling and production in some areas, consumers who took on more debt may find it more difficult to stay current on their payments. Recent evidence suggests that delinquency rates in auto debt have increased in counties with once high production (Haughwout et al., 2016).

Using micro data on consumer debt from the New York Fed Consumer Credit Panel, I am able to observe individual levels of consumer debt across several categories with special interest in credit and retail cards, auto and consumer finance debit. Information is also available on average consumer credit scores. Oil and gas activity is measured by the number of new wells drilled in a county in a given quarter using data from Drillinginfo. At quarterly frequency from q1:2000 to q2:2016, I estimate the effect of the oil and gas boom on consumer debt in areas that experienced the boom and subsequent bust in the lower 48 states. The concentration of oil and gas activity creates relatively well-defined areas whose local economies have experienced a bust after the boom, while the rest of the United States, on average, experienced relatively steady improvements in employment and income.

Despite a significant literature on labor market effects from oil and gas development and an emerging literature analyzing royalty income streams, very few studies have looked directly at consumption. This paper addresses two empirical questions: 1) How did personal consumption as measured by consumer debt respond to oil and gas development for the average county over time? and 2) what was the marginal propensity to consume from shocks to wage income via drilling activity? I find that consumer debt for the average credit score holder increased significantly in counties that experienced growth oil and gas activity in 2007, peaking in 2015 with a slight decline in 2016. Most of this increased debt was from consumer finance and auto debt. Shocks to local wages via drilling revealed a marginal propensity to consume from debt of 0.45, mostly from new auto debt.

Relative to areas with oil and gas development experience, the marginal propensity to consume was over 70 percent higher in previously undeveloped areas. My results suggest that areas with previous development likely do a better job of internalizing that booms in development often giving way to busts. This is consistent with consumers in these areas viewing income shocks arising from oil and gas development as more transitory. As a result, consumers in previously undeveloped areas may be most at risk of the irrational exuberance that good times will continue indefinitely, and therefore, be more at risk of default on their debt during busts in development.

2 Previous Literature

2.1 Consumption Response to Income and Wealth Shocks

A large literature in has investigated how people's consumption responds to income and wealth shocks (e.g., Souleles (1999); Agarwal et al. (2007); Jappelli and Pistaferri (2010, 2014); Agarwal and Qian (2014, 2016); Baker and Yannelis (2017)). Questions addressed in the literature typically analyze if consumers' response depends on the nature and duration of income changes, whether or not the changes are anticipated, or if transitory income shocks have lower effects compared to permanent changes. A few examples include studies that looked at changes in income and consumption arising from tax changes, real estate market shocks, and receiving an inheritance. This non-exhaustive review of the literature shows that such income shocks often affect consumers' behavior through boosting consumption and borrowing.

Changes in the U.S. tax code have been exploited to investigate the marginal propensity to consume out of income changes. Two well known examples are Shapiro and Slemrod

(2003, 2009). Using survey data, the authors found that most respondents reported they would either save the tax rebate or use towards debt repayment. As a result, little additional spending from the rebates likely occurred. However, Parker et al. (2013) did find spending to be higher for older, lower-income, and home-owning households.

Large, one-time windfalls, such as inheritances are more likely consequential compared to smaller, unexpected changes in income from taxes. Brown et al. (2010) show that receipt of an inheritance significantly increases the probability of retirement, especially when the inheritance is unexpected. Some recipients may subsequently choose self-employment. For example, Blanchflower and Oswald (1998) find that receipt of an inheritance or gift increases the probability of self-employment, with further support from Andersen and Nielsen (2012) who find that unexpected inheritances increase business survival rates. Holtz-Eakin et al. (1994) show that conditional on becoming an entrepreneur, larger inheritances lead to larger capital investment in their business, offering one possible explanation of higher survival rates.

A significant number of studies investigate how wealth changes caused by housing market shocks affect consumption, borrowing, and entrepreneurship. Benjamin et al. (2004) find that an additional dollar of real estate wealth increases consumption by 8 cents in current year, as compared with only 2 cents for financial wealth. Campbell and Cocco (2007) study the effects of wealth shocks on consumption by using information on housing prices by metropolitan and household-level data indicating whether the household owned or rented. They find that older homeowners increase their consumption in response to greater wealth. Hurst and Lusardi (2004), Disney and Gathergood (2009), and Fairlie and Krashinsky (2012) use changes in housing values to estimate the link between wealth and entry into entrepreneurship. The first two studies find little evidence while the third, which used spatially disaggregated measures of housing prices, found a positive effect of appreciation on entry to self-employment. Mian and Sufi (2011) show that positive shocks to home equity led households to increase borrowing for consumption and home improvements, finding that the average homeowner extracts 25 to 30 cents of every dollar increase in home equity. Mian et al. (2013) estimate the average marginal propensity to consume out of housing wealth between 5–7 cents.

The above literature focuses on responses to income or wealth shocks and to a lesser extent the broader effects on the local economy in which they occur. One exception is Rajan and Ramcharan (2015) who estimate the effects of a wealth shock on local land prices around the time of the shock and decades afterwards. Gilje et al. (2016) also documents the behavior of windfall recipients via increased bank deposits and the subsequent effects of the deposits on lending in other areas via the branch structure of banks. They find that banks in shale areas exported much of their additional lending capacity to non-boom areas, increasing mortgage lending in areas where they had branch offices.

2.2 Boom in Oil and Gas Development

The rapid and widespread drilling in shale and other rock formations in the 2000s stems from improvements in horizontal drilling and using hydraulics to break up the surrounding rock (Montgomery et al., 2010; Wang and Krupnick, 2013). Around 2000, Mitchel Energy began to see consistent success in applying horizontal drilling and hydraulic fracturing to Texas Barnett Shale. In the following years, the technology continued to evolve and was applied to shale formations in more than a dozen states, creating a boom in natural gas and then oil production. Data from the Energy Information Administration show that over the 2000 to 2015 period, combined onshore production of natural gas and oil increased by 40 percent, making the U.S. the global leader in hydrocarbon production. Over the same period, the number of new wells drilled nearly tripled (Figure 1).

The large increase in domestic drilling activity and production over the past decade has garnered interest from researchers. Several have explored the consequences of the development, which mostly occurred in shale and tight oil formations. A large percentage of the attention focused on local labor market effects, such as changes to local income, employment, wages, and population (Weber, 2012, 2014; Brown, 2014; Paredes et al., 2015; Munasib and Rickman, 2015; Komarek, 2016; Jacobsen and Parker, 2016; Allcott and Keniston, 2017;

Feyrer et al., 2017; Maniloff and Mastromonaco, 2017). The literature shows that the boom brought significant income and employment growth and in most cases higher wages and greater population (Marchand and Weber, 2017).

Another growing literature documents the housing market effects of oil and gas development. The findings have varied depending on the context of development via state policy (e.g. local taxation of oil and gas wells), housing characteristics such as ground water dependence, or outright bans on drilling as in the case of the New York moratorium on hydraulic fracturing (Gopalakrishnan and Klaiber, 2014; Muehlenbachs et al., 2015; Weber et al., 2016). Most studies which found negative effects have often focused on very specific geographical areas such as Balthrop and Hawley (2017). Others have noted the decline in delinquency of mortgage payments in areas that experienced a boom, presumably through higher income received as a result of oil and gas development (McCollum and Upton, 2016). Jacobsen (2016) considered both the local labor and housing markets and found that on average the boom increased housing as well as employment and wages across several industries.

An emerging literature is starting to document that royalty income flows from oil and gas development are at least as large as if not larger than direct and indirect wage and salaries from drilling. Brown et al. (2016b) use leasing data from across the U.S. to show that royalty rates and the extent of local ownership vary substantially across space. They also estimate royalty income from the major shale formations, reporting that six formations generated $39 billion in royalties in 2014. Feyrer et al. (2017) is the first study that attempts to estimate the local royalty income effect in an analysis of the full income effect of shale development. They use total adjusted gross income less wage income and interest and dividend income from IRS county-level tabulations as a proxy for royalty income. They find that each million dollars in production generated $66,000 in wage income and $61,000 in royalty income within the county where production occurred. Brown et al. (2016a) show that between 2000 and 2014, royalties accounted for 70 percent of the local income effect of oil and gas development and shifted both the low and high ends of the income distribution.

3 Income Effects of Oil and Gas Development

Despite this emerging literature, virtually no studies have explicitly looked at how consumption has responded to the oil and gas boom and subsequent bust. To help frame the empirical model, consider the theoretical framework proposed by Allcott and Keniston (2017), where counties indexed by i are part of a large economy. Each county has a resource extraction sector (r) producing the same product for export. In addition, there are $K+1$ monopolistically competitive sectors indexed by k. The first K sectors produce final goods for consumption, with sector $K+1$, denoted by u, is an upstream sector that produces intermediate goods for the resource extraction sector.

Since labor is mobile in and across counties, total employment E_i is endogenous to wage w_i, with an upward sloping labor supply curve. The labor market clearing condition in the county requires that total employment is the sum of labor demand across all sectors:

$$E_i(w_i) = \sum_{k=1}^{K+1} E_i^k + E_i^r. \tag{1}$$

Consumers receive a portion θ_i of the profits from the resource extraction sector $\left(\pi_i^r\right)$ in county i via royalty payments to mineral rights owners. These shares of profits are part of the aggregate budget constraint for the county:

$$\sum_{k=1}^{K+1} P_i^k Q_i^k = \sum_{k=1}^{K+1} E_i^k w_i + E_i^r w_i + \theta_i \pi_i^r, \tag{2}$$

where total expenditures in county i are a sum across $k+1$ sectors at price P_i^k and quantity Q_i^k and must equal the income received from wages across the nonresource and resource extraction sectors and income from royalty payments, both local and absentee. Total expenditures in county i under Cobb-Douglas preferences imply that the expenditure share for sector k is η^k (where $\sum_{k=1}^{K+1} \eta^k = 1$). As a result, total expenditures across all sectors in county i are:

$$C_i = \sum_{k=1}^{K+1} E_i^k w_i + E_i^r w_i + \theta_i \pi_i^r. \tag{3}$$

Equations 2 and 3 show how the effects of a resource boom on local consumption can vary across regions depending on the amount of income captured locally. Brown et al. (2016a) find that U.S. counties with complete local ownership of the subsurface capture an estimated 29 cents more of each dollar in production than a county with absentee ownership.

The aggregate effects on the local labor market are more complicated. Allcott and Keniston (2017) show that if labor supply is not fully elastic, a resource boom: 1) increases wages, 2) increases local sector (nontradable) employment, 3) decreases tradable sector employment, but 4) increases upstream sector employment with sufficiently high trade costs. One strong assumption from this framework is that all of the wages and other derived income from the resource extraction sector are spent locally, which is unlikely–especially for absentee owners and workers who live elsewhere.

The theoretical framework suggests that economic effects of a resource boom may be observed in a variety of channels. There may be gains to employment and labor income. Of course, these gains might be direct, such as industry employment, but they can also be indirect or induced, such as expansion of supporting sectors. Oil and gas development provides direct and indirect employment opportunities, potentially boosting employment and income in both extractive and supporting sectors. This income channel is well established in the literature (Marchand and Weber, 2017). Non-labor returns, such as royalty payments or other returns to asset ownership, are another potential pathway. All of these are expected to affect the local consumption.

4 Empirical Approach

4.1 Estimating the Average Effect in O&G Growth Counties

I first investigate consumer debt response for the average shale county across three categories. The categories are auto debt and consumer finance including credit and retail cards and the sum of the two categories. Estimating equation 4 for each category reveals how the difference in average consumer debt between oil and gas growth and nongrowth counties evolved year by year over the study period:

$$D_{it} = \alpha_i + \gamma_t + \sum \beta_t(O\&G\ Growth_i \times Year_t) + \theta_k X^k_{it-1} + \varepsilon_{it}, \tag{4}$$

where α and γ are county and year fixed effects, θ is a vector of coefficients from county-level control measures in X related to industrial composition, net-migration, and average credit scores. I use a similar approach as Brown et al. (2016a), where the binary variable *O&G Growth* equals one if the county lies over a shale formation and had an increase in the number of active wells from 2000 to 2014.[1] The well requirement helps exclude counties that are technically in a shale formation but that have sufficiently poor geology to make drilling uneconomical.

Being geologically determined, the binary variable is credibly exogenous to county-specific shocks (other than those related to shale development) that affect the various consumer debt measures and are unlikely associated with different prior trends for O&G growth and nongrowth counties. To confirm similar prior trends, I estimate equation 4 for the 2000-2016 period for the different debt categories. The technologically breakthroughs and higher oil and gas prices that made drilling in shale and tight formations profitable only emerged after 2000. As a result, differences in consumer debt trends between O&G growth and nongrowth counties would not reflect factors associated with shale development.

[1] The ending year 2014 was chosen because of the peak in oil prices in mid-2014.

4.2 Marginal Propensity to Consume via Debt from Wage Income Shocks

Increased drilling activity in a local area operates as a local demand shock depending upon the intensity of development. This local shock in turn increases prevailing wages in response to direct demand for workers from the oil and gas sector as well as indirectly from the local goods and services they require. Consumers who experience wage increases as a result of increased local demand may alter their consumption patterns. I estimate how shocks to wage income via drilling activity affects the marginal propensity to consume out of debt by using a difference-in-difference approach where the quarter to quarter change in county-level average debt per person is regressed on the change in wages per person:

$$\Delta D_{it} = \alpha_i + \gamma_t + \lambda \Delta Wages_{it} + \theta_k X_{it-1}^k + \varepsilon_{it}, \tag{5}$$

where α and γ are county and year fixed effects, λ measures the response of debt from changes in wages, and θ is vector of coefficients from the same county-level control measures in equation 4. The coefficient λ is interpreted as the marginal propensity to consume out of debt with each new dollar in wage income.

The change in wages from drilling activity depends upon the intensity of development. I measure drilling intensity based upon the change in the number of wells drilled (spudded) and the average depth of drilling. Because of variation in the size of county economies, I normalize the wells drilled by the count of credit score holders in each county. Measures of depth capture both the abundance and average profitability of drilling. More oil and gas may be found by drilling deeper, but costs also increase with depth. Other attributes, such as lateral measures of drilling, would also be helpful but are not readily available. Given that wage shocks differ by drilling intensity, I use an instrumental variable approach that exploits variation in the amount and depth of drilling. One would not expect depth of drilling to have any effect on consumer debt except through the channel of drilling activity. The corresponding first stage regression is:

$$\Delta Wages_{it} = \alpha_i + \gamma_t + \sigma \Delta Wells_{it} + \mu Depth_{it} + \theta_k X^k_{it-1} + \varepsilon_{it}. \quad (6)$$

Both drilling and depth of drilling are expected to be positively correlated with increases in wages. The depth of drilling varies by county and time. Therefore as drilling technology changed over the sample period, and therefore depth of drilling, these measures will partially capture this aspect. The use of two instruments also allows for examining the exogeneity of the instrument via a Hansen J-statistic, which is robust to heteroskedasticity.

5 Data

5.1 Oil and Gas Activity

Information from Drillinginfo was used to build a county-level panel dataset of oil and gas activity.[2] Monthly totals of oil and gas wells spudded were aggregated to the county-quarterly level between q1:2000 and q2:2016. County averages of depth of drilling were also tabulated from Drillinginfo.

Oil and gas growth counties were determined by the presence of a shale formation and increases in drilling activity. Shale formation was determined by if a county overlies a shale formation as indicated by the Energy Information Administration's 2011 delineation of shale boundaries. For the Permian Shale, which the EIA largely excluded, I also include geospatial information from the Los Alamos National Laboratories geologic data. Increases in drilling activity were measured by the change in the number of wells drilled between 2000 and 2014.[3] The well requirement excludes counties that have a geologic endowment but were implicitly deemed unprofitable for drilling by the absence of wells drilled. Figures 2a and 2b show how this restriction affects the sample of treated counties.

[2] `http://www.drillinginfo.com`
[3] The year 2014 was chosen because of peak oil prices in the middle of that year.

5.2 Consumer Debt Data

Direct measures of consumption are not available at the local level. As a result, information from the Federal Reserve Bank of New York Consumer Credit Panel was used as a proxy. The panel includes detailed Equifax credit-report data for a unique longitudinal quarterly panel of individuals and households. The panel is a nationally representative five percent random sample of all individuals with a social security number and a credit report plus individuals in a household connected to the "primary" individual. The primary database has approximately 12 million individuals in each quarter with information on debt balances across several categories including credit card (bank and retail), consumer finance loans (e.g., home appliance financing), auto, mortgage, and student loans (Lee and van der Klaauw, 2010). For this analysis, I pulled data from the primary list of individuals from the first quarter of 2000 through the second quarter of 2016.

Measures of consumer debt were tabulated from several categories including, credit and retail cards, consumer finance, and auto. The combination of these categories I classified as total consumer debt as these categories are most closely associated with personal consumption. Mortgage debt was excluded because it was much larger than other debt categories and was always lower in counties with oil and gas development even before development occurred.[4] In addition to the debt measures, I also tabulated the average credit score at the county-quarter level. This measure will help control for average borrowing ability of consumers. While controlling for income would be preferred, quarterly measures of income at the county-level are not available.

A unique feature of the CCP is the dynamic nature of location information. For each individual the county they live in is recorded. From this it is possible to follow peoples' movement and tabulate county-level in- and out-migration flows. Once individual movements from one quarter to the next are flagged, county totals are tabulated. Using the number

[4] Average mortgage debt was significantly lower in oil and gas growth counties in every quarter in the sample likely indicating lower housing values in these areas before oil and gas development occurred and remained low afterwards.

of individuals in the sample in a given county, it is possible to calculate migration rates. Such data are not available elsewhere at such a frequency and spatial aggregation. At the state-level, these migration rates calculated form the CCP are comparable to migration rates produced from the American Community Survey. A univariate regression between CCP in-migration and ACS migration rates at the state-level in 2014 revealed the migration rates were similar. The coefficient on the ACS rate was 0.99, indicating a very close relationship with the in-migration rate calculated from the CCP. Moreover, the R^2 was 0.91.[5] This suggests migration rates from the CCP are potentially useful measures of migration despite the reference population being different than the entire U.S. population used in the ACS. As a result, I use net(in − out) domestic migration rates at county-quarter level to control for general population movements.

5.3 Wage Income and Industrial Structure Data

Trends in consumer debt may differ by county due to differences in industrial composition and the relative performance of the industry at a given point in time. Data from the Bureau of Labor Statistics, Quarterly Census of Wages was used to construct measures of industrial structure.[6] Average quarterly wages across all industries were used as the measure of wage income. Share of total employment were made from mining, manufacturing, construction, and service sector employment.[7] One potential challenge is that employment in the QCEW is based on place of work versus place of residence. It could be possible that people live and work in different counties. Unfortunately, there is no alternative for quarterly measures of employment.

[5] A similar result was given when looking at out-migration rates in the same year.

[6] `http://www.bls.gov/data/`

[7] In a few cases where BLS did not report employment for certain sectors the missing value was replaced with a zero. The most common occurrence is when counties have a very small number of establishments in that sector. Employment is not provided to avoid potential disclosure.

5.4 Descriptive Statistics

Table 1a provides descriptive statistics at the county-quarter-level pooled from q1:2000 to q2:2016, with 3,062 counties in the sample. All dollar values are in constant 2010 price levels via the Consumer Price Index of the Bureau of Labor Statistics (U.S. average city). Average county-level consumer debt per credit score holder over the sample period ranges between $826 and $107,913. Consumer finance makes up about 61 percent of total consumer debt in the sample. As expected, it also has a wider range compared to auto debt. The number of wells spudded in a given quarter was quite skewed. This was also reflected in the number of shale counties, which made up approximately 13 percent of counties in the sample.

In order to better illustrate the differences between areas with and without oil and gas development, I also report descriptive statistics for oil and gas growth (Table 1b) and non-growth (Table 1c) counties. Quarter-to-quarter changes in debt are reported. On average, credit score holders in O&G growth counties had larger increases in total consumer and auto debt, and less of a decline in consumer finance debt. As expected, oil and gas growth counties had larger changes in the number of wells spudded per credit score holder. Average changes wages were also larger in oil and gas growth counties.[8] On average, credit scores, net migration rates, and industrial composition were similar between the two sets of counties. One difference was a higher share of mining employment in oil and gas growth counties.

6 Results

6.1 Average Difference in Debt in O&G Growth Counties

Figure 3 shows the β_t coefficients in (4) estimated using data from q1:2000 to q2:2016 across three outcomes: total consumer debt, auto debt, consumer finance. Complete regression results are shown in Table 2. O&G growth and nongrowth counties experienced roughly

[8] The average quarter to quarter changes in wages were negative because they are expressed in real terms, with real wages in the U.S. declining on average over the sample period.

similar debt trends during the early 2000s. The differences observed starting in the mid 2000s correspond to the rise in oil and gas development in shale counties. Initially, this occurred in mostly gas-producing counties, but spread to oil-producing counties by 2009. The average difference in total consumer debt between shale and non-shale counties peaked in 2015 (Figure 3a).

Economically large differences in consumer debt between O&G growth and nongrowth counties, only emerged in the late 2000s, corresponding to widespread shale development. By 2015, the average credit score holder had $840 more in total consumer debt than those in non-shale counties, a 10 percent increase over the average non-shale county debt holder in 2000 and equivalent to 1.7 percent of median household income in counties with shale endowment and increased drilling. Breaking total consumer debt into its components reveals that over two-thirds (68 percent) of the total response in shale counties came from growth in auto debt (Figure 3b). The contribution of auto debt grew over time, representing 41 percent in 2006. The increase in auto share may suggest that as development continued consumers became more comfortable with any increases in income they were experiencing and were willing to make larger purchases.

The difference in the average auto debt for consumers in shale counties very closely follows the pattern of oil and gas activity. Average auto debt steadily increased between 2005 and 2008, but declined in 2009 due to the Great Recession. During the recession, oil prices collapsed with drilling activity following. Once oil prices began to recover in 2010, drilling activity started increasing again and continued its steady march. Oil prices peaked again in the summer of 2014 with drilling slowing over the course of 2015 into 2016. Credit card and consumer finance appears to have followed a similar pattern, but with difference between O&G growth and nongrowth counties peaking earlier in 2011 (Figure 3c).

The definition of oil and gas growth counties is arguably arbitrary. As a result, I test the sensitivity of my initial definition of O&G growth counties by also considering: (1) all counties that had increased drilling between 2000 and 2014, (2) only counties that overlay shale and experienced increase oil and gas production between 2000 and 2014, and (3) all counties that increased production between 2000 and 2014. Despite differences in the definition with respect to drilling, production, and shale formations, the results were fairly robust, but did increase in magnitude when considering all growth counties regardless of shale formations and defining growth from changes in production versus drilling (Appendix Tables A1–A3). However, focusing the definition on growth in drilling and shale formations was preferred because of the lag between initial drilling and final production, and because the intensity of development was greatest in shale formations.

I also consider compositional effects and whether or not people moving into oil and gas growth counties were driving the increase in average debt over time. To do this, I constructed new debt measures only using consumers who did not move from quarter to quarter. Equation (4) was re-estimated across the same three debt categories using the nonmover sample. The results in Table 3 show coefficients for the oil and gas growth counties that are only about 3 percent smaller compared to the full sample, suggesting that people who moved into these areas are not driving the results. However, oil and gas workers debt purchases that accrue to outside oil and gas growth counties would not be captured in any of these estimates.

6.2 Marginal Propensity to Consume Wage Shocks via Drilling

I establish the relevance of the instrumental variables – changes in drilling and depth of drilling – by estimating equation (6). The fixed effects model also controls for average credit score of consumers, net migration rates, industrial composition, and year fixed effects. Table 4 shows that each well drilled was associated with \$305 in quarterly wages, while each 10,000 feet of drilling was correlated with an additional \$53 in quarterly wages. Both measures help capture the intensity of drilling as expected. The F-stat on the exclusion restriction of the instrumental variables was 31 indicating that the instruments have ample strength in predicting the changes in local wages.

Table 5 shows the second stage results across the three debt categories. Estimates from OLS for the same equations are provided in Table A4 in the appendix. The coefficients on the change in wages are smaller than the IV estimates which lends further evidence to the bias in the OLS results. Tests for endogeneity confirm that changes in wages was endogenous. Moreover, the Hansen-J tests also offers support of the exogeneity of the instruments, e.g., uncorrelated with the error term in the second stage equation.

Looking at total consumer debt, the marginal propensity to consume (mpc) from changes in wage income was 0.45. A large percentage (73%) of the mpc estimate was driven by auto debt. The second column shows the estimated mpc in auto debt was 0.33 versus 0.12 for consumer finance. A higher mpc for auto debt is somewhat expected because it is associated with a durable good, which tend to have larger mpcs relative to nondurables (Jappelli and Pistaferri, 2010). However, it is possible that durables could have been purchased with consumer finance debt. The point estimate of the mpc in the consumer finance category was just outside of conventional statistical levels. Although imprecisely estimated, the point estimate (0.12) was similar to what Kueng (2015) found for a mpc of nondurables.

The control variables generally have the expected signs. Counties with higher average credit scores have larger increases in consumer debt. Areas with higher net migration rates in the previous quarter had lower increases in total consumer debt, suggesting payback of debt incurred from moving in the prior period. Relative to government employment, manufacturing share of employment was positively and significantly correlated with debt, while the construction employment share was negatively correlated. Areas dominated by higher shares of manufacturing relative to government employment experienced declines in wages as shown in the first stage results. Consumers in these areas seem to have responded to the secular decline in manufacturing over the sample by taking on more debt.

Similar to the average debt response, I also consider changes in sample composition from people moving into areas of increased drilling potentially influencing the marginal response estimates. To address this, I use the nonmover sample and re-estimate equation 5. The results in Table 6 shows a coefficient on auto debt of 0.31, about 7 percent below the full sample mpc estimate (0.33). Comparable estimates between the two samples suggests that the initial estimates were also not driven by changes in people moving into areas with new activity.

6.3 Local Spatial Spillovers

Given the fluid movement of people and workers across counties, the response of consumer debt to oil and gas developed in a county may also be influenced by development in neighboring counties. One possible channel of local spatial spillovers is from employees living in one county but working in a neighboring county. Another possibility is ownership of oil and gas mineral rights in neighboring counties. In both cases, income generated from oil and gas development could spillover to neighboring counties. More generally, increased local demand as a result of the additional income from oil and gas development directly through wages from the oil and gas sector or the flow royalty dollars may induce additional spending in neighboring counties.

I test for local spatial spillovers by estimating:

$$\Delta C_{it} = \alpha_i + \gamma_t + \lambda \Delta Wages_{it} + \phi W \Delta Wages_{it} + \theta_k X_{it-1}^k + \varepsilon_{it}, \tag{7}$$

where W is a N by N weight matrix containing information about whom is a neighbor of whom and ϕ is measure of local spatial spillovers from changes in wages in neighboring counties. I use shared county boarders following queen contiguity to identify neighboring counties. Equation 7 has two endogenous variables, $\Delta Wages_{it}$ and $W\Delta Wages_{it}$. I instrument them by using the change in wells drilled and average depth of drilling and spatial lags of those measures. First and second stage results are reported in Tables 7 and 8. The total effect is sum of the coefficients, λ and ϕ.

The first stage results show a positive and significant relationship between increases in drilling and depth of drilling in both own and neighboring counties and changes in wages. However, the point estimates on the change in wages in neighboring counties in the second stage were imprecisely estimated. The sum of coefficients on the direct (λ) and indirect (ϕ) effects were qualitatively similar to the main results suggesting limited influence on changes in debt from local spatial spillovers of oil and gas development. As a result, I dispense with further investigation and implications of spatial spillovers.

6.4 Influence of Historical Oil and Gas Development

Changes in consumer debt may have evolved differently in areas depending on whether they had previously experienced booms and busts in oil and gas development. In order to test this, I use a measure of the historic drilling activity in quarter mile by quarter mile grids. Using ArcGIS, I calculated the percent of each county that ever had an oil or gas well as of 1980. This measure was constructed using historic geospatial data on oil and gas wells from the U.S. Geologic Survey.[9] Figure 4 shows shares of historical coverage across U.S. counties. The share ranges from 0 to 1. Complete coverage indicates that each quarter mile by quarter mile grid in the county had at least one well drilled as of 1980. I split the sample based on the top quartile of development, which was near 5 percent. Counties with a percentage of development greater/less than the 75th percentile were considered as developed/undeveloped. Given that many urban areas have little to no development I exclude metropolitan counties and only focus previously developed or undeveloped nonmetro areas.

Second stage results of the subsamples are reported in Tables 9 and 10.[10] Areas with previous development had marginal propensities to consume similar to the full sample; 0.43 for total consumer debt. Similarly, most of the mpc estimate was from increases in auto debt.

[9] Available at: http://pubs.usgs.gov/dds/dds-069/dds-069-q/text/cover.htm

[10] First stage results are reported in Table A5.

The difference in the estimated mpcs between previously developed and undeveloped counties was significant. The estimated mpc for total consumer debt was 0.74 in undeveloped counties, 72 percent higher compared to the estimate from previously developed counties. Most of the difference in mpcs between previously developed and undeveloped areas was from consumer finance. In previously undeveloped areas, the estimated mpc from consumer finance debt was 0.51, which was over four times higher than the point estimate from previously developed areas.

One caveat was failure of the exclusion restrictions on the instrumental variables in the previously developed subsample as the threshold for previous development reached the 90th percentile or higher. Also this is a small number of counties relative to the full sample, it suggests that areas with very high amounts of previous development may have lingering income effects that are correlated with changes in consumer debt. This, however, is not an issue for counties outside of the top 10 percent in the distribution of historical development.

Overall, the subsample results suggest that areas with previous oil and gas development likely do a better job internalizing that booms in development often give way to busts. As a result, consumers in previously undeveloped areas may be most at risk of the irrational exuberance that good times will continue. These consumers would also likely be more at risk to default on their debt during busts in development.

6.5 Discussion of Results

Local demand shocks from changes in oil and gas activity produced the expected effects with respect to increases in prevailing wages and consumer debt. The results show that through the wage channel, consumers on average were willing to increase their consumption via debt. Overall, my estimates of the marginal propensity to consume from debt are consistent with previous estimates in the literature ranging between 0.2–0.6 (Jappelli and Pistaferri, 2010, 2014). However, it is important to point out that my estimate of the marginal propensity to consume is only through one income channel as a result of increased oil and gas activity.

I am not able to observe non-wage income at a quarterly frequency. Specifically, royalty income from the production of oil and gas is likely to be as large if not larger depending upon patterns of local ownership of mineral rights (Brown et al., 2016a; Feyrer et al., 2017).

Estimates of the marginal propensity to consume royalty income are likely to be higher depending upon their duration and anticipation by consumers. Because I do not observe the royalty income channel, my results are likely a lower bound estimate of drilling's effect on debt-financed consumption. Moreover, transactions with cash or debit cards were outside of my consumer debt measures. They also do not capture spending out of returns from potential investments that used income generated from drilling activity, i.e., investment or retirement accounts. Still, the consumption effect I estimate is economically significant and is consistent with consumers increasing discretionary spending out of wage income shocks associated with oil and gas development.

7 Conclusion

One of the challenges noted in the literature on consumer spending is the difficulty in identifying income shocks that are genuinely exogenous and can be used to follow consumption after a shock. In this paper I investigate how consumers responded to booms and busts in oil and gas development. Oil and gas development generates potentially large streams of income via wages and salaries to workers and royalty income to mineral rights owners. I show that shocks to local demand shocks via drilling lead consumers to increase their spending depending. Using quarterly information on consumer debt and oil and gas activity, I find that consumer debt increased $840 per capita equivalent to 1.7 percent of median household income in counties with shale endowment and increased drilling. Shocks to local wages via drilling revealed a marginal propensity to consume from debt of 0.45, mostly from new auto debt. My estimates are within the range previously identified in the literature.

My estimates of the marginal propensity to consume only consider the wage channel.

This would capture increases in prevailing wages from increases in labor demand from the oil and gas sector and increases in other sectors directly and indirectly supporting oil and gas. While I do not directly observe royalty payments to mineral right owners, the wage channel picks up increases in local wages as a result of expenditure of royalty income in the local economy.

One important finding is that the marginal propensity to consume wage income shocks in previously undeveloped counties was 70 percent higher compared to developed counties. My results suggest that areas with previous oil and gas development likely do a better job anticipating and internalizing that booms in development often give way to busts. This is consistent with consumers in these areas viewing income shocks arising from oil and gas development as more transitory. Consumers in previously undeveloped areas may be most at risk of the irrational exuberance that good times will continue indefinitely. As a result, these consumers would also likely be more at risk of defaulting on their debt during busts in oil and gas development.

My findings also raise additional questions. For example, how much of the increase in income from oil and gas development is saved or spent and over what time frame? Given a development shock, how long does the effect last on consumer debt? These questions are beyond the scope of the current analysis, but are likely fruitful areas of future research.

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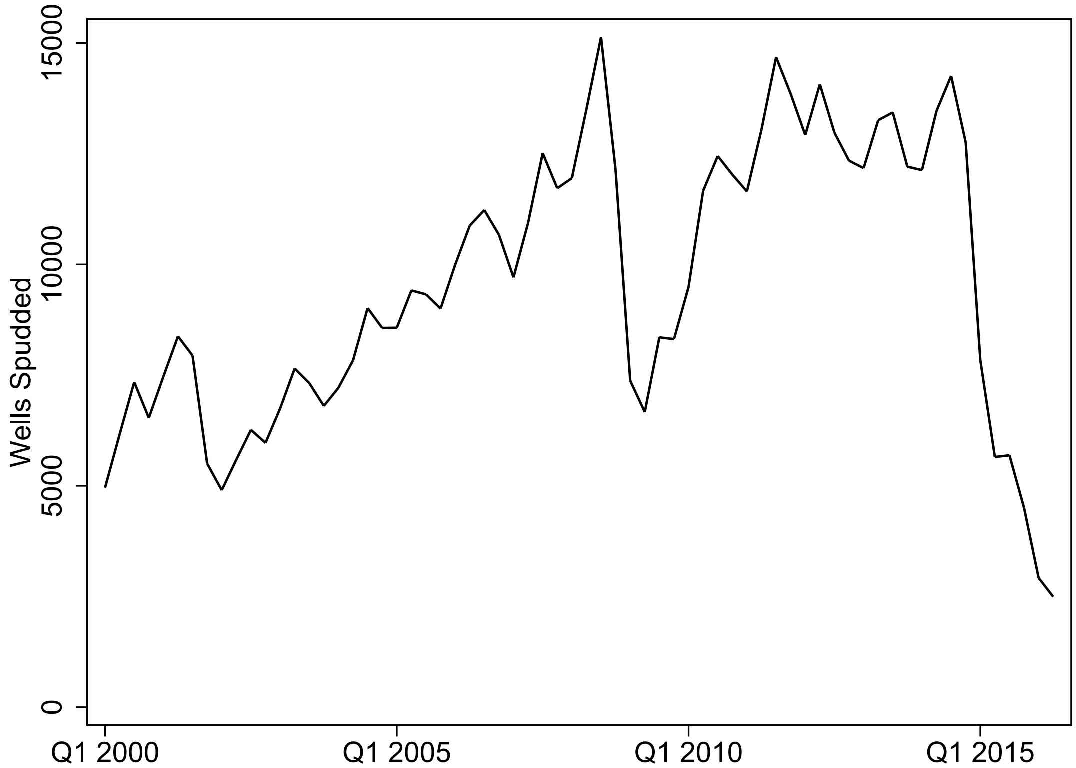
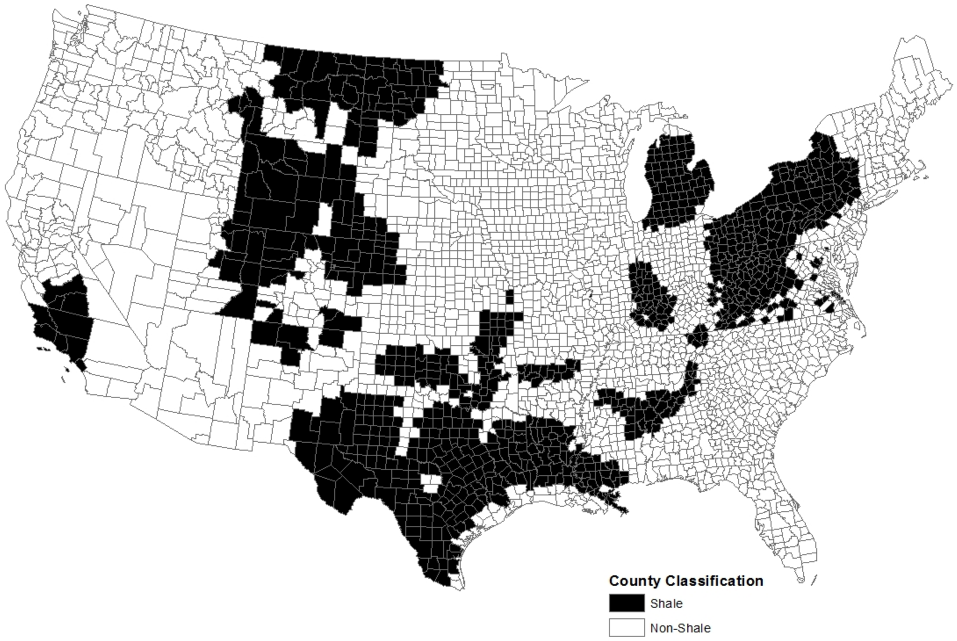
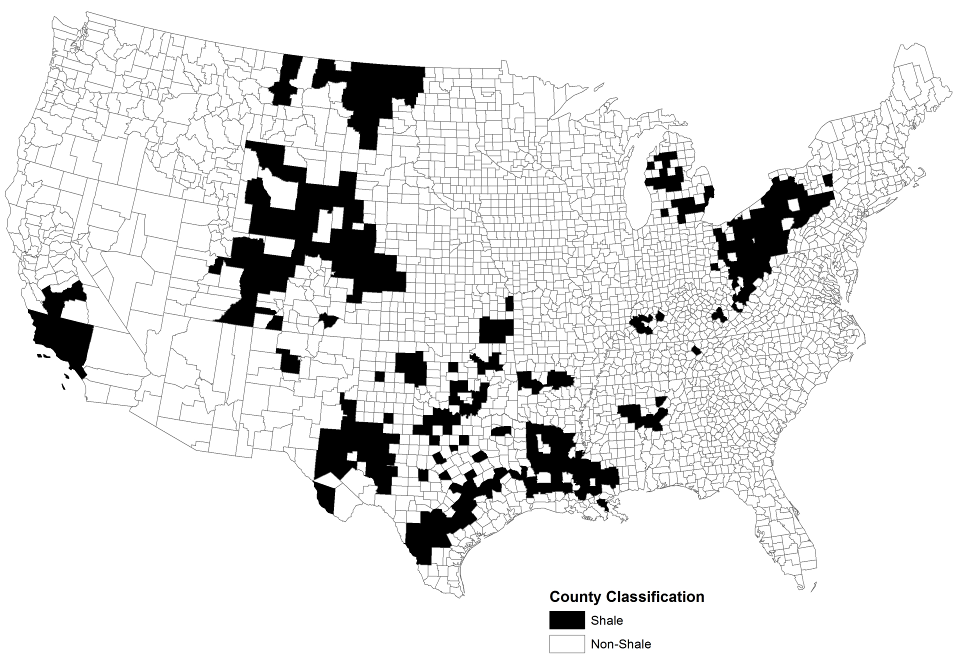


Source: DrillingInfo

Figure 1: Total U.S. Oil and Gas Wells Spudded

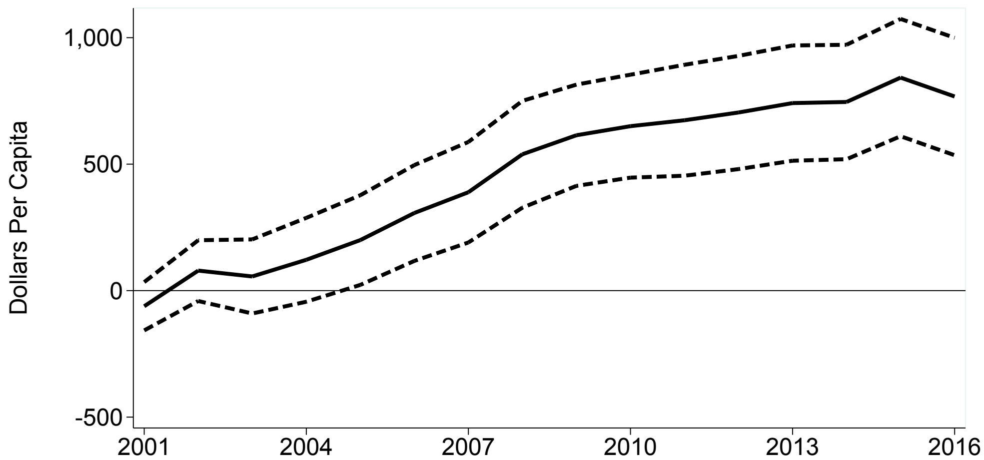


(a) All Counties Overlying Shale Deposits

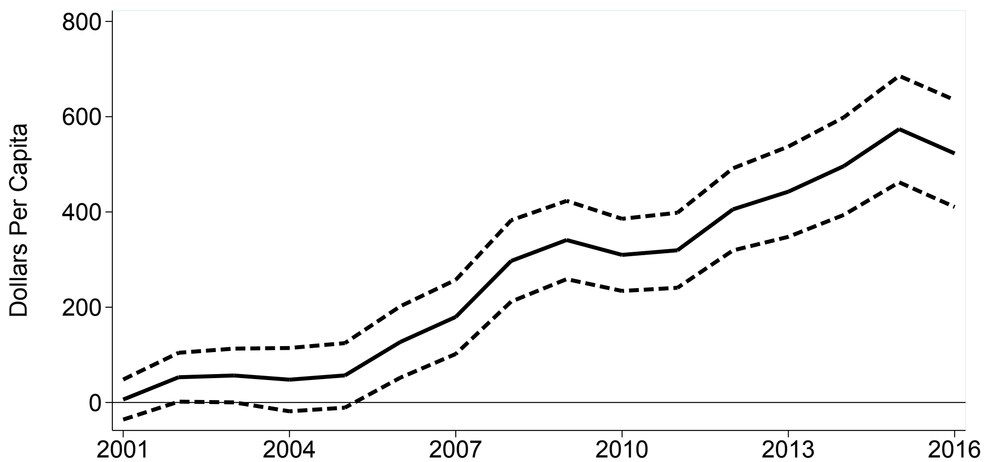


(b) Counties Overlying Shale with Increase in Wells Drilled, 2000–2014

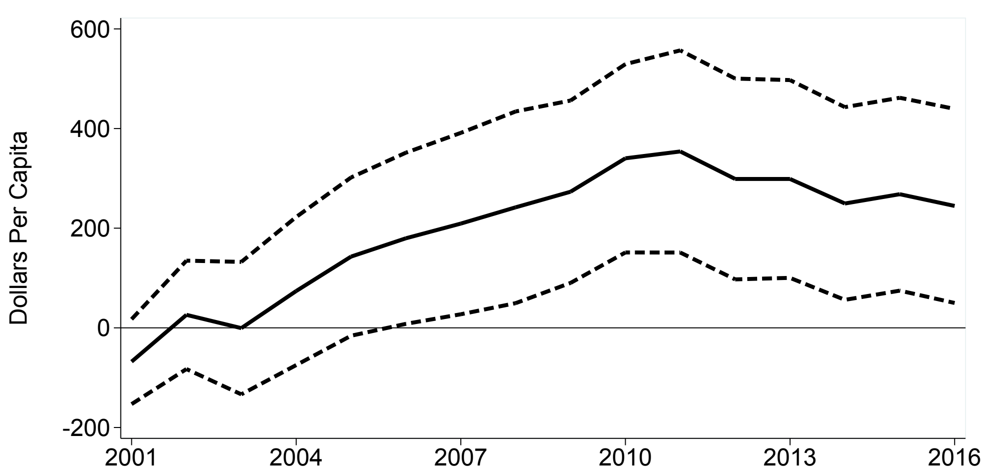
Figure 2: Defining O&G Growth vs. Nongrowth Counties



(a) Total Consumer Debt



(b) Auto Debt



(c) Credit Card and Consumer Finance

Figure 3: Difference in Consumer Debt of O&G Growth vs. Nongrowth Counties

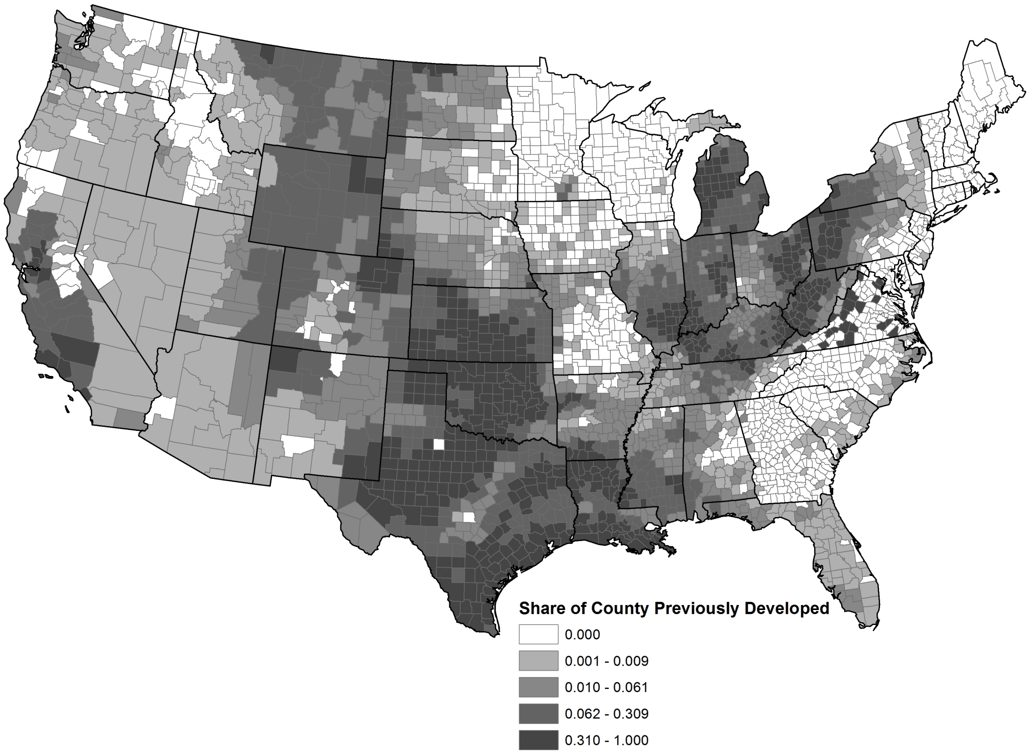


Figure 4: Share of County Previously Developed

Table 1: Descriptive Statistics

(a) Full Sample

	Mean	SD	Min	Max
Avg. Total Consumer Debt	8,010.20	2,195.17	825.79	107913.40
Avg. Auto Debt	3,101.68	1,006.80	0.00	20,310.67
Avg. Consumer Finance	4,908.52	1,912.72	96.74	104347.01
Average Quarterly Wages	8,584.39	2,309.42	2,401.74	62,660.93
Spudded Wells	0.01	0.18	0.00	36.67
Shale County (0/1)	0.13	0.34	0.00	1.00
Credit Score	688.04	28.30	570.03	789.45
Net Migration Rate (%)	-0.00	0.01	-0.64	0.42
Mining Emply Share	0.01	0.05	0.00	0.97
Manufacturing Emply Share	0.16	0.13	0.00	0.79
Construction Emply Share	0.06	0.04	0.00	0.84
Services Emply Share	0.70	0.14	0.00	1.00
N	201227			

(b) O&G Growth Counties

	Mean	SD	Min	Max
Avg. Total Consumer Debt	8,370.19	2,115.06	1,940.81	32,936.40
Avg. Auto Debt	3,494.52	1,253.77	266.69	15,646.42
Avg. Consumer Finance	702.12	254.66	0.00	13,554.35
Average Quarterly Wages	8,928.66	2,208.43	3,665.72	34,718.94
Spudded Wells	0.05	0.50	0.00	36.67
Credit Score	683.33	26.72	581.49	768.36
Net Migration Rate (%)	-0.00	0.01	-0.64	0.42
Mining Emply Share	0.04	0.08	0.00	0.71
Manufacturing Emply Share	0.13	0.12	0.00	0.69
Construction Emply Share	0.06	0.04	0.00	0.42
Services Emply Share	0.69	0.14	0.00	0.97
N	25978			

(c) Nongrowth Counties

	Mean	SD	Min	Max
Avg. Total Consumer Debt	7,956.83	2,201.80	825.79	107913.40
Avg. Auto Debt	3,043.44	951.12	0.00	20,310.67
Avg. Consumer Finance	682.82	290.00	0.00	6,908.18
Average Quarterly Wages	8,533.36	2,319.68	2,401.74	62,660.93
Spudded Wells	0.00	0.03	0.00	2.17
Credit Score	688.74	28.46	570.03	789.45
Net Migration Rate (%)	-0.00	0.01	-0.46	0.33
Mining Emply Share	0.01	0.04	0.00	0.07
Manufacturing Emply Share	0.17	0.13	0.00	0.79
Construction Emply Share	0.06	0.04	0.00	0.84
Services Emply Share	0.70	0.15	0.00	1.00
N	175249			

Source: Author's calculations using data from the Federal Reserve Bank of New York Consumer Credit Panel / Equifax and BLS QCEW.

Table 2: Average Consumer Debt Response

	Consumer Total	Auto	Consumer Finance
O&G Growth × 2001	-61.71	6.13	-67.84
	(48.70)	(21.44)	(43.48)
O&G Growth × 2002	79.13	53.05*	26.08
	(61.32)	(26.19)	(55.48)
O&G Growth × 2003	56.12	56.68*	-0.55
	(74.69)	(28.80)	(67.81)
O&G Growth × 2004	121.87	47.94	73.93
	(84.59)	(33.91)	(75.81)
O&G Growth × 2005	199.87*	56.86	143.01
	(90.42)	(34.57)	(81.05)
O&G Growth × 2006	306.92**	127.07***	179.85*
	(96.61)	(38.25)	(87.64)
O&G Growth × 2007	388.98***	179.69***	209.28*
	(101.39)	(39.70)	(92.89)
O&G Growth × 2008	539.13***	297.18***	241.95*
	(107.70)	(43.56)	(98.15)
O&G Growth × 2009	614.30***	341.11***	273.19**
	(102.09)	(41.93)	(93.37)
O&G Growth × 2010	650.19***	309.86***	340.33***
	(103.82)	(38.64)	(96.41)
O&G Growth × 2011	673.57***	319.56***	354.01***
	(111.88)	(40.20)	(103.50)
O&G Growth × 2012	704.25***	405.46***	298.79**
	(114.19)	(43.96)	(102.81)
O&G Growth × 2013	741.38***	442.54***	298.84**
	(116.27)	(48.34)	(101.27)
O&G Growth × 2014	745.78***	496.15***	249.62*
	(115.41)	(52.23)	(98.65)
O&G Growth × 2015	842.19***	573.93***	268.26**
	(118.29)	(57.00)	(98.75)
O&G Growth × 2016	767.49***	522.80***	244.70*
	(118.40)	(57.31)	(99.36)
Credit Score	-5.69	2.46*	-8.15**
	(2.97)	(1.03)	(2.69)
Net Migration Rate (%)	3219.66***	1810.01***	1409.65***
	(361.65)	(197.17)	(292.12)
Mining Emply Share	2839.96***	1664.01***	1175.95**
	(580.07)	(350.11)	(358.77)
Manufacturing Emply Share	1275.70***	258.09**	1017.61***
	(298.45)	(94.26)	(276.73)
Construction Emply Share	3007.94***	1835.33***	1172.62***
	(477.14)	(210.72)	(352.18)
Services Emply Share	-1216.72***	-529.53***	-687.19***
	(220.32)	(79.34)	(191.48)
R-squared	0.293	0.367	0.367
N	201,227	201,227	201,227

Notes: * p<0.05, ** p<0.01, *** p<0.001. Robust standard errors clustered by county are in parentheses. All regressions include year fixed effects. O&G Growth counties are counties overlying a shale formation and that had an increase in the number of active wells over the 2000–2014 period.

Table 3: Average Consumer Debt Response for Nonmovers

	Consumer Total	Auto	Consumer Finance
O&G Growth × 2001	-69.83	-1.01	-68.82
	(48.35)	(22.10)	(42.58)
O&G Growth × 2002	70.44	47.46	22.98
	(61.64)	(26.83)	(55.10)
O&G Growth × 2003	45.79	48.19	-2.40
	(75.87)	(29.67)	(68.61)
O&G Growth × 2004	113.56	40.70	72.86
	(85.12)	(34.38)	(75.62)
O&G Growth × 2005	194.06*	50.72	143.35
	(92.32)	(35.08)	(82.89)
O&G Growth × 2006	299.43**	121.22**	178.21*
	(98.00)	(38.52)	(89.13)
O&G Growth × 2007	381.49***	173.48***	208.01*
	(103.08)	(40.03)	(95.03)
O&G Growth × 2008	524.33***	284.70***	239.63*
	(109.55)	(43.55)	(100.22)
O&G Growth × 2009	579.47***	327.55***	251.92**
	(102.99)	(42.19)	(94.36)
O&G Growth × 2010	626.52***	295.67***	330.84***
	(105.43)	(39.22)	(98.46)
O&G Growth × 2011	644.43***	303.60***	340.83**
	(113.23)	(40.54)	(105.34)
O&G Growth × 2012	676.78***	386.45***	290.33**
	(116.15)	(44.46)	(105.09)
O&G Growth × 2013	722.50***	437.37***	285.13**
	(118.03)	(49.39)	(103.01)
O&G Growth × 2014	727.39***	484.13***	243.26*
	(117.22)	(52.48)	(100.29)
O&G Growth × 2015	830.19***	562.12***	268.06**
	(119.52)	(57.33)	(100.37)
O&G Growth × 2016	749.64***	511.13***	238.51*
	(119.08)	(57.22)	(100.49)
Credit Score	-6.19*	2.32*	-8.51**
	(3.01)	(1.04)	(2.73)
Net Migration Rate (%)	1648.08***	920.53***	727.55*
	(351.38)	(181.85)	(288.79)
Mining Emply Share	2838.76***	1685.75***	1153.01**
	(590.28)	(353.56)	(368.06)
Manufacturing Emply Share	1265.57***	250.22**	1015.35***
	(302.82)	(95.11)	(281.66)
Construction Emply Share	3011.75***	1852.44***	1159.31**
	(485.88)	(213.41)	(359.59)
Services Emply Share	-1225.29***	-527.60***	-697.69***
	(221.91)	(79.35)	(194.09)
R-squared	0.299	0.359	0.372
N	201,227	201,227	201,227

Notes: * $p<0.05$, ** $p<0.01$, *** $p<0.001$. Robust standard errors clustered by county are in parentheses. All regressions include year fixed effects. O&G Growth counties are as defined in the text – counties overlying a shale formation and that had an increase in the number of active wells over the 2000–2016 period.

Table 4: First Stage Results

	Δ Wages
Δ Wells	304.99***
	(60.37)
Depth (10,000 ft.)	53.56***
	(9.43)
Credit Score	15.47***
	(0.56)
Net Migration Rate	2483.84***
	(339.42)
Mining Emply Share	287.99***
	(104.15)
Manufacturing Emply Share	-443.94***
	(71.43)
Construction Emply Share	519.58***
	(126.61)
Services Emply Share	284.05***
	(55.45)
IV-F	31.22***
R-squared	0.020
N	198,175

Notes: * p<0.10, ** p<0.05, *** p<0.01. Robust standard errors clustered by county are in parentheses. All regressions include year fixed effects.

Table 5: Marginal Propensity to Consume from Debt

	Δ Consumer Total	Δ Auto Debt	Δ Consumer Finance
Δ Wages	0.45***	0.33***	0.12
	(0.12)	(0.12)	(0.08)
Credit Score	0.93	-2.50	3.43***
	(1.90)	(1.78)	(1.31)
Net Migration Rate	-1479.96***	-1018.20***	-461.75
	(431.45)	(358.67)	(296.27)
Mining Emply Share	-48.63	-23.92	-24.70
	(66.19)	(56.68)	(49.23)
Manufacturing Emply Share	184.43***	160.84***	23.58
	(68.79)	(54.25)	(51.67)
Construction Emply Share	-212.98*	-172.32**	-40.66
	(113.60)	(83.73)	(80.75)
Services Emply Share	-66.22	-75.62	9.40
	(54.52)	(46.99)	(32.53)
Over-identification test (Chi-sq)	0.079	0.887	0.754
Endogeneity test	12.02***	17.12***	1.67
N	198,175	198,175	198,175

Notes: * p<0.10, ** p<0.05, *** p<0.01. Robust standard errors clustered by county are in parentheses. All regressions include year fixed effects.

Table 6: Marginal Propensity to Consume from Debt: Nonmovers

	Δ Consumer Total	Δ Auto Debt	Δ Consumer Finance
Δ Wages	0.40***	0.31**	0.10
	(0.12)	(0.12)	(0.08)
Credit Score	1.86	-2.23	4.10***
	(1.93)	(1.89)	(1.33)
Net Migration Rate	441.78	106.20	335.58
	(461.62)	(381.93)	(295.07)
Mining Emply Share	-17.96	-26.40	8.44
	(61.00)	(57.33)	(42.87)
Manufacturing Emply Share	156.37**	141.92**	14.44
	(69.08)	(57.30)	(52.36)
Construction Emply Share	-156.93	-174.47**	17.54
	(114.33)	(84.30)	(84.89)
Services Emply Share	-28.44	-72.86	44.41
	(54.56)	(46.63)	(32.24)
Over-identification test (Chi-sq)	0.270	0.816	0.320
Endogeneity test	8.44***	12.12***	0.97
N	198,175	198,175	198,175

Notes: * p<0.10, ** p<0.05, *** p<0.01. Robust standard errors clustered by county are in parentheses. All regressions include year fixed effects.

Table 7: First Stage Results: Local Spatial Spillovers

	Δ Wages	W ×Δ Wages
Δ Wells	303.173***	291.991**
	(60.327)	(121.636)
Depth (10,000 ft.)	47.186***	86.029***
	(9.412)	(28.777)
W ×Δ Wells	43.331**	432.288***
	(20.325)	(57.980)
W × Depth	32.694***	147.244***
	(3.074)	(11.855)
Credit Score	15.473***	64.464***
	(0.559)	(1.944)
Net Migration Rate	2476.013***	8247.872***
	(339.467)	(870.175)
Mining Emply Share	300.588***	1113.255***
	(104.902)	(240.424)
Manufacturing Emply Share	-446.226***	-2067.000***
	(71.685)	(208.940)
Construction Emply Share	508.065***	5025.269***
	(126.201)	(442.750)
Services Emply Share	285.573***	480.140***
	(55.477)	(161.898)
IV-F (Multivariate)	9.83***	13.31***
R-squared	0.020	0.043
N	198,175	198,175

Notes: * p<0.10, ** p<0.05, *** p<0.01. Robust standard errors clustered by county are in parentheses. All regressions include year fixed effects.

Table 8: Marginal Propensity to Consume from Debt: Local Spatial Spillovers

	Δ Consumer Total	Δ Auto Debt	Δ Consumer Finance
Δ Wages	0.46***	0.41**	0.05
	(0.17)	(0.17)	(0.09)
W ×Δ Wages	-0.04	-0.07*	0.03
	(0.04)	(0.04)	(0.02)
Credit Score	3.28***	0.72	2.56***
	(1.08)	(1.08)	(0.77)
Net Migration Rate	-1183.26***	-648.87**	-534.39**
	(357.14)	(257.59)	(264.40)
Mining Emply Share	-8.83	27.32	-36.15
	(63.16)	(52.52)	(43.03)
Manufacturing Emply Share	108.60*	53.57	55.03
	(55.55)	(43.35)	(41.85)
Construction Emply Share	-19.04	143.14	-162.19*
	(150.54)	(150.37)	(98.06)
Services Emply Share	-51.30	-67.15	15.85
	(53.00)	(44.12)	(29.38)
Over-identification test (Chi-sq)	2.08	0.38	2.16
Endogeneity test	9.37***	9.87***	3.86***
N	198,175	198,175	198,175

Notes: * p<0.10, ** p<0.05, *** p<0.01. Robust standard errors clustered by county are in parentheses. All regressions include year fixed effects.

Table 9: Marginal Propensity to Consume from Debt: Previously Developed Counties

	Δ Consumer Total	Δ Auto Debt	Δ Consumer Finance
Δ Wages	0.43***	0.32**	0.11
	(0.14)	(0.13)	(0.09)
Credit Score	4.01**	-0.65	4.66***
	(1.95)	(1.47)	(1.34)
Net Migration Rate	-1430.40*	-793.54*	-636.85
	(731.29)	(465.18)	(536.06)
Mining Emply Share	-22.84	2.13	-24.96
	(94.18)	(78.97)	(68.16)
Manufacturing Emply Share	161.31	136.09**	25.22
	(103.57)	(57.51)	(91.64)
Construction Emply Share	-292.87	-208.32	-84.56
	(202.17)	(132.97)	(145.86)
Services Emply Share	-127.64	-169.43*	41.79
	(108.21)	(102.61)	(58.86)
Over-identification test (Chi-sq)	1.85	2.71	0.08
Endogeneity test	8.70***	9.24***	0.73
N	50,972	50,972	50,972

Notes: * p<0.10, ** p<0.05, *** p<0.01. Robust standard errors clustered by county are in parentheses. All regressions include year fixed effects.

Table 10: Marginal Propensity to Consume from Debt: Previously Undeveloped Counties

	Δ Consumer Total	Δ Auto Debt	Δ Consumer Finance
Δ Wages	0.74***	0.23***	0.51**
	(0.24)	(0.08)	(0.21)
Credit Score	-4.35	-1.51	-2.84
	(3.65)	(1.25)	(3.17)
Net Migration Rate	-2272.14***	-883.52***	-1388.62**
	(800.39)	(271.19)	(688.73)
Mining Emply Share	-170.68	-74.22*	-96.46
	(116.77)	(37.89)	(107.11)
Manufacturing Emply Share	251.91**	96.47**	155.44
	(122.55)	(41.80)	(100.97)
Construction Emply Share	-213.75	-71.28	-142.47
	(240.50)	(82.17)	(192.94)
Services Emply Share	-84.37	-10.27	-74.10
	(82.21)	(30.36)	(62.79)
Over-identification test (Chi-sq)	0.03	0.002	0.01
Endogeneity test	5.54***	5.74***	2.99**
N	74,072	74,072	74,072

Notes: * p<0.10, ** p<0.05, *** p<0.01. Robust standard errors clustered by county are in parentheses. All regressions include year fixed effects.

Appendix: Additional Empirical Results

Table A1: Alternative Definition of Shale Counties, Increased Drilling

	Consumer Total	Auto	Consumer Finance
O&G Growth × 2001	-69.32	-30.78	-38.55
	(42.09)	(18.54)	(36.79)
O&G Growth × 2002	133.95*	1.72	132.23**
	(57.68)	(23.92)	(50.88)
O&G Growth × 2003	178.17*	-8.53	186.70*
	(82.10)	(25.88)	(78.19)
O&G Growth × 2004	212.72*	-43.12	255.84**
	(85.43)	(29.89)	(79.99)
O&G Growth × 2005	295.27***	-31.06	326.33***
	(81.59)	(30.48)	(75.13)
O&G Growth × 2006	437.21***	40.09	397.12***
	(86.20)	(33.03)	(79.97)
O&G Growth × 2007	543.43***	83.90*	459.53***
	(89.64)	(35.55)	(83.26)
O&G Growth × 2008	742.63***	190.90***	551.73***
	(103.18)	(38.13)	(96.36)
O&G Growth × 2009	825.49***	235.04***	590.44***
	(101.85)	(37.21)	(96.55)
O&G Growth × 2010	854.37***	246.91***	607.47***
	(99.88)	(33.93)	(93.66)
O&G Growth × 2011	890.57***	276.74***	613.82***
	(107.04)	(34.57)	(99.05)
O&G Growth × 2012	920.44***	339.78***	580.66***
	(108.21)	(37.31)	(98.99)
O&G Growth × 2013	945.55***	354.31***	591.23***
	(108.50)	(40.10)	(98.52)
O&G Growth × 2014	1008.37***	394.75***	613.62***
	(117.16)	(43.23)	(108.11)
O&G Growth × 2015	1072.75***	454.68***	618.07***
	(110.65)	(46.51)	(98.47)
O&G Growth × 2016	974.45***	405.45***	569.00***
	(108.94)	(46.75)	(96.70)
Credit Score	-5.85*	2.19*	-8.04**
	(2.97)	(1.03)	(2.69)
Net Migration Rate (%)	3125.19***	1776.45***	1348.74***
	(359.19)	(196.56)	(290.53)
Mining Emply Share	2633.70***	1663.11***	970.59**
	(562.99)	(352.18)	(351.04)
Manufacturing Emply Share	1177.76***	221.40*	956.36***
	(292.70)	(92.18)	(273.32)
Construction Emply Share	2885.44***	1807.07***	1078.37**
	(475.77)	(211.80)	(349.66)
Services Emply Share	-1129.10***	-499.60***	-629.49***
	(217.29)	(78.96)	(190.25)
R-squared	0.299	0.369	0.370
N	201,227	201,227	201,227

Notes: * p<0.05, ** p<0.01, *** p<0.001. Robust standard errors clustered by county are in parentheses. All regressions include county and year fixed effects. O&G Growth counties are counties that had an increase in the number of active wells over the 2000–2014 period.

Table A2: Alternative Definition of Shale Counties, Overlay Shale and Increased Production

	Consumer Total	Auto	Consumer Finance
O&G Growth × 2001	58.63	23.37	35.27
	(55.00)	(20.65)	(48.91)
O&G Growth × 2002	199.34**	67.51**	131.83
	(74.47)	(24.28)	(71.62)
O&G Growth × 2003	133.54	67.77*	65.78
	(75.18)	(28.38)	(68.37)
O&G Growth × 2004	211.00*	56.03	154.97*
	(87.53)	(34.70)	(77.44)
O&G Growth × 2005	279.54**	55.59	223.95**
	(93.11)	(33.95)	(82.55)
O&G Growth × 2006	393.76***	128.89***	264.87**
	(98.58)	(37.36)	(87.52)
O&G Growth × 2007	492.30***	192.24***	300.06***
	(93.99)	(39.87)	(83.93)
O&G Growth × 2008	664.27***	316.91***	347.37***
	(101.77)	(44.47)	(89.77)
O&G Growth × 2009	728.67***	348.63***	380.04***
	(99.07)	(42.31)	(87.95)
O&G Growth × 2010	747.83***	285.43***	462.40***
	(99.96)	(39.04)	(90.79)
O&G Growth × 2011	804.43***	298.17***	506.27***
	(106.63)	(40.34)	(97.57)
O&G Growth × 2012	894.19***	393.69***	500.50***
	(108.45)	(43.55)	(97.59)
O&G Growth × 2013	933.47***	443.93***	489.55***
	(107.74)	(46.88)	(94.59)
O&G Growth × 2014	953.40***	502.66***	450.74***
	(109.15)	(50.55)	(93.94)
O&G Growth × 2015	1015.98***	592.27***	423.71***
	(108.24)	(55.84)	(89.35)
O&G Growth × 2016	963.41***	563.08***	400.32***
	(109.73)	(55.58)	(90.23)
Credit Score	-5.55	2.47*	-8.02**
	(2.96)	(1.03)	(2.69)
Net Migration Rate (%)	3237.30***	1824.81***	1412.49***
	(361.57)	(197.52)	(292.19)
Mining Emply Share	2644.42***	1608.73***	1035.68**
	(554.16)	(343.86)	(348.14)
Manufacturing Emply Share	1233.58***	237.45*	996.13***
	(297.10)	(94.18)	(276.01)
Construction Emply Share	2987.93***	1853.75***	1134.17**
	(472.42)	(210.09)	(349.51)
Services Emply Share	-1202.36***	-528.09***	-674.27***
	(219.72)	(78.88)	(191.14)
R-squared	0.296	0.369	0.368
N	201,227	201,227	201,227

Notes: * $p<0.05$, ** $p<0.01$, *** $p<0.001$. Robust standard errors clustered by county are in parentheses. All regressions include county and year fixed effects. O&G Growth counties are counties overlying a shale formation and that had an increase in production over the 2000–2014 period.

Table A3: Alternative Definition of Shale Counties, Increased Production

	Consumer Total	Auto	Consumer Finance
O&G Growth × 2001	46.06	-2.85	48.91
	(44.71)	(16.68)	(40.04)
O&G Growth × 2002	265.80***	40.57	225.23***
	(62.76)	(21.26)	(59.13)
O&G Growth × 2003	252.60**	26.01	226.59**
	(77.99)	(24.80)	(74.67)
O&G Growth × 2004	293.15***	-5.05	298.20***
	(85.10)	(29.58)	(79.77)
O&G Growth × 2005	357.08***	0.10	356.98***
	(80.51)	(29.47)	(74.21)
O&G Growth × 2006	476.83***	71.02*	405.80***
	(84.69)	(31.93)	(77.58)
O&G Growth × 2007	601.14***	130.36***	470.78***
	(84.86)	(34.68)	(77.50)
O&G Growth × 2008	811.77***	248.31***	563.46***
	(96.65)	(37.47)	(88.63)
O&G Growth × 2009	880.05***	275.43***	604.62***
	(96.95)	(36.23)	(90.28)
O&G Growth × 2010	869.47***	244.52***	624.94***
	(95.11)	(33.42)	(88.00)
O&G Growth × 2011	910.47***	268.31***	642.16***
	(100.01)	(34.24)	(91.83)
O&G Growth × 2012	1005.86***	340.18***	665.68***
	(102.52)	(36.85)	(93.31)
O&G Growth × 2013	1062.43***	379.23***	683.20***
	(102.41)	(39.31)	(92.78)
O&G Growth × 2014	1082.70***	437.22***	645.48***
	(103.68)	(42.24)	(93.10)
O&G Growth × 2015	1155.47***	518.88***	636.60***
	(100.57)	(45.73)	(87.96)
O&G Growth × 2016	1058.48***	491.29***	567.19***
	(99.70)	(45.64)	(86.28)
Credit Score	-5.84*	2.15*	-7.99**
	(2.96)	(1.03)	(2.69)
Net Migration Rate (%)	3181.83***	1801.68***	1380.15***
	(359.59)	(196.85)	(291.06)
Mining Emply Share	2502.96***	1603.92***	899.04**
	(544.34)	(344.78)	(346.27)
Manufacturing Emply Share	1127.61***	201.31*	926.30***
	(292.37)	(92.31)	(273.15)
Construction Emply Share	2923.38***	1834.75***	1088.63**
	(464.54)	(207.64)	(345.01)
Services Emply Share	-1127.92***	-499.66***	-628.27**
	(218.73)	(78.55)	(191.53)
R-squared	0.300	0.371	0.370
N	201,227	201,227	201,227

Notes: * $p<0.05$, ** $p<0.01$, *** $p<0.001$. Robust standard errors clustered by county are in parentheses. All regressions include county and year fixed effects. O&G Growth counties are counties that had an increase in production over the 2000–2014 period.

Table A4: Marginal Propensity to Consume from Debt: OLS

	Δ Consumer Total	Δ Auto Debt	Δ Consumer Finance
Δ Wages	0.05***	0.01***	0.04***
	(0.00)	(0.00)	(0.00)
Credit Score	7.04***	2.33***	4.71***
	(0.38)	(0.15)	(0.34)
Net Migration Rate	-485.76*	-231.91**	-253.85
	(261.94)	(93.17)	(247.05)
Mining Emply Share	74.60	73.54*	1.07
	(52.40)	(41.52)	(39.18)
Manufacturing Emply Share	6.60	20.21	-13.60
	(38.41)	(15.36)	(34.90)
Construction Emply Share	-1.67	-5.20	3.53
	(72.29)	(30.90)	(65.05)
Services Emply Share	43.61	11.25	32.36
	(34.59)	(18.57)	(25.71)
R-squared	0.020	0.035	0.009
N	198,175	198,175	198,175

Notes: * $p<0.10$, ** $p<0.05$, *** $p<0.01$. Robust standard errors clustered by county are in parentheses. All regressions include year fixed effects.

Table A5: First Stage Results: Previously Developed vs. Undeveloped

	Previously Developed Δ Wages	Previously Undeveloped Δ Wages
Δ Wells	264.11***	136.58
	(51.76)	(130.26)
Depth (10,000 ft.)	63.04***	135.53***
	(10.95)	(37.48)
Credit Score	11.41***	14.89***
	(0.89)	(0.94)
Net Migration Rate	1969.83***	2833.70***
	(702.69)	(429.34)
Mining Emply Share	255.76	387.22***
	(168.04)	(68.76)
Manufacturing Emply Share	-378.70***	-365.11***
	(131.95)	(90.40)
Construction Emply Share	583.41***	436.12*
	(183.28)	(244.94)
Services Emply Share	517.41***	184.16***
	(105.64)	(70.06)
IV-F	31.61***	6.54***
R-squared	0.016	0.022
N	50,972	74,072

Notes: * p<0.10, ** p<0.05, *** p<0.01. Robust standard errors clustered by county are in parentheses. All regressions include year fixed effects.