Shale Shocked:

The Long Run Effect of Income on Household Debt*

J. Anthony Cookson, Leeds School of Business, University of Colorado at Boulder,

Erik P. Gilje, The Wharton School, University of Pennsylvania and NBER,

Rawley Z. Heimer, Carroll School of Management, Boston College

Abstract

We study the long-run effect of non-labor income shocks on household debt. Specifically, we focus on how $14.6 Billion in oil and gas shale royalty payments over 11 years affect the balance sheets of 404,937 consumers. We find that initially-subprime consumers decrease their credit utilization by paying down pre-existing revolving debts, whereas prime consumers increase their mortgage and auto debts. Overall, household balance sheets become less risky (measured by credit scores), even though near-prime consumers have increases in delinquent and derogatory accounts. The results are similar for consumers that reside inside or outside shale areas, which suggests that the agglomeration effect on local economies cannot explain the results. Our findings highlight the role of heterogeneity in household balance sheets when considering how positive economic shocks affect future debt levels.

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1 Introduction

Household debt plays a crucial role in driving key macroeconomic outcomes, such as business cycles. In particular, the growth of household debt predicts economic slowdowns in many countries around the world (Mian, Sufi, and Verner (2017)). Yet, the literature in financial economics does not have a clear understanding for what precipitates increased debt accumulation for households. Prior research debates whether household debt accumulation is the result of shocks to credit supply (Mian and Sufi (2011); Di Maggio and Kermani (2017)) or demand-side shocks, such as optimistic beliefs about future asset prices (Bailey et al. (2018)). In this paper, we construct a new data set of oil and gas royalty payments to individuals to study how unexpected income shocks affect household borrowing choices in the long-run and how these borrowing decisions affect the riskiness of household balance sheets.

Our analysis is motivated by recent theoretical research that seeks to explain the cyclical nature of aggregate debt. In these theories, a precipitating event makes some economic agents optimistic about future cash flows (e.g., Minsky (1977)). Such optimism results in a positive shock to credit-demand because some agents over-extrapolate the value or duration of the shock (e.g., Fuster, Laibson, and Mendel (2010); Bordalo, Gennaioli, and Shleifer (2018)). These agents then struggle to repay their debts and some default, which can cause economic slowdowns through a variety of mechanisms.[1] Moreover, these theories are appealing because of their micro-foundations. Much psychological and empirical research finds that people form forecasts that are excessively influenced by recent events (e.g., Tversky and Kahneman (1983); Malmendier and Nagel (2011); Landier, Ma, and Thesmar (2017); Kuchler and Zafar (2018)).

Despite compelling micro-evidence of extrapolative beliefs, there are few empirical studies that contain well-identified precipitating shocks with which to link to debt accumulation. For example, accounts of the recent financial crisis are complicated by the dual occurrence of relaxed credit constraints (Favara and Imbs (2015)) and the growth of housing market speculation (Chinco and Mayer (2015)). Therefore, it is essential to identify economic shocks that are not correlated with

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[1]For example, when households have "too much" debt, it can slow key macroeconomic inputs, such as investment (Melzer (2017)), consumption (Mian, Rao, and Sufi (2013)), and labor supply (Bernstein (2016)).

other macroeconomic factors, because the relation between the shocks and debt could be caused by factors such as credit supply expansions. Furthermore, estimates of economic shocks on household debt usage could depend on the state of household balance sheets. To capture the effects of such heterogeneity we would need to know precisely who experiences such shocks, whereas prior studies tend to rely on aggregate sources of variation (e.g., the ZIP code-level variation in Mian and Sufi (2009)).

We focus on an empirical setting that allows us to make significant progress on these empirical challenges. Specifically, we study how the debt usage and the financial risk of 404,937 individuals changes in response to $14.6 Billion in oil and gas royalty payments over 11 years for Barnett Shale mineral owners. The income shocks in our sample range from less than $1 dollar per month at the lowest to $703,030.30 dollars per month at the highest. Households that receive these shocks live in every U.S. state, and span every credit score category, including 84,073 subprime individuals. Our sample has significant overlap with demographics across the entire U.S. population. Because payments are largely driven by the price of natural gas and the number of wells drilled, these payments have many attractive features to address the most salient endogeneity issues. Moreover, the historical narrative surrounding oil and gas fueled economic booms is one that suggests households over-extrapolate the persistence of such shocks. The well-known phrase, "Please, God, send me one more oil boom. This time, I promise not to piss it away," suggests that many households in the past have mistakenly expected incomes from oil and gas booms to be more persistent than they end up being.

We start by testing how the royalty payments affect different types of debt usage for consumers with different initial household balance sheet conditions. Initially-subprime individuals begin the sample with nearly 50 percent utilization of their revolving balances, but after a decade of receiving payments, we estimate that their utilization declines by 6.9 percentage points. Initially-subprime individuals also reduce their mortgage balances slightly, and exhibit a reduction of 3.35 percentage points in their debt-to-income ratio. By contrast, initially prime credit consumers *increase* their revolving balances by 25 percent. Prime consumers also increase their use of installment credit. Their mortgage balances increase by 6.5 percent and their automobile loans are 2 percent larger. The behavior of prime credit individuals is consistent with them using debt markets as a complement to consumption. These differential credit behaviors have important consequences. Receiv-

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ing mineral rights payments more than halves the likelihood that a subprime individual would fail to qualify for a mortgage based on debt-to-income (Qualifying Mortgage threshold (DTI>43%)), but it increases the likelihood that an initially prime credit individual would fail to qualify for a mortgage on the basis of debt-to-income.

Next, we examine how the changes in debt usage we document affect levels of risk on consumer balance sheets. Studying the riskiness of household balance sheets is important because it can affect the willingness of lenders to extend credit to households, which can itself slow consumption and investment. For example, lenders would be more reluctant to provide mortgage loans to consumers who are at greater risk of default. We study consumer's financial risk in two ways. First, we test for the incidence of payment delinquencies and derogatory accounts. We find that subprime consumers lower their delinquency rates – the fraction of credit accounts that are at least 90 days past due falls by 44 percent. Similarly, the fraction of severe derogatory accounts falls by 13 percent for subprime consumers. On the other hand, consumers who initially have medium creditworthiness – those with credit scores between 620 and 720 – have marked increases in delinquent and derogatory accounts. The fraction of accounts at least 90 days past due increases by 63 percent and the fraction of severe derogatory accounts increases by 16 percent. Prime consumers also increase their incidence of delinquent and derogatory accounts, but the effects are not as large and in some cases statistically insignificant.

Second, we measure the effect of royalty payments on consumer credit scores, which the credit bureaus use to measure consumers' implied probability of default. We find that individuals who receive royalty payments experience significant improvements in credit scores. Specifically, credit scores of individuals who receive royalty income shocks increase 10 points on average. This increase is economically meaningful, and is similar to effects identified by Dobbie, Goldsmith-Pinkham, and Yang (2017) and Brown, Cookson, and Heimer (2018).[2] Individuals who had subprime credit prior to receiving royalty payments benefit the most, with a 15 to 18 point increase in credit scores. Medium creditworthiness consumers improve their credit scores by between 10 and 15 points. Contrasting with the results on delinquencies, the financial health benefits to medium creditworthiness consumers offset the negative effects of the increase in delinquent and deroga-

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[2]In the context of Native American reservations Brown, Cookson, and Heimer (2018) find that an increase of this magnitude results in a decrease in the cost of mortgage financing of 5.1%.

tory accounts. This evidence suggests that, despite the financial mistakes and consumption effects noted in the literature, non-labor cash transfers could result in economically large reductions in the financial risk of households.

How much do payment sizes matter to household financial risk? We find that even relatively small payment sizes have large effects on consumer default risk, and that the effect of payments levels out in the $20,000 to $50,000 aggregate payment range. Specifically, we find that payments of over $1 million do not result in any increase in credit scores, relative to payments in the $20,000 range. We obtain similar results looking at both Barnett shale residents and non-Barnett residents. The implication of these findings is that individuals benefit from significant improvement even from relatively small increases in cash transfers of $20,000 over 11 years or $151/month on average.

Finally, we consider the mechanisms through which the royalty payments affect consumer debt usage. Specifically, we can test for the effects of the royalty payments for those living in the Barnett Shale and for those who live elsewhere. According to theories of agglomeration economies (e.g., Glaeser (2010)), the concentration or clustering of economic activity brings about reductions in costs of producing goods. Thus, from this perspective, the benefits of the royalty payments should be even larger for those residing in the Barnett Shale, because the Shale boom affected economic opportunities throughout the local region. However, we do not find significant differences between the outcomes for those receiving royalty payments inside versus outside the Barnett Shale. We can therefore attribute most of our findings to individualistic debt decision-making, rather than decision-making spurred by changes to the broader economy.

Our primary contribution is to provide novel evidence on how income shocks affect the level of household debt over the long-run. Prior work has shown that high levels of household debt place important constraints on real outcomes and the macroeconomy (Mian, Rao, and Sufi (2013); Favara and Imbs (2015); Bernstein (2016); Melzer (2017)). At the same time, a complete understanding of what determines household debt levels has remained elusive. Existing work has identified the role of increased credit supply (Mian and Sufi (2011); Di Maggio and Kermani (2017)) or, on the demand-side, beliefs about future prices (Bailey et al. (2018)) in driving household debt levels. Relative to this literature, we provide a systematic investigation of how personal incomes affect household borrowing choices in the long-run and how these borrowing decisions affect the riskiness of household balance sheets.

We also furnish new evidence on the long-run effects of non-labor incomes on household outcomes. For the most part, this literature draws on evidence from two settings: lottery winners in Sweden and recipients of payments from the Alaska Permanent Fund. Lottery winners in Sweden report higher subjective well-being decades after winning, have reduced labor earnings, and increase their stock market participation rates (Briggs et al. (2015); Cesarini et al. (2017); Lindqvist, Östling, and Cesarini (2018)). However, Swedish lottery winners do not experience improved health and their children do not have improved developmental outcomes (Cesarini et al. (2016)). Anticipated cash transfers from the Alaska Permanent Fund leads to increased consumption by high-income households, but does not significantly decrease aggregate employment (Kueng (Forthcoming); Jones and Marinescu (2018)).[3] We differ from these studies in the following ways. The royalty payments in our sample are frequent, long-lasting, and large for a significant number of individuals in our sample, whereas the Swedish lottery winners receive a one-time wealth shock and the payments distributed by the Alaska Permanent Fund average less than $2,000 per person per year. Furthermore, we exploit the substantial heterogeneity in financial conditions of households at the time that they begin to receive royalty payments. To our knowledge, we are also the first in this literature to study the long-run effects of non-labor income on credit market outcomes.

A much lengthier literature studies individuals' near-term response to expected and unexpected income shocks. Many papers in this area attempt to estimate a marginal propensity to consume out of income. These studies rely on a variety of natural experiments including government shutdowns (Baker and Yannelis (2017)), mortgage payment resets (Di Maggio et al. (2017); Jørring (2017)), tax refunds and stimulus checks (Johnson, Parker, and Souleles (2006); Baugh et al. (2014)), and lottery windfalls (Kuhn et al. (2011)).[4] Other papers specifically study how unanticipated income shocks affect household borrowing (Agarwal, Liu, and Souleles (2007); Agarwal and Qian (2014)). In contrast to our work, these other papers study the short-term rather than long-run effects on debt usage, they study income shocks that are one-time payments rather than recurring, and the payments they study are much smaller, and have less variation, than our royalty payments. Additional papers study the joint effect of income shocks on consumption and debt (e.g., Aaronson,

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[3]Early research finds no effect of the Alaska Permanent Fund on consumption (Hsieh (2003)). However, Kueng (Forthcoming) uses new transaction-level data from a personal finance website to update this finding.

[4]Some papers study the effect of cash transfers to households in developing countries. For example, Haushofer and Shapiro (2016) find that unconditional cash transfers to poor households in rural Kenya lead to increased consumption and higher subjective well-being.

Agarwal, and French (2012); Baker (2018)), while related research extends these settings to consider the effect on neighboring households that do not receive income shocks (Agarwal, Mikhed, and Scholnick (2018)). We differ from these near-term studies in that we focus on long run consequences. In this way, our analysis extends the current literature by showing the degree to which the benefits of income shocks persist beyond shorter horizons.

Our paper also contributes to an emerging literature on the determinants of household's financial risk. This literature contains mixed evidence on the effectiveness of various policies on the financial health of households. For example, exposure to financial institutions at a young age leads to long-lasting improvements in debt management and financial health (Brown, Cookson, and Heimer (2018)). Credit counseling, credit monitoring, and restrictions on payday lending can all improve credit outcomes (e.g., Roll and Moulton (2016); Blascak et al. (2016); Baugh (2017)), as can repayment reminders targeted to borrowers (Bracha and Meier (2014); Bursztyn et al. (forthcoming)). On the other hand, financial literacy programs are found to have had only modest and short-lived effects on financial well-being (e.g., Brown et al. (2016); Fernandes, Lynch, and Netemeyer (2014)). Related to this literature, some papers study the determinants of consumer credit access and the subsequent effects on financial well-being. Important determinants of credit access include the political economy (Akey, Heimer, and Lewellen (2017); Akey et al. (2018)), as well as debt collection and bankruptcy protection laws (Fedaseyeu (2013); Severino and Brown (2017)). More closely related to our study, Brown (2018) and Haughwout et al. (2016) examine the local effects of the oil and gas boom in the U.S. on consumer debt accumulation and financial distress, respectively. These studies use the FRBNY - CCP/Equifax panel data set to measure credit outcomes. However, these studies rely on local aggregates, rather than trace out the effects of royalty payments to individuals. As such, our paper builds on these studies by highlighting the role of ex-ante heterogeneity in households' balance sheets and by considering the effects on non-local beneficiaries of the Shale boom.

Our paper also relates to a growing literature on the economic effects of shale development. Existing literature has documented that natural gas shale development has led to job growth (Feyrer, Mansur, and Sacerdote (2017)), lending (Gilje (Forthcoming) and Gilje, Loutskina, and Strahan (2016)), and changes in house prices (Muehlenbachs, Spiller, and Timmins (2017)). Our paper is

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the first paper to use individual level monthly oil and gas royalty payments to trace out the effects of shale development on household outcomes.

2 Data and Institutional Setting

The analysis uses several data sets that are novel to the literature. Below we outline the data and its construction.

2.1 Oil and Gas Lease and Royalty Data

When an oil and gas firm decides to drill and develop an oil and gas reservoir, it must first negotiate a contract, often with a private individual for the right to do so. These are the individuals in our sample. Contracts to develop oil and gas compensate a mineral owner on two different dimensions. First, prior to any extraction, a mineral owner will receive an upfront bonus payment, which will typically be a dollar per acre value. For example, a person receiving a $5,000 per acre bonus that owns 10 net mineral acres would receive a check for $50,000. Second, once extraction commences, individuals receive a royalty stream based on their share in a well. In our sample royalty percentages range from 12.5% to 30%, with 18.75% being the most common. An individual's dollar royalty payment is also scaled by their interest percentage in a drilling unit. Royalties are computed based on gross revenues, and no costs can legally be deducted from the gross revenue. For example, if a well generates gross revenue of $10,000 in a month, and an individual owns 10 net mineral acres at a 20% royalty on a 400 acre drilling unit, that individual would receive a check for $10,000*10/400*20% = $50 for that month.

Accurate data on payments that individuals receive is exceedingly difficult to obtain and compute. In all states except Texas, royalty ownership interests in wells are held by private companies and not released to the public. Public county court records can be used to compute ownership percentages, but this often requires manually searching county indices and filings, and oil and gas firms typically pay an average of $50,000 per well to compile accurate royalty owner information from these public records. To put this in perspective, the number of wells in our sample is 7,041. Fortunately, in the state of Texas, producing royalty interests are required to pay property tax, unlike other states. Texas requires all oil and gas firms to turn over their so-called "pay decks" with detailed

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well-by-well ownership interest information to the state. This royalty interest information is then used to compute an ownership value based on the production profile of each well. Because property tax information is public information in the state of Texas, one can conduct open record requests to obtain the detailed title and ownership information that private firms paid millions of dollars to construct. Appendix Figure 9 provides an example of the raw mineral appraisal rolls which are used in this study. The data is often provided in PDF format, and requires substantial data manipulation to translate the data into a format conducive to analysis. In our study we focused on compiling mineral appraisal roll data for the four main producing counties in the Barnett Shale going back to the year 2000.

Mineral roll appraisal data is highly attractive to work with because the address provided on the rolls is the address at which people receive their tax bills. This accurate address is very important for ensuring a high quality merge with credit bureau data. However, it is not enough to simply know a persons name, address, and well ownership percentage. One must match these percentages with well production and natural gas pricing. For each well in our sample, we compile monthly production data from the oil and gas regulatory body in Texas, the Texas Railroad Commission. We then multiply production by prevailing spot natural gas prices reported by the U.S. energy information administration for a given month, this computation gives us the total gross revenue of a well, which is sufficient to calculate the amount of each individual check.

In our sample, royalty payments from production account for 60% of total payments. The remaining payments are the bonus payments that mineral owners received at the time a lease was signed. To compute this, we conducted public record requests for all oil and gas leases from the four counties in our study, as well as county indexes. The lease bonus payment in many cases is not reported on a lease because it is not required to be. However, some leases do have this information, as well as net acreage amounts. Based on the leases that do have lease bonus information we estimate a regression which attempts to predict the dollar per acre amount a lease bonus is based on time fixed effects, county fixed effects, and operator fixed effects. The R-squared we obtain from the regression is 0.82. We then use this predicted amount to estimate the lease bonus amounts for the rest of our sample for which we do not have this information. An example of a lease in our sample is provided in Appendix Exhibit 10.

Once we have computed lease bonus payments and royalty payments for the sample, we then merge the royalty payment data and the lease bonus payment data to obtain our overall payment amounts. The first panel in Table 1 provides and overview of the distribution of payments. Overall the payment someone receives is a function of prevailing natural gas prices, the amount of net mineral acreage they own, and the amount of natural gas produced on their mineral acreage. The high correlation between monthly payments and natural gas prices can be seen in Figure 1, which plots the aggregate monthly payments in our sample versus the prices of natural gas. For our sample we compute the monthly correlation of payments and natural gas prices to be 0.61.

2.2 Barnett Shale Overview

The focus of our study is the sample of oil and gas mineral owners who own minerals in the Barnett Shale from 2005 through 2015. The Barnett Shale was the first shale gas development in the United States. Shale gas had historically been uneconomic to drill and develop. However, the combination of horizontal drilling with hydraulic fracturing ("fracking"), by Devon Energy and George Mitchell, led to a technological breakthrough which allowed vast new quantities of natural gas to be developed. According the U.S. Energy Information administration shale gas production was less than 1% of total U.S. natural gas production in the year 2000, but by 2015 accounted for 46.2% of total U.S. gas production. Moreover, the Barnett shale was the first, and among the most prolific shale development in the United States, and the four Barnett Shale counties we focus on in our study accounted for 17.3% of total U.S. shale gas production when production from the shale field peaked in 2012. Figure 2 plots the number of Barnett Shale wells over time. There is a 14-fold increase in shale wells during the time period of our study. We start in 2005 largely because that is towards the beginning of the shale discovery (only 6.7% of our mineral owners were getting any payments at that time) and it is the first time period which high quality credit bureau data was available to us. To provide a spatial perspective of the development over the Barnett over time, we plot shale well development over different years on a map in Figure 3. As can be seen, there is a high degree of spatial heterogeneity that existed over time, as development ramped up.

The development of the Barnett Shale offers several attractive features. First, because shale development was unexpected by the industry (Chevron CEO quote here), mineral ownership in the Barnett Shale represented a deep out of the money option, which had minimal value until there was a

technological breakthrough. For those fortunate to own minerals, which typically occurred through family ancestry, the shale breakthrough led to the deep out of the money option becoming a vary valuable cash flow stream when natural gas was drilled. Therefore, while people that own minerals are certainly different than the average credit profile in the U.S., the shock they experience "within" person was due to an exogenous technological breakthrough over which they had not control.

2.3 Royalty Owners vs. Average Household Nationally

A question central to the identification we use in our study is why some people own mineral royalties while others do not. The National Association of Royalty Owners estimates that 12 million people in the United States own oil and gas minerals. Mineral interests can be associated with real estate ownership, but often is not. In many instances mineral interests are severed from surface rights, and retained by the initial family ancestry that settled an area. Because undeveloped minerals represent a deep out of the money option, little value is ascribed to minerals until there is drilling activity. Therefore it is common in surface real estate transactions for minerals to be severed as buyers, especially in areas with shale, as no development was expected, would pay little extra to own the minerals and surface.

Figure 4 plots the locations of mineral owners in our sample. These individuals live in all 50 states, the District of Columbia, and three U.S. territories. In total, 16.6% of the royalty payments in our sample are received by people that do not live in the four Barnett Shale counties of our study. The state in our sample with the second highest gross mineral payments is California, consistent with the mass migration patterns of Texans during the Dust Bowl. In most instances, mineral interests can be traced back generations, as families pass down deep out of the money options. Later in our study, we undertake a series of tests to document that our main results are robust to focusing only on treated individuals (individuals with same net mineral acreage plots, but some that receive large payments due to more prolific wells and some who receive small payments due to less prolific wells). The purpose of this section is to document, that while mineral owners may be different than the U.S. population on average, there is significant overlap of our sample with key parts of the overall U.S. distribution of borrowers. For this, we will compare our sample of oil and gas royalty owners to a random sample of U.S. borrowers provided by Experian.

As Figure 5 shows, our sample has 84,073 people that are subprime. Our sample has a significant number of observations in each credit category. Table 1 reports detailed summary statistics on the distribution of payments in the sample and credit characteristics of the individuals in our sample.

2.4   Experian Data Overview

From the raw data we compiled, we identified approximately 500,000 mineral rights owners, and computed a monthly panel data set of the payments received by rights owners from 2000 onward. We contracted with Experian to merge the mineral rights data with individual-level credit bureau data.[5] We provided information on payments, names and addresses, and Experian conducted the merge on name and address. In addition, Experian provided us with two control samples, (i) a sample matched on the geography and age distribution of our Experian records, and (ii) a nationally representative sample. The merge with credit bureau data returned an 80 percent hit rate, leaving us with approximately 404,000 consumers who received mineral rights payments. Each of our control samples has approximately 300,000 individuals, leaving us with approximately one million credit histories.

We observe an annual snapshot of credit bureau characteristics (credit score, estimated personal incomes modeled using actual W2 statements form the IRS, an internal debt-to-income measure, plus 250 credit attributes). Our primary outcome variables are the total amounts of debt usage across different product categories (e.g., unsecured credit lines, auto loans, and mortgage debt), as well as measures of the financial risk on consumer balance sheets (e.g., delinquencies and credit scores). Because our focus is on long run outcomes in this study, we restrict attention to two snapshots of the data – year 2005 and year 2015.

For our main tests, it will be useful to contrast individuals who receive mineral rights payments to those in our control samples. To ensure covariate balance, we refine the geography-age matching provided by Experian with a propensity score matching procedure in which we match on initial credit score in 2005 and length of credit history. We select controls with replacement and we restrict matched controls to be individuals who live in the same three digit zip as the mineral owner. Table 2 reports how the treatment (mineral owner) sample compares to the matched (control)

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sample. Across a wide range of 2005 characteristics, the propensity score matching procedure does well, even for credit characteristics that were not targeted in the matching procedure (e.g., mortgage and credit card balances).

3   Conceptual Framework

Our analysis is guided by canonical theories of intertemporal consumption choice. In this framework, consumers have preferences over initial and future consumption given by

$$u_i\left(c_{0i}\right) + \delta \cdot E_i\left[u\left(c_{1i}\right)\right] \tag{1}$$

where c_{0i} is consumption at time 0, the discount factor δ is less than 1, and E_i is the expectations of individual i. The agents' utility function $u_i\left(\cdot\right)$ is an increasing and concave function. Assuming that consumers can borrow or lend at the real interest rate R, we obtain the well-known Euler equation for consumption:

$$u'\left(c_{0i}\right) = \delta^{-1} \cdot E_i\left[R \cdot u'\left(c_{1i}\right)\right]. \tag{2}$$

Assuming that the interest rate is constant and equal to the discount factor, the marginal utility of consumption is a martingale:

$$E_i\left[u'\left(c_{1i}\right)\right] = u'\left(c_{0i}\right). \tag{3}$$

3.1   Income shocks and expectations

How do income shocks affect changes in consumption? Well-known theoretical results, summarized by Jappelli and Pistaferri (2010), distinguish between anticipated and unanticipated income shocks. If income changes are predictable, then (theoretically) no known variables in periods $t-1-j$ would predict changes in consumption in period t, for all $j \geq 0$.

On the other hand, theory suggests that consumption responds to *unpredictable* income shocks and that the magnitude of consumption changes depend on expectations about the persistence of the income process, ρ. Permanent income shocks lead to large increase in consumption, whereas transitory shocks lead to small consumption revisions. However, the expected income process is, for the

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most part, unobservable to the econometrician, because it depends on the expected lifetime of future income shocks, which are unobservable at time t. Hence, Jappelli and Pistaferri (2010) propose the following general expression for consumption growth, that can be estimated in reduced form:

$$\triangle ln\, c_{it} = z_{it}\lambda + \alpha E_{t-1}\triangle ln\, y_{it} + \sum_{k=1}^{K} \phi^k \pi_{it}^k + \zeta_{it} \tag{4}$$

where z_{it} measures exogenous consumption preferences (e.g., the consumer's age), ϕ^k measures the effect of innovations to the k-th income component, and ζ_{it} is the error term. We can consider $\sum_{k=1}^{K} \phi^k \pi_{it}^k + \zeta_{it}$ to be a composite error term, which would be the residual of an OLS regression.

Our setting is conducive to estimating equation 3.1 because of the nature of the income shocks. The income streams from the royalty payments would have been unanticipated by most households, because new drilling technologies allowed for renewed oil and gas exploration in the Barnett Shale. We also require estimates of the perceived persistence of the income shocks. For this, we can consider the historical narrative surrounding oil and gas booms in Texas. Such booms have been perceived to bring initial prosperity, but much economic distress in their wake. This pattern has inspired a phrase well-known to residents of resource-dependent areas, "Please, God, send me one more oil boom. This time, I promise not to piss it away." This suggests that many households (mistakenly) expect that incomes from oil and gas booms are highly persistent. We can also infer persistence parameters from our estimates of equation 3.1, namely the coefficient estimate of α. A larger value of α would suggest that households expect income shocks to be more persistent.

3.2 Household debt

With this framework in mind, we summarize the role of debt in determining intertemporal consumption choice. As a starting point, debt factors into the agent's intertemporal budget constraint and one such example is (see e.g., Telyukova and Wright (2008)):

$$c_{0i} = y_{0i} - Rb_{0i} + b_{1i} \tag{5}$$

where b_{0i} are debts that need to be repaid in the initial period and b_{1i} are debts used to finance consumption in $t = 1$. In such a formulation, period 0 debts are a state variable, whereas the agent

chooses c_{0i} and (or) b_{1i} in order to maximize their utility. In its most basic form, debt is used to smooth consumption between periods. It is also clear from equation 5 that initial debts dampen consumption responses to income shocks, because the additive effect of such debts are equivalent to making an income shock smaller by the amount of the initial debts $(y_{0i} - Rb_{0i})$. Some theories also introduce default costs on debt. For example, Bailey et al. (2018) impose a debt default penalty, which makes debt more costly to hold and makes consumers have to decide if and when to default.

While our goal is not to test any particular theory, equation 4 and these theories of debt usage motivate our more general empirical tests. In particular, we expect royalty payments to have effects on consumption and debt, and we can estimate these effects using the following equations:

$$\triangle ln \, c_{it} = \lambda_1 + \beta_{1,1} \triangle ln \, y_{it} + \varepsilon_{1,it}$$
$$\triangle ln \, b_{it} = \lambda_2 + \beta_{2,1} \triangle ln \, y_{it} + \varepsilon_{2,it} \qquad (6)$$

We highlight the following ingredients: (1) these income shocks were unanticipated by households and consequently, we expect to find positive effects on consumption and debt usage; (2) there is heterogeneity in consumers' initial debt burden, which would diminish the positive consumption response and instead lead to debt repayment; and (3) optimism about the persistence of the income shock would lead to larger debt consumption.

4   Results on Household Debt Usage

In this section, we provide evidence on how consumers affected by the mineral payments shock change their debt usage behavior. Specifically, we examine how consumers' use of revolving credit, mortgage instruments, and total debt-to-income change after receiving mineral rights payments.

4.1   Revolving Credit

We start by examining the effects of income on revolving credit balances, because many consumers use revolving credit card accounts to pay monthly expenses. At the same time, revolving credit with high interest rates presents a significant challenge for constrained borrowers who carry a credit card balance from month to month.

We estimate the effect of mineral payments on revolving credit choices by estimating the following specification:

$$Rev\ Credit_{it} = \gamma + \gamma_{zt} + \beta_1 treatment_i \times post_t + \epsilon_{it}, \qquad (7)$$

where $Rev\ Credit_{it}$ is either the utilization of revolving credit (balance/limit) or the logged revolving credit balance for individual i in year t. The independent variable $treatment_i$ is an indicator for whether individual i is an individual who received a bonus payment (=1) versus an individual in the propensity-matched control sample (=0). The $post$ variable is an indicator for the post period (=1 for year 2015, =0 for year 2005), γ_i are individual fixed effects, and γ_{zt} are ZIP3-year fixed effects. To allow for local correlation in errors, we cluster standard errors by ZIP3.

The specification includes main effects for $post_i$ and $treatment_i$ when these effects are identified separately from fixed effects. The coefficient of interest is β_1, which captures how the credit balances of treated individuals changes in the long term relative to control individuals.

Panel A of Table 3 presents the results on revolving credit utilization. In the full sample, there is no significant effect of mineral payments on utilization, but there is a striking dimension of heterogeneity across initial creditworthiness. Subprime and near prime credit individuals dramatically reduce revolving credit utilization by 6.9 and 3.7 percentage points, respectively, whereas consumers with initially prime credit records increase their utilization by 2.6 percentage points. These changes to revolving credit utilization are statistically significant at the 1 percent level. As the triple interaction in columns (5) and (6) indicates, the heterogeneity of the effect of mineral payments by initial creditworthiness is statistically significant on the full sample, as well as the subsample of residents who live outside of the Barnett shale area.

Turning to magnitudes, the 6.9 percentage point effect for subprime individuals corresponds to reducing revolving utilization by greater than one-sixth of the initial revolving utilization of 48.4%. Similarly, the 2.6 percentage point increase in utilization by prime credit individuals corresponds to an 18 percent increase over the baseline utilization of 14.6%. These effects are economically meaningful and point to a sensible form of heterogeneity in the ways in which the mineral payments are used by consumers of differing creditworthiness. Subprime consumers – who have

greater benefit to paying down revolving debts – do indeed pay down debts, whereas prime credit consumers who more likely pay off revolving balances monthly do not. Indeed, the month-to-month variation among these individuals seems to represent a natural increase in consumption by these consumers.

Panel B of Table 3 presents the results of an analogous specification, which uses the logged revolving balances as the dependent variable instead. These specifications portray a similar qualitative picture to the utilization results. Mineral payments translate to significant reductions to the balances of subprime and near prime credit consumers (21.7% and 29.5%, respectively), but a significant increase for prime credit consumers. Moreover, the magnitudes of the estimates on balances are similar to those magnitudes computed from utilization, which also accounts for credit limits. The consistency of the findings across these specifications suggests that the findings are not due to changes in credit limits, but actual debt paydown and increasing consumption behavior.

4.1.1 Heterogeneity in Payments

One of the attractive features of our setting is the wide variation in payments we observe. The distribution of mineral payments ranges from small payments (less than \$5,000) to very large payments (totaling more than \$1 million over the decade). Estimating how different payment amount translate into consumer debt usage is important for understanding the degree to which we can translate the lessons from experiments of a smaller magnitude (i.e., shocks on the order of \$1,000s) to much larger scale policies.

To quantify the impact of heterogeneity in payments, we estimate a specification for credit score using the following specification.

$$
Rev\ Credit_{it} = \gamma_i + \gamma_{zt} + \gamma_{at} + \sum_{b=1}^{B} \beta_1^b pmt\_bin_i^b \times post_t + \beta_2 InitScore_i \times post + \epsilon_{it}, \quad (8)
$$

which has two notable departures from the initial difference-in-difference design: (1) we replace the treatment dummy with payment bin dummies $pmt\_bin_i^b$ to flexibly estimate the effect of payments for different payment amounts, and (2) we estimate these specifications for the treated sample only, using individuals who received very small payments ($<$\$5000) as controls within the treated sample.

This specification choice holds constant unobservable determinants of signing a mineral lease, while benchmarking the effects against individuals who receive small payments (due to drilling decisions and oil price fluctuations beyond the consumer's control). In this specification, the coefficients of interest are β_1^b, which capture the long-term effect on revolving credit usage for the payment bin b relative to individuals who receive very small payments.

In these within-treated specifications, we enrich the specification to account for important potential confounding differences that could lead to larger payments. For example, better quality individuals may own greater acreage and hence receive larger payments. We account directly for this potential mechanism by including *acreage quintile x year* fixed effects in some specifications. Beyond this direct control, we also account for initial credit quintiles interacted with *post*, as well as *income* and *age quintile x year* fixed effects.

Table 4 presents the estimation results on heterogeneity in payments, separately by initially subprime, near prime and prime credit consumers. Consistent with the broad evidence, the effects on revolving balance tend to be negative among initially subprime consumers and near prime consumers, and the effects tend to be positive for initially prime consumers. We also find that the effects are most pronounced among moderate payments and are muted for larger payments. Figure 6 presents graphs of the estimates with 90% confidence bands, which more clearly conveys the muted effect among large payments.

4.2   Mortgage Credit

We now turn to understanding the effects of mineral payments on mortgage balances and utilization of mortgage financing. Specifically, we estimate the main specification (9), but with mortgage measures as the dependent variable. Our specifications consider two complementary outcome variables – mortgage utilization (balance/limit) and the log of (one plus) mortgage balances.

Panel A of Table 5 presents the estimates for mortgage utilization. Consumers who receive mineral payments have nearly one percentage point greater utilization of mortgage credit, on average, than matched control consumers. This effect is statistically significant at the 1 percent level, and because of the size and importance of mortgage debt, one percentage point is an economically significant increase. The increase in mortgage utilization is strongest among the initially prime creditworthiness consumers, and is absent among the subsample of initially subprime consumers.

The estimate for subprime consumers is a small negative estimate that is not statistically different from zero.

Panel B of Table 5 presents the estimates for mortgage balances. Overall, consumers who receive mineral payments increase their mortgage balance by 5.9%, an effect that is statistically significant at the one percent level. Using the in-sample average mortgage balance of $134,970, the increase in mortgage balance is equivalent to an average increase of $7,963. Turning to heterogeneity, subprime consumers reduce their balances slightly (-4.25%, p-value of 0.108), whereas near prime consumers and prime consumers increase their mortgage balance in a statistically significant manner by greater than 5 percent each.

4.3 Automobile Loans

Next, we examine how mineral payments affect automobile loans. Specifically, we estimate the main specification (9), but with the log of (one plus) the consumer's auto loan limit as the dependent variable. We employ the auto loan limit as the dependent variable to more accurately measure the full size of the auto loan, which is closely related to durable goods consumption.

Table 6 presents the results from estimating the effect of mineral rights payments on auto loans. Overall, consumers who receive mineral rights payments increase their auto loan balance by approximately 1.7% relative to matched control consumers. This effect is statistically significant at the 1 percent level. Like our finding on mortgages, this effect on automobile lending is strongest among the subsample of prime creditworthiness consumers, and it is absent among subprime consumers. This finding is consistent with broad interpretation that prime consumers expand their use of debt markets to complement their consumption, whereas subprime consumers primarily pay down debts with the influx of income.

4.4 Debt-to-Income

We conclude the discussion of credit usage by analyzing how total debt-to-income responds to mineral payments. As in the mortgage credit specifications, we estimate the main specification (9), but using Experian's measure of total debt to W2 income as the outcome variable.

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Panel A of Table 7 presents our estimation results on debt-to-income overall (column 1), and split by different initial credit score bins (columns 2 through 4). Overall, individual who receive mineral payments reduce their debt-to-income ratio by 1.25 percentage points, which is a sizable effect, relative to the average debt-to-income in 2005 of 15.1%. This estimate is statistically significant at the 1 percent level, clustering standard errors at the ZIP3 level. Turning to heterogeneity, subprime consumers reduce their debt-to-income by the most – an effect of 3.4 percentage points on a base of 20.3%. Notably, both subprime and near prime credit consumers reduce debt-to-income significantly, but initially prime credit consumers do not.

To address the concern that these shifts in debt-to-income are not economically important, Panel B presents a series of specifications in which the dependent variable is an indicator for whether the debt-to-income ratio exceeds the Qualified Mortgage threshold of 43 percent. In 2005, 10.66% of subprime consumers, 6.37% of near prime credit consumers, and 1.39% of prime credit consumers had a debt-to-income ratio exceeding this threshold.

Consistent with the broad reductions in debt-to-income, mineral rights payments significantly reduce the percentage of consumers with debt-to-income that would disqualify them from receiving a mortgage. The average effect is a reduction of 1.6 percentage points in the likelihood of not qualifying for a mortgage. For subprime consumers, the effect is more than triple the average effect at 5.9 percentage points, and this reduction amounts to more than half of the subprime consumers who did not qualify for a mortgage in 2005. By contrast, receiving mineral rights payments increases the likelihood that an initially prime credit consumer exceeds the Qualified Mortgage threshold by 0.33 percentage points, which is significant compared to the baseline rate of 1.39% for prime creditworthiness consumers.

The results on the Qualified Mortgage threshold provides tangible evidence on one benefit of reducing the debt-to-income ratio, but access to mortgage financing is but one benefit from having a low debt-to-income ratio. The effects we observe for mortgages likely translate into the access to and cost of other products as well.

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5 Results on Household Financial Risk

This section presents the main results on the consequences of mineral rights payments for financial risk, which we measure using observed delinquencies, as well as Experian credit score. Beyond providing evidence on the treatment effect of mineral rights payments, we investigate natural sources of heterogeneity in initial creditworthiness, initial income, and heterogeneity in the payment amount.

5.1 Delinquencies and Derogatory Accounts

We begin our analysis of the consequences of mineral rights payments for consumer financial risk by examining the long-run impact on observed delinquencies and severe derogatory accounts. We follow the same treatment-control strategy as in our analysis of debt usage, and estimating equation 7 using the percent of accounts delinquent as the dependent variable.

Panel A of Table 8 presents the results on delinquencies in which the payment is 90 days past due. Overall, the delinquency result suggests that the mineral rights payments lead to a slight decline, on average, in the likelihood of a consumer going delinquent on an account, relative to the matched control sample. Turning to heterogeneity, the decline in the likelihood of going delinquent is concentrated among initially-subprime borrowers who nearly halve their likelihood of going delinquent. On the other hand, near prime households have a substantially *higher* propensity to have delinquent accounts if they received mineral rights payments versus matched control.

As a complement to these results on delinquencies, Panel B uses a more severe form of delinquency, an indicator for whether the consumer has at least one account that is in severe derogatory status. By this measure of household financial risk, the average effect of mineral rights payments is to increase slightly the propensity to have a severe derogatory account (by 0.4 percentage points, statistically significant at the 10 percent level). Similar to the findings on delinquencies, subprime consumers who receive mineral rights payments exhibit a strong reduction in their propensity to have a severe derogatory account relative to matched controls. Consistent with some risk of their greater consumption, near prime and prime consumers exhibit a higher likelihood of having an account in severe derogatory status.

5.2 Credit Scores

The empirical cumulative distribution functions (CDFs) in Figure 7 provide a visual depiction of the effect of mineral rights shocks on the distribution of credit scores. The figure presents the distribution function of credit scores, separately for before (year 2005) and after (year 2015) the shale payments. Consistent with the mineral rights payments translating into better financial well being throughout the distribution of credit scores, the distribution of credit scores shifts markedly to the right. In contrast, the distribution of credit scores for matched controls does not show a similar shift. In Table 9, we subject this relation between mineral payments and financial well-being to more stringent specifications that account for individual and ZIP3-year fixed effects. Specifically, the main specification for credit score, $Score_{it}$ is:

$$Score_{it} = \gamma_i + \gamma_{zt} + \beta_1 treatment_i \times post_t + \epsilon_{it}. \tag{9}$$

This specification is analogous to equation (7), but replaces the dependent variable with $Score_{it}$, which is the Experian Vantage score for individual i in year t. Mirroring our tests of debt usage, we employ individual and ZIP3-year fixed effects and cluster the standard errors by ZIP3. To consider overall and heterogeneous effects, we estimate the specification on the full sample and on sub-samples split by initial credit score (subprime, near prime and prime).

Columns (1) through (4) in Table 9 present regression estimates for the full sample, with fixed effects of increasing granularity. The coefficient estimate ranges between 8.86 and 10.03 credit score points, and is statistically significant at the 1 percent level across all specifications. These estimates represent an important average long-term improvement of credit profiles by individuals who receive payments. Brown, Cookson, and Heimer (2018) quantify the impact of an increase in the credit score of 10 points to reduce the cost of mortgage financing by approximately 5.1 percent.

Columns (4) through (8) in Table 9 present the estimates on the sub-sample of individuals who reside outside of the Barnett Shale. The estimated magnitudes are similar on this subsample (ranging from 8.9 to 12.0 credit score points), and are statistically significant at the 1 percent level across specifications. The similarity of the estimates inside and outside of the Barnett shale suggest the effects we observe are not due to shocks that hit the Barnett shale, more generally.

5.3 Heterogeneity by Initial Credit Score and Income

Next, we examine heterogeneity in the types of consumers who most benefit from the mineral rights shock. Ex ante, it is unclear whether low credit quality consumers or high credit quality consumers would benefit more from a significant income shock. From the standpoint of credit score as an indicator of quality, one might expect a smaller effect on low credit score individuals. On the other hand, to the extent that poor credit leads to a debt trap, individuals with low credit scores may gain more than high creditworthiness consumers because the mineral payments alleviate a constraint.

We examine heterogeneity by the initial credit score by estimating equation (9) separately for subprime credit (initial score < 620), near prime credit (initial score between 620 and 720), and prime credit (initial score > 720). We conduct the same exercise using data on income provided by Experian, splitting the sample into five income quintiles. Across all specifications, we include individual and ZIP3-year fixed effects, and cluster standard errors by ZIP3.

Panel A of Table 10 presents the heterogeneity in the effect by initial credit score. Consistent with the hypothesis that mineral payments alleviate consumer credit constraints, the effects are approximately twice as strong among initially subprime borrowers than borrowers with initially prime credit. Nevertheless, even among prime credit individuals, mineral payments translate into a large, statistically significant improvement to creditworthiness – treated individuals see an improvement of approximately 8 credit score points. As the specifications estimated on individuals outside of the Barnett shale indicate (even columns), this pattern holds robustly outside of the Barnett shale area.

Panel B of Table 10 presents the heterogeneity in the effect by initial income across quintiles of the 2005 income distribution. Again, consistent with constraints, the effect of mineral payments on creditworthiness is much stronger among individuals in the bottom quintile of the income distribution than it is at higher incomes. The effect monotonically decreases in income, becoming very small (1.46 credit score points) for the top quintile of the income distribution.

In Panel C of Table 10, we perform a double sort on initial income and initial creditworthiness. To simplify the exposition, we pool the bottom two quintiles into "Low Income" and pool the top two quintiles into "High Income." Using this categorization, we estimate the specification (9) with individual and ZIP3-year fixed effects separately by each combination of income (low or high) and creditworthiness (subprime, near prime, prime).

The estimates indicate that both initial creditworthiness and initial income are important dimensions of heterogeneity, but that low initial income matters more than initially subprime credit. Within credit category, the effect of mineral payments on credit scores is approximately 10 credit score points higher for low income individuals than for high income individuals. Interestingly, low initial income appears to be a pre-condition for creditworthiness (subprime versus credit) to matter. This is sensible. For an inflow of mineral rights payments to matter for creditworthiness through alleviating a constraint, the individual would need to be constrained in the first place. Put differently, for an individual who is subprime despite having high initial income, it is difficult to imagine how mineral rights payments alleviate consumer financial risk by alleviating the income constraint.

5.4 Heterogeneity in Payments

We also estimate specifications that allow the effect of mineral payments to vary by payment size. Specifically, we estimate a specification for credit score using the following specification.

$$Score_{it} = \gamma_i + \gamma_{zt} + \gamma_{at} + \sum_{b=1}^{B} \beta_1^b pmt\_bin_i^b \times post_t + \beta_2 InitScore_i \times post + \epsilon_{it}, \qquad (10)$$

which is perfectly analogous to the specification for revolving credit in equation (8). As in the previous specification, we estimate these specifications for the treated sample only, using individuals who received very small payments (<\$5000) as controls within the treated sample. The only difference is the dependent variable $Score_{it}$ – Experian Vantage Score. In this specification, the coefficients of interest are β_1^b, which capture the long-term effect on credit scores for the payment bin b relative to individuals who receive very small payments.

Table 11 presents the estimation results on heterogeneity in payments, separately by initially subprime, near prime and prime credit consumers. Consistent with the broad evidence, the effects are largest among initially subprime and near prime credit consumers. Indeed, prime credit individuals exhibit small and statistically insignificant effects across the distribution of payments. Regardless of the specification and controls, the effect of payments on creditworthiness is largest for low and moderate payments. Payments between \$5,000 and \$20,000 have a similar effect to much larger payments (e.g., \$100,000 to \$1 million), and across specifications are larger than the effect among

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individuals who receive $1 million or more in payments. Figure 8 presents these estimates visually, with 90 percent confidence bands. This finding suggests that – after a moderate shock – additional payments do not significantly translate into improvements to a consumer's creditworthiness.

6   Conclusions and Discussion

This paper provides new evidence of the long-run effects of non-labor incomes on household outcomes. We combine new data on $14.6 billion in oil and gas royalty payments over 11 years with individuals' credit reports from one of three large credit reporting agencies. These royalty payments were presumably unanticipated by households because they are the result of the fracking revolution that shocked the U.S. oil and gas industry in the mid- to late-2000s. Recipients of these royalty payments reside in all 50 states and span the range of creditworthiness prior to receiving these payments. The royalty payments vary in size from less than $1 dollar to hundreds of thousands of dollars per month. Hence, the coverage of the data, combined with the variation in the size and timing of payments provides an ideal setting to test for the credit market effects of non-labor income streams.

We find that sub-prime households use the royalty payments to pay down debt on revolving credit lines. This result suggests that household financial stresses may blunt the effects of fiscal stimulus, such as cash-transfer like tax rebates. On the other hand, those with high initial credit scores increase their demand for installment credit, such as mortgages. This implies that non-labor incomes complement the demand for credit for those that are in good financial standing. We next consider the effects of these royalty payments and the changes in debt usage on households' financial risk. We find that these royalty payments lead to large improvements in the state of the consumer balance sheets a decade after the payments commence. The financial-health improvements are largest for those that were initial sub-prime, but we observe improvements for all credit score ranges. These results suggest that unexpected incomes can lead to marked, broad reductions in financial risk. Taken together, these findings provide important new evidence on the affect income has on household balance sheets.

Our findings also provide important new evidence for policymakers considering wealth transfer programs, such as a Universal Basic Income. Other papers in the literature have studied the

long-run effects of non-labor incomes on outcomes, such as health, employment, stock market participation, and subjective well-being. Our paper is the first to study effects on consumer credit outcomes, with a particular interest in consumer debt levels and the amount of risk on household balance sheets. These credit market outcomes are just as important because they determine an individuals' borrowing costs, and they have also been linked to outcomes such as mental health, mortality, and job finding rates. Future efforts of ours will exploit this setting to study outcomes, such as employment and retirement.

References

Aaronson, D., S. Agarwal, and E. French. 2012. The spending and debt response to minimum wage hikes. *American Economic Review* 102:3111–39.

Agarwal, S., C. Liu, and N. S. Souleles. 2007. The reaction of consumer spending and debt to tax rebates – evidence from consumer credit data. *Journal of Political Economy* 115:986–1019.

Agarwal, S., V. Mikhed, and B. Scholnick. 2018. Does the relative income of peers cause financial distress? Evidence from lottery winners and neighboring bankruptcies. Working Papers 18-16, Federal Reserve Bank of Philadelphia.

Agarwal, S., and W. Qian. 2014. Consumption and debt response to unanticipated income shocks: Evidence from a natural experiment in Singapore. *American Economic Review* 104:4205–30.

Akey, P., C. Dobridge, R. Z. Heimer, and S. Lewellen. 2018. Pushing boundaries: Political redistricting and consumer credit. *Working Paper* .

Akey, P., R. Z. Heimer, and S. Lewellen. 2017. Politicizing consumer credit. *Working Paper* .

Bailey, M., E. Dávila, T. Kuchler, and J. Stroebel. 2018. House price beliefs and mortgage leverage choice. *Review of Economic Studies* forthcoming.

Baker, S. R. 2018. Debt and the response to household income shocks: Validation and application of linked financial account data. *Journal of Political Economy* 126:1504–57.

Baker, S. R., and C. Yannelis. 2017. Income changes and consumption: Evidence from the 2013 federal government shutdown. *Review of Economic Dynamics* 23:99–124.

Baugh, B. 2017. Payday borrowing and household outcomes: Evidence from a natural experiment. *Working Paper* .

Baugh, B., I. Ben-David, H. Park, and J. Parker. 2014. Disentangling financial constraints, precautionary savings, and myopia: Household behavior surrounding federal tax returns. Working Paper, National Bureau of Economic Research.

Bernstein, A. 2016. Household debt overhang and labor supply. *Working Paper* .

Blascak, N., J. Cheney, R. Hunt, V. Mikhed, D. Ritter, and M. Vogan. 2016. Identity theft as a teachable moment. *FRB of Philadelphia Working Paper* .

Bordalo, P., N. Gennaioli, and A. Shleifer. 2018. Diagnostic expectations and credit cycles. *The Journal of Finance* 73:199–227.

Bracha, A., and S. Meier. 2014. Nudging credit scores in the field: The effect of text reminders on creditworthiness in the United States. Working Papers 15-2, Federal Reserve Bank of Boston.

Briggs, J. S., D. Cesarini, E. Lindqvist, and R. Östling. 2015. Windfall gains and stock market participation. NBER Working Papers 21673, National Bureau of Economic Research.

Brown, J. P. 2018. Response of consumer debt to income shocks: The case of energy booms and busts. Working Paper 17-05, Federal Reserve Bank of Kansas City.

Brown, J. R., J. A. Cookson, and R. Heimer. 2018. Growing Up without Finance. *Journal of Financial Economics* forthcoming.

Brown, M., J. Grigsby, W. van der Klaauw, J. Wen, and B. Zafar. 2016. Financial education and the debt behavior of the young. *Review of Financial Studies* 29:2490–522.

Bursztyn, L., S. Fiorin, D. Gottlieb, and M. Kanz. forthcoming. Moral incentives in credit card debt repayment: Evidence from a field experiment. *Journal of Political Economy* .

Cesarini, D., E. Lindqvist, M. J. Notowidigdo, and R. Östling. 2017. The effect of wealth on individual and household labor supply: Evidence from Swedish lotteries. *American Economic Review* 107:3917–46.

Cesarini, D., E. Lindqvist, R. Östling, and B. Wallace. 2016. Wealth, health, and child development: Evidence from administrative data on Swedish lottery players. *The Quarterly Journal of Economics* 131:687–738.

Chinco, A., and C. Mayer. 2015. Misinformed speculators and mispricing in the housing market. *The Review of Financial Studies* 29:486–522.

Di Maggio, M., and A. Kermani. 2017. Credit-induced boom and bust. *The Review of Financial Studies* 30:3711–58.

Di Maggio, M., A. Kermani, B. J. Keys, T. Piskorski, R. Ramcharan, A. Seru, and V. Yao. 2017. Interest rate pass-through: Mortgage rates, household consumption, and voluntary deleveraging. *American Economic Review* 107:3550–88.

Dobbie, W., P. Goldsmith-Pinkham, and C. S. Yang. 2017. Consumer bankruptcy and financial health. *Review of Economics and Statistics* Forthcoming.

Favara, G., and J. Imbs. 2015. Credit supply and the price of housing. *American Economic Review* 105:958–92.

Fedaseyeu, V. 2013. Debt collection agencies and the supply of consumer credit. Working Papers 13-38, Federal Reserve Bank of Philadelphia.

Fernandes, D., J. G. J. Lynch, and R. G. Netemeyer. 2014. Financial literacy, financial education, and downstream financial behaviors. *Management Science* 60:1861–83.

Feyrer, J., E. T. Mansur, and B. Sacerdote. 2017. Geographic Dispersion of Economic Shocks: Evidence from the Fracking Revolution. *American Economic Review* 107:1313–34.

Fuster, A., D. Laibson, and B. Mendel. 2010. Natural expectations and macroeconomic fluctuations. *Journal of Economic Perspectives* 24:67–84.

Gilje, E. Forthcoming. Does local access to finance matter? evidence from u.s. oil and natural gas shale booms. *Management Science* .

Gilje, E. P., E. Loutskina, and P. E. Strahan. 2016. Exporting liquidity: Branch banking and financial integration. *Journal of Finance* 71:1159–84.

Glaeser, E. L. 2010. Introduction to" agglomeration economics". In *Agglomeration economics*, 1–14. University of Chicago Press.

Haughwout, A., D. Lee, J. Scally, and W. van der Klaauw. 2016. Hints of increased hardship in america's oil-producing counties. Working Paper, Federal Reserve Bank of New York.

Haushofer, J., and J. Shapiro. 2016. The short-term impact of unconditional cash transfers to the poor: Experimental evidence from Kenya. *The Quarterly Journal of Economics* 131:1973–2042.

Hsieh, C.-T. 2003. Do consumers react to anticipated income changes? Evidence from the Alaska Permanent Fund. *American Economic Review* 93:397–405.

Jappelli, T., and L. Pistaferri. 2010. The consumption response to income changes. *Annual Review of Economics* 2:479–506.

Johnson, D. S., J. A. Parker, and N. S. Souleles. 2006. Household expenditure and the income tax rebates of 2001. *American Economic Review* 96:1589–610.

Jones, D., and I. Marinescu. 2018. The labor market impacts of universal and permanent cash transfers: Evidence from the Alaska Permanent Fund. NBER Working Papers 24312, National Bureau of Economic Research.

Jørring, A. T. 2017. The costs of financial mistakes: Evidence from US consumers. *Working Paper* .

Kuchler, T., and B. Zafar. 2018. Personal experiences and expectations about aggregate outcomes. *Journal of Finance* forthcoming.

Kueng, L. Forthcoming. Excess sensitivity of high-income consumers. *The Quarterly Journal of Economics* .

Kuhn, P., P. Kooreman, A. Soetevent, and A. Kapteyn. 2011. The effects of lottery prizes on winners and their neighbors: Evidence from the Dutch postcode lottery. *American Economic Review* 101:2226–47.

Landier, A., Y. Ma, and D. Thesmar. 2017. New experimental evidence on expectations formation. *Working Paper* .

Lindqvist, E., R. Östling, and D. Cesarini. 2018. Long-run effects of lottery wealth on psychological well-being. Working Paper 24667, National Bureau of Economic Research.

Malmendier, U., and S. Nagel. 2011. Depression babies: Do macroeconomic experiences affect risk taking? *Quarterly Journal of Economics* 126:373–416.

Melzer, B. T. 2017. Mortgage debt overhang: Reduced investment by homeowners at risk of default. *The Journal of Finance* 72:575–612.

Mian, A., K. Rao, and A. Sufi. 2013. Household Balance Sheets, Consumption, and the Economic Slump. *Quarterly Journal of Economics* 128:1687–726.

Mian, A., and A. Sufi. 2009. The consequences of mortgage credit expansion: Evidence from the US mortgage default crisis. *The Quarterly Journal of Economics* 124:1449–96.

———. 2011. House Prices, Home Equity-Based Borrowing, and the US Household Leverage Crisis. *The American Economic Review* 101:2132–56.

Mian, A., A. Sufi, and E. Verner. 2017. Household debt and business cycles worldwide. *The Quarterly Journal of Economics* 132:1755–817.

Minsky, H. P. 1977. The Financial Instability Hypothesis: An Interpretation of Keynes and an Alternative to "Standard" Theory. *Nebraska Journal of Economics and Business* 16:5–16.

Muehlenbachs, L., E. Spiller, and C. Timmins. 2017. The Housing Market Impacts of Shale Gas Development. *American Economic Review* 105:3633–59.

Roll, S., and S. Moulton. 2016. The impact of credit counseling on consumer outcomes: Evidence from a national demonstration program. *Working Paper* .

Severino, F., and M. Brown. 2017. Personal bankruptcy protection and household debt. *Working Paper* .

Telyukova, I. A., and R. Wright. 2008. A model of money and credit, with application to the credit card debt puzzle. *The Review of Economic Studies* 75:629–47.

Tversky, A., and D. Kahneman. 1983. Extensional versus intuitive reasoning: The conjunction fallacy in probability judgment. *Psychological review* 90:293–.

Figures

Figure 1: Mineral Rights Payments versus Natural Gas Prices

Note: This figure plots the aggregate monthly payments received by minerals over time (primary y-axis), relative to the price of natural gas ($/mmbtu, secondary y-axis). The mineral payment data is computed using the payment data compiled from our study and the natural gas price data is obtained from the U.S. Energy Information Administration.
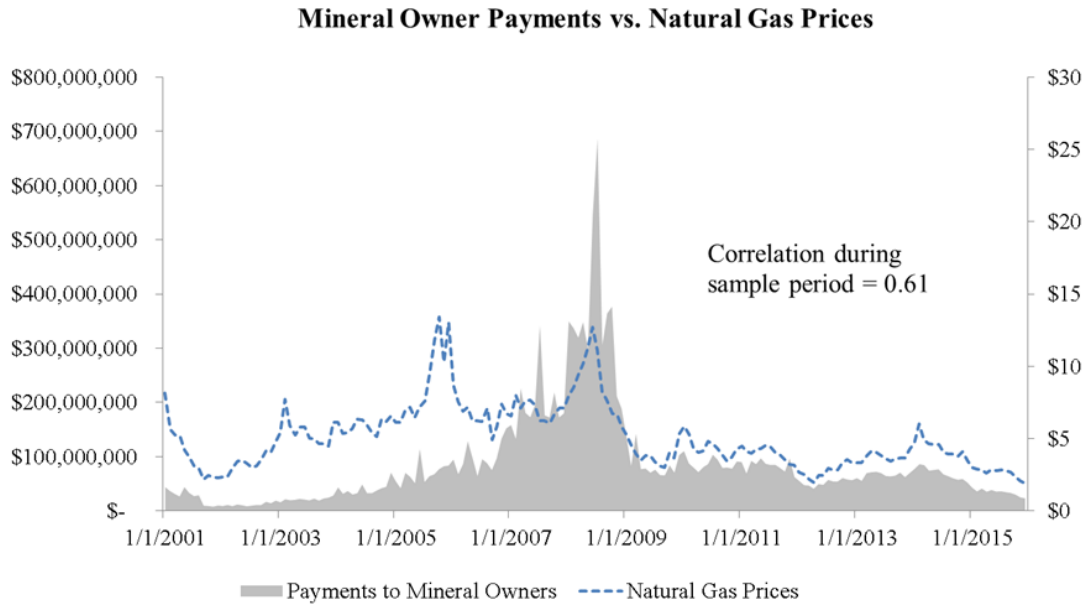

Mineral Owner Payments vs. Natural Gas Prices

Correlation during sample period = 0.61

Payments to Mineral Owners   ----Natural Gas Prices

Figure 2: Wells under Production in the Barnett Shale over Time

Note: This figure plots the number of Barnett Shale wells over time in the four counties of our study: Wise, Denton, Tarrant, and Johnson. The data on well numbers was obtained from Smith International Corporation and the Texas Railroad Commission.
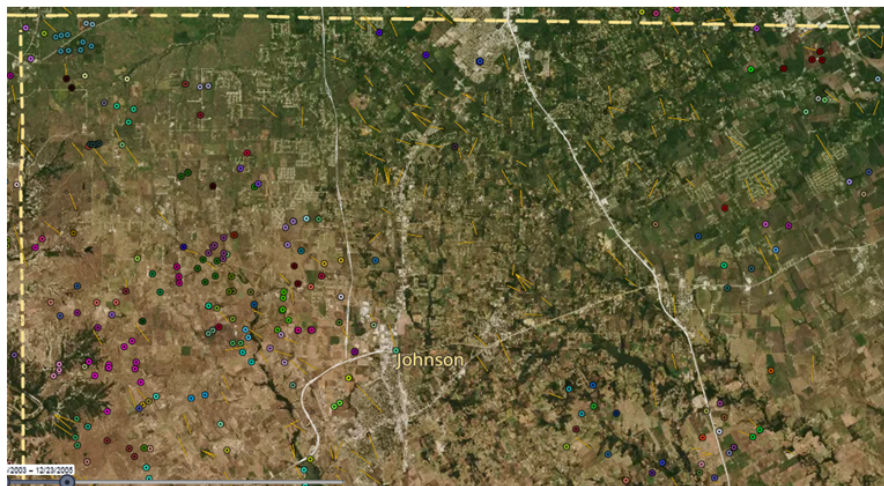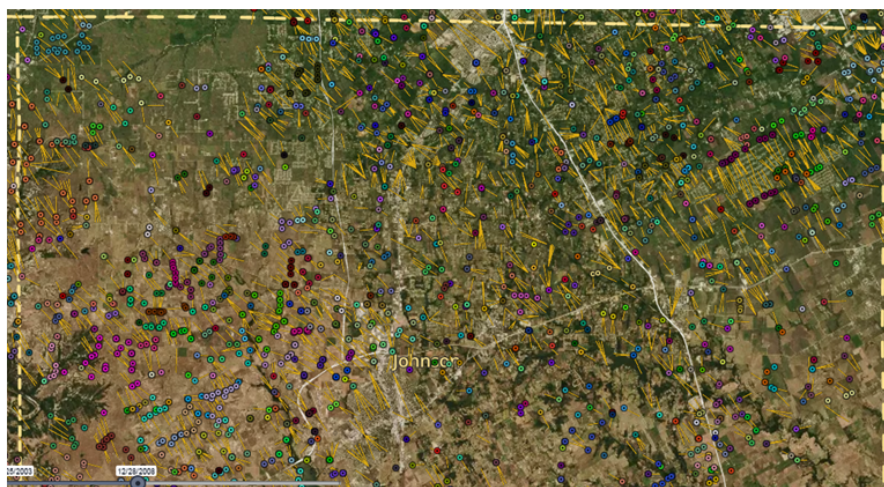

Shale Wells in Barnett Shale Over Time
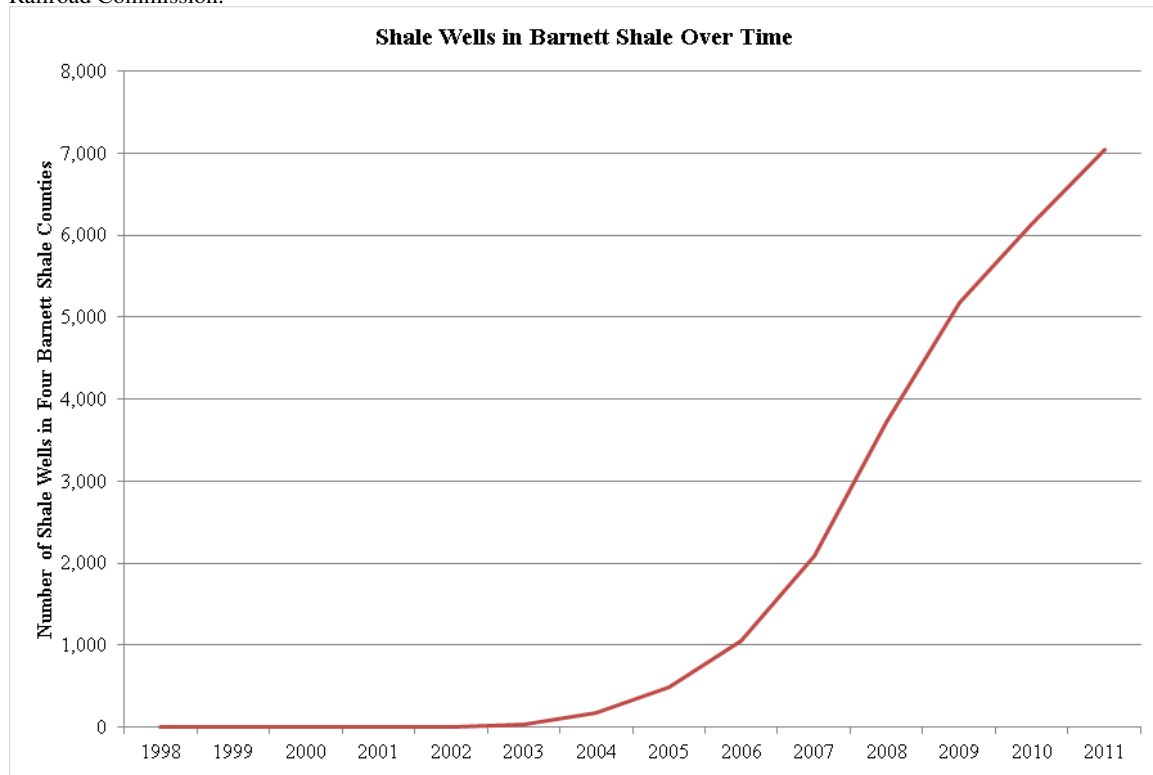
Figure 3: The Spatial Distribution of Wells (Johnson County)

Note: This figure plots a series of maps of snapshots of shale drilling activity over time. The yellow lines represent the horizontal wellbores of the Barnett Shale wells.

Johnson County, TX 2005
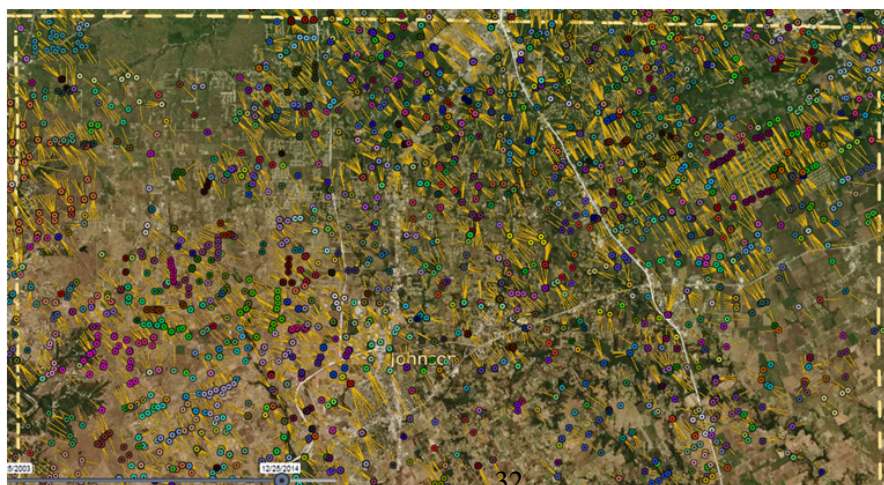

Johnson County, TX 2008

Johnson County, TX 2014

Figure 4: Locations of Individuals Receiving Mineral Rights Payments

Note: This figure plots the location of the different mineral owners in our study who own minerals in the Barnett Shale. The location data is based on the zip code that mineral owners reside at according to property tax and credit bureau records.

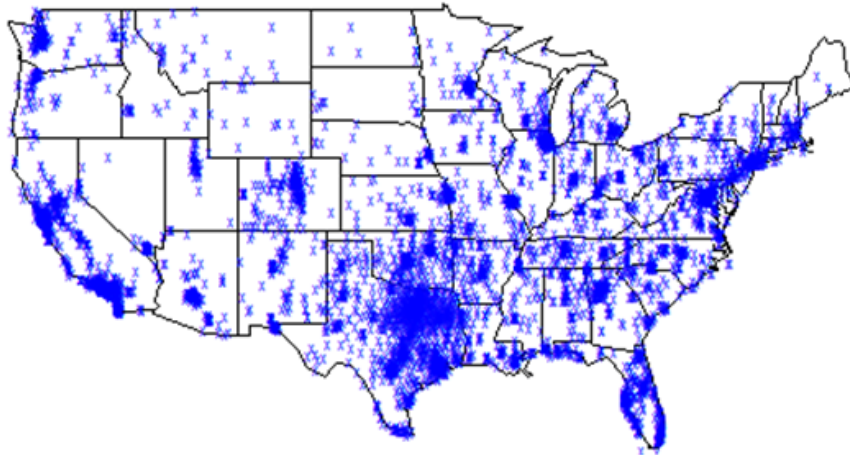## Mineral Owner
Residential Locations

Figure 5: Comparison of Mineral Rights Owners to the Nationally Representative Sample

Note: This figure plots the distribution of credit scores of the mineral owners in our sample relative to a national random sample of people in the United Stats as of 2005. The blue bars represent the national random sample and the tan bars represent the mineral owner sample. The national random sample is based on a national random sample of 259,634 people.
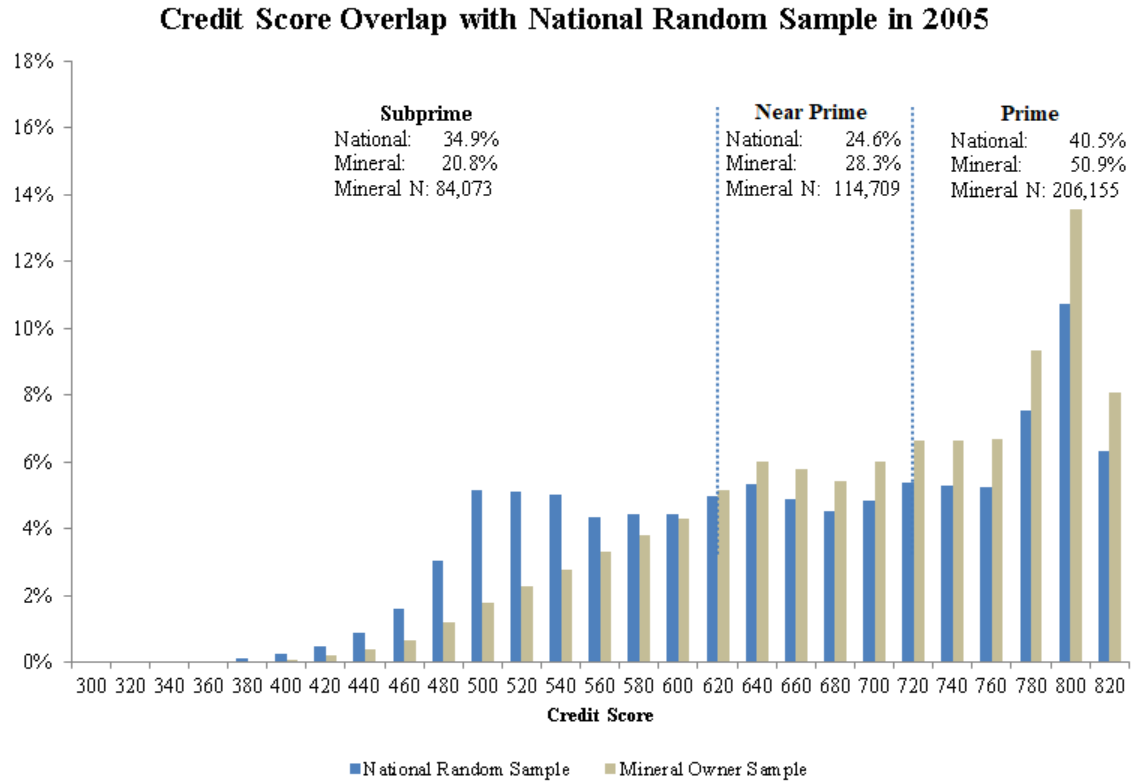
Figure 6: Long Run Effects of Income Shocks on Revolving Balances – Heterogeneous Payment Amounts, Split by Initial Credit Quality

Note: This figure presents plots of the heterogeneous effect of mineral rights payments on revolving balance using the estimates in Table 4. The dependent variable is 100 x log of (one plus) the revolving balance to admit a percentage change interpretation. The baseline category in these specifications is the set of individuals who receive small payments (below $5,000 in aggregate). The blue dashed lines are 90% error bands, standard errors clustered by ZIP3.
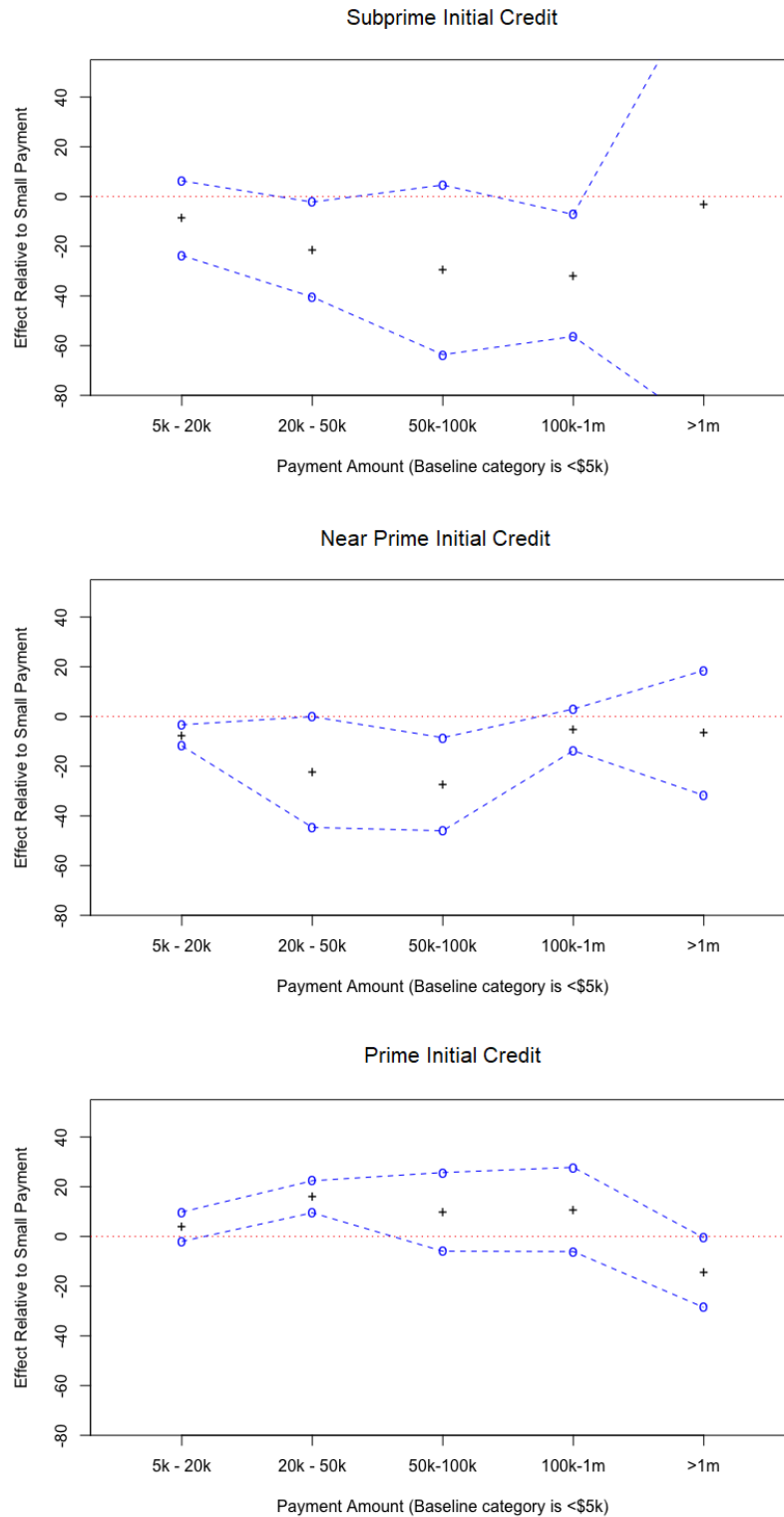
Figure 7: Cumulative Distribution of Credit Scores – Treated versus Control Sample, Before versus After Payments

Note: This figure presents plots of the empirical cumulative distribution functions for the credit score distribution in 2005 (before payments) and for the credit score distribution in 2015 (after payments), separately for the treatment sample and the propensity matched control sample. These plots provide an unconditional depiction of how the distribution of credit scores changes in the treatment and control samples.
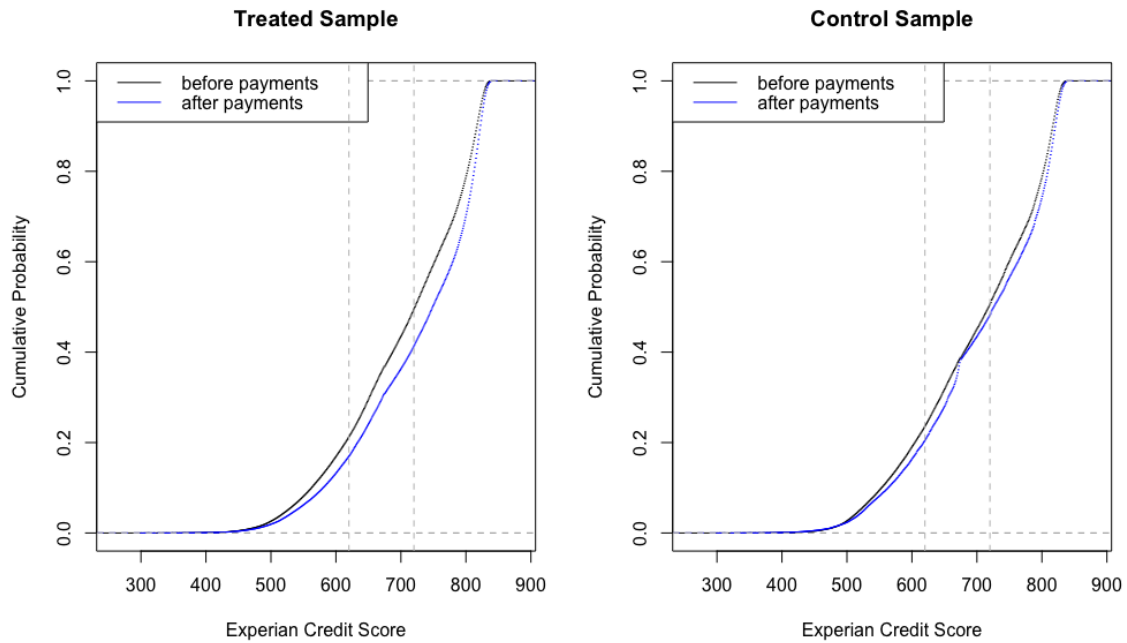
Figure 8: Long Run Effects of Income Shocks on Credit Scores – Heterogeneous Payment Amounts, Split by Initial Credit Quality

Note: This figure presents plots of the heterogeneous effect of mineral rights payments on credit score using the estimates in Table 10. The baseline category in these specifications is the set of individuals who receive small payments (below $5,000 in aggregate). The blue dashed lines are 90% error bands, standard errors clustered by ZIP3.
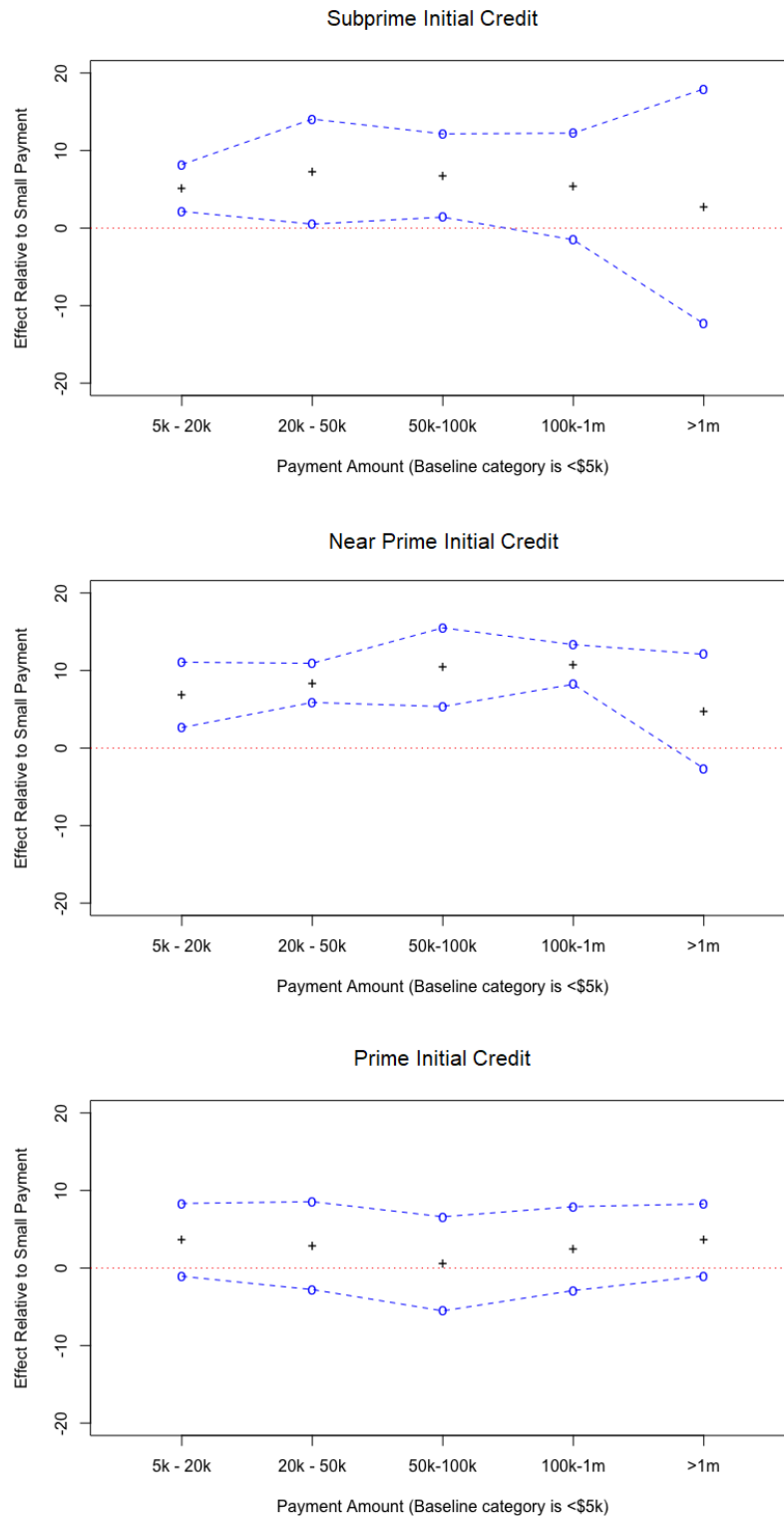
Tables

Summary Statistics and Balance

Table 1: Summary Statistics

Note: This table reports summary statistics for our mineral payment and credit bureau data. The Mineral Payment data has a unit of observation at the mineral owner level and provides summary statistics on the payments that mineral owners receiv along with the amount of net mineral acres they own. The Credit Data provides summary statistics on the credit data used in our main regressions, and has a unit of observation at the individual-year level (the two years being 2005 and 2015). It includes both mineral owners and matched control individuals used in our panel.

Mineral Payment Data	N	Mean	Std Dev	p1	p10	p25	p50	p75	p90	p99
Total Payments to Mineral Owners	404,937	$45,831	$580,198	—	$180	$756	$2,584	$7,554	$33,949	$751,507
Acres Owned by Mineral Owners	255,784	3.97	69.15	0.02	0.10	0.20	0.31	0.63	2.63	80.00

Credit Data – Panel	N	Mean	Std Dev	p1	p10	p25	p50	p75	p90	p99
Credit Score (Vantage Score)	1,591,543	709	97	474	566	640	726	798	819	832
W2 Income	1,591,543	$52,285	$24,521	$22,000	$30,000	$37,000	$46,000	$61,000	$79,000	$147,000
Mortgage Balance	732,055	$135,064	$172,598	$1,101	$27,631	$57,599	$98,010	$157,836	$260,727	$737,330
Mortgage Limit	731,921	$159,503	$242,045	$19,768	$50,000	$75,100	$115,648	$180,000	$294,368	$844,650
Mortgage Utilization	717,775	82%	21%	10%	52%	77%	90%	96%	99%	99%
Credit Card Balance	1,324,757	$9,547	$27,635	—	$34	$707	$3,188	$10,065	$24,166	$82,786
Credit Card Balance	1,324,757	$42,708	$58,148	$250	$2,391	$10,430	$29,120	$58,300	$96,224	$213,200
Credit Card Utilization	1,187,992	28%	28%	0%	2%	5%	17%	46%	75%	98%

Table 2: Comparison of Outcomes for Treatment and Matched Controls

Note: This Table reports differences in key variables from credit data across our treatment (Mineral Owner) and control (matched sample) groups, as well as our treatment (Mineral Owner) as of 2005. The t-test comparisons are done for each variable and the p-value, based on clustering by 3 digit zip (similar to our main tests) is reported.

Variable	Treatment	Control	Difference	p-value
Credit Score (Vantage Score)	705	701	4	0.8092
W2 Income	$50,771	$47,389	$3,382	0.6668
Mortgage Balance	$130,874	$123,951	$6,924	0.9341
Mortgage Limit	$146,962	$140,678	$6,284	0.9465
Mortgage Utilization	87%	85%	2%	0.5649
Credit Card Balance	$10,099	$8,321	$1,778	0.7515
Credit Card Limit	$43,401	$37,113	$6,288	0.6810
Credit Card Utilization	28%	28%	0%	0.9366

Credit Card Utilization, Balances and Limits

Table 3: Long-Run Effects on Revolving Card Utilization

Note: In Panel A, the dependent variable is percentage revolving card utilization (balance as a percentage of available revolving card limits, between 0 and 100%). In Panel B, the dependent variable is $100 \times log(1 + rev.balance)$, where the 100 x log functional form yields an approximate percentage change interpretation. The unit of observation is an individual-year in which two years are considered, 2005 (pre) and 2015 (post). The variable *treatment* is an indicator for whether the individual received royalty or bonus payments as part of our sample from the Barnett Shale between 2005 and 2015. The variable *post* is an indicator for whether the individual-year observation is in 2015. Individuals who are not treated are matched controls (propensity score matching on ZIP3, 2005 credit score, and length of credit history) drawn from the control sample from Experian. The interaction *treatment x post* captures the average difference in the change in credit scores between those receiving mineral payments and those in our control sample. Standard errors clustered by ZIP3 in parentheses. *, **, and *** indicate statistical significance at the 10%, 5% and 1% level respectively.

Panel A: Percent Revolving Card Utilization

	(1)	(2)	(3)	(4)	(5)	(6)
subsample	all	$S < 620$	$620 < S < 720$	$S > 720$	all	outside of Barnett
treatment x post	−0.29	−6.86***	−3.73***	2.64***	−1.35***	−2.89***
	(0.20)	(0.79)	(0.46)	(0.09)	(0.30)	(0.75)
treatment x post x initial credit score (Z)	−	−	−	−	4.24***	5.18***
					(0.33)	(0.85)
post x initial credit score (Z)	−	−	−	−	3.83***	3.30***
					(0.31)	(0.65)
Fixed Effects	individual	individual	individual	individual	individual	individual
	ZIP3-year	ZIP3-year	ZIP3-year	ZIP3-year	ZIP3-year	ZIP3-year
Adj. R-squared	0.5299	0.3923	0.4012	0.4084	0.5469	0.5274
Observations	1,372,961	193,551	390,501	781,372	1,372,961	158,920
Baseline Rate	25.41%	48.43%	35.43%	14.62%	25.41%	24.75%

Panel B: Logged Revolving Balances (100 x log)

	(1)	(2)	(3)	(4)	(5)	(6)
subsample	all	S < 620	$620 < S < 720$	S > 720	all	outside of Barnett
treatment x post	4.87***	−21.69***	−29.54***	26.81***	−2.02	−19.72***
	(0.99)	(7.88)	(1.84)	(2.54)	(1.33)	(6.89)
treatment x post x initial credit score (Z)	−	−	−	−	30.25***	48.91***
					(3.68)	(7.66)
post x initial credit score (Z)	−	−	−	−	−17.10***	−18.02***
					(4.44)	(6.30)
Fixed Effects	individual	individual	individual	individual	individual	individual
	ZIP3-year	ZIP3-year	ZIP3-year	ZIP3-year	ZIP3-year	ZIP3-year
Adj. R-squared	0.4673	0.3484	0.4290	0.5099	0.4683	0.4627
Observations	1,393,988	207,360	395,711	783,280	1,393,988	161,268

Note: The dependent variable is the balance across all revolving card accounts (100 x log of balances in odd columns, dollar value in even columns). The unit of observation is an individual-year in which two years are considered, 2005 (pre) and 2015 (post). In these specifications, the variable *treatment* is replaced by a set of indicator variables for whether total royalty or bonus payments between 2005 and 2015 is in the specified interval. The baseline category for these indicator variables is small payments (< $5000). The variable *post* is an indicator for whether the individual-year observation is in 2015. The interaction *treatment x post* captures the average difference in the change in credit scores between those receiving mineral payments and those in our control sample. Standard errors clustered by ZIP3 in parentheses. *, **, and *** indicate statistical significance at the 10%, 5% and 1% level respectively.

	Subprime Credit ($S < 620$)		Near Prime Credit ($620 < S < 720$)		Prime Credit ($S > 720$)	
	(1)	(2)	(3)	(4)	(5)	(6)
post x payment $\in$ {5k, 20k}	−8.71	−1712.7***	7.57***	-534.3	3.90	462.8
	(9.12)	(581.2)	(2.58)	(516.0)	(3.59)	(304.5)
post x payment $\in$ {20k, 50k}	−21.33*	−2358.8	−22.35*	-1351.6	15.95***	1339.1**
	(11.60)	(1871.2)	(13.54)	(1042.1)	(3.91)	(636.2)
post x payment $\in$ {50k, 100k}	−29.52	−4038.7**	−27.27**	-1228.4	9.87	1568.0**
	(20.75)	(1786.0)	(11.38)	(2161.2)	(9.62)	(611.6)
post x payment $\in$ {100k, 1mm}	−31.77**	−2999.50	5.39	-550.6	10.86	497.4
	(14.92)	(3323.8)	(5.08)	(1863.2)	(10.30)	(724.2)
post x payment $\geq$ 1mm	−3.04	−2871.30	6.62	-1807.0	−14.53*	2124.9
	(54.76)	(2378.6)	(15.28)	(2211.5)	(8.52)	(2110.5)
Fixed Effects	individual	individual	individual	individual	individual	individual
	ZIP3-year	ZIP3-year	ZIP3-year	ZIP3-year	ZIP3-year	ZIP3-year
	acreage bin-year	acreage bin-year	acreage bin-year	acreage bin-year	acreage bin-year	acreage bin-year
	credit bin-year	credit bin-year	credit bin-year	credit bin-year	credit bin-year	credit bin-year
Adj. R-squared	0.2787	0.2900	0.3537	0.3576	0.4392	0.2688
Observations	65,018	65,018	120,981	120,981	249,330	249,330
Average Revolving Balance in 2005	$11,173	$11,173	$16,866	$16,866	$6,317	$6,317

Mortgages

Table 5: Long-Run Effects on Mortgage Utilization and Balances

Note: In Panel A, the dependent variable is the percentage mortage utilization (balance / credit limit). In Panel B, the dependent variable is the log of one plus the mortgage balance, and the coefficient estimates are multiplied by 100 to elicit an approximate percentage change interpretation. The unit of observation is an individual-year in which two years are considered, 2005 (pre) and 2015 (post). The variable *treatment* is an indicator for whether the individual received mineral payments as part of our sample from the Barnett Shale between 2005 and 2015. The variable *post* is an indicator for whether the individual-year observation is in 2015. Individuals who are not treated are matched controls (propensity score matching on ZIP3, 2005 credit score, and length of credit history) drawn from the control sample from Experian. The interaction *treatment x post* captures the average difference in the change in credit scores between those receiving mineral payments and those in our control sample. Standard errors clustered by ZIP3 in parentheses. *, **, and *** indicate statistical significance at the 10%, 5% and 1% level respectively.

Panel A: Mortgage Utilization as a Percentage of Loan

	(1)	(2)	(3)	(4)
subsample	all	$S < 620$	$620 < S < 720$	$S > 720$
treatment x post	0.86***	−0.20	0.80*	1.01**
	(0.32)	(0.63)	(0.47)	(0.43)
Fixed Effects	individual	individual	individual	individual
	ZIP3-year	ZIP3-year	ZIP3-year	ZIP3-year
Adj. R-squared	0.4338	0.4261	0.4243	0.4206
Observations	764,659	130,351	243,574	386,071
Baseline Rate	81.58%	86.65%	84.78%	77.81%

Panel B: Logged Mortgage Balances (100 x log)

	(1)	(2)	(3)	(4)
subsample	all	S < 620	$620 < S < 720$	S > 720
treatment x post	5.92***	−4.25	5.09***	6.51**
	(1.96)	(2.64)	(1.26)	(3.13)
Fixed Effects	individual	individual	individual	individual
	ZIP3-year	ZIP3-year	ZIP3-year	ZIP3-year
Adj. R-squared	0.4663	0.5751	0.5155	0.4560
Observations	764,794	130,371	243,642	386,117
Average Mortgage Balance in 2005	$134,970	$111,398	$136,557	$138,466

Automobile Lending

Table 6: Auto Loans

Note: The dependent variable is the log of one plus the consumer's auto loan limit. The unit of observation is an individual-year in which two years are considered, 2005 (pre) and 2015 (post). The variable *treatment* is an indicator for whether the individual received royalty or bonus payments as part of our sample from the Barnett Shale between 2005 and 2015. The variable *post* is an indicator for whether the individual-year observation is in 2015. Individuals who are not treated are matched controls (propensity score matching on ZIP3, 2005 credit score, and length of credit history) drawn from the control sample from Experian. The interaction *treatment x post* captures the average difference in the change in credit scores between those receiving mineral payments and those in our control sample. Standard errors clustered by ZIP3 in parentheses. *, **, and *** indicate statistical significance at the 10%, 5% and 1% level respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
subsample	all	$S < 620$	$620 < S < 720$	$S > 720$	all	outside of Barnett
treatment x post	0.017***	0.002	0.01	0.019***	0.014**	−0.06
	(0.005)	(0.03)	(0.02)	(0.007)	(0.006)	(0.05)
treatment x post x initial credit score (Z)	−	−	−	−	0.008	0.04
					(0.01)	(0.05)
post x initial credit score (Z)	−	−	−	−	−0.06***	−0.08**
					(0.01)	(0.04)
Fixed Effects	individual	individual	individual	individual	individual	individual
	ZIP3-year	ZIP3-year	ZIP3-year	ZIP3-year	ZIP3-year	ZIP3-year
Adj. R-squared	0.3833	0.3774	0.3814	0.3942	0.3852	0.3639
Observations	1,372,961	193,551	390,501	781,372	1,372,961	158,920

Total Debt-to-Income

Table 7: Long-Run Debt-to-Income Effects overall and split by credit score bin

Note: In Panel A, the dependent variable is the total debt-to-income of the consumer provided by Experian. In Panel B, the dependent variable is an indicator for whether the consumer's debt-to-income ratio exceeds the Qualified Mortgage threshold of 43%, multiplied by 100 to admit a percentage change interpretation. The unit of observation is an individual-year in which two years are considered, 2005 (pre) and 2015 (post). The variable *treatment* is an indicator for whether the individual received royalty or bonus payments as part of our sample from the Barnett Shale between 2005 and 2015. The variable *post* is an indicator for whether the individual-year observation is in 2015. Individuals who are not treated are matched controls (propensity score matching on ZIP3, 2005 credit score, and length of credit history) drawn from the control sample from Experian. The interaction *treatment x post* captures the average difference in the change in credit scores between those receiving mineral payments and those in our control sample. Standard errors clustered by ZIP3 in parentheses. *, **, and *** indicate statistical significance at the 10%, 5% and 1% level respectively.

Panel A: Total Debt-to-Income Ratio

	(1)	(2)	(3)	(4)
credit score bin	all	$S < 620$	$620 < S < 720$	$S > 720$
treatment x post	-1.25^{***}	-3.35^{***}	-2.39^{***}	0.02
	(0.12)	(0.44)	(0.10)	(0.14)
Fixed Effects	individual	individual	individual	individual
	ZIP3-year	ZIP3-year	ZIP3-year	ZIP3-year
Adj. R-squared	0.5035	0.3426	0.4316	0.5350
Observations	1,508,375	276,184	429,752	794,118
Average Debt-to-Income in 2005	15.1%	20.3%	19.0%	11.3%

Panel B: Percentage of Consumers with DTI Exceeding Qualified Mortgage Threshold

	(1)	(2)	(3)	(4)
credit score bin	all	$S < 620$	$620 < S < 720$	$S > 720$
treatment x post	-1.63^{***}	-5.91^{***}	-2.51^{***}	0.33^{***}
	(0.21)	(1.18)	(0.27)	(0.09)
Fixed Effects	individual	individual	individual	individual
	ZIP3-year	ZIP3-year	ZIP3-year	ZIP3-year
Adj. R-squared	0.1436	0.1088	0.1303	0.1299
Observations	1,508,375	276,184	429,752	794,118
% of Consumers ¿ 43% in 2005	4.49%	10.66%	6.37%	1.39%

Financial Risks

Table 8: Severe Delinquencies and Derogatory Accounts

Note: The dependent variable is the percentage of accounts that are more than 90 days past due (Panel A) or an indicator for having any severe derogatory accounts (Panel B; these are defaults, settled for less than the amount, etc.). The unit of observation is an individual-year in which two years are considered, 2005 (pre) and 2015 (post). The variable *treatment* is an indicator for whether the individual received royalty or bonus payments as part of our sample from the Barnett Shale between 2005 and 2015. The variable *post* is an indicator for whether the individual-year observation is in 2015. Individuals who are not treated are matched controls (propensity score matching on ZIP3, 2005 credit score, and length of credit history) drawn from the control sample from Experian. The interaction *treatment x post* captures the average difference in the change in credit scores between those receiving mineral payments and those in our control sample. Standard errors clustered by ZIP3 in parentheses. *, **, and *** indicate statistical significance at the 10%, 5% and 1% level respectively.

Panel A: Percent of Accounts 90 or More Days Past Due

	(1)	(2)	(3)	(4)	(5)	(6)
subsample	all	$S < 620$	$620 < S < 720$	$S > 720$	all	outside of Barnett
treatment x post	−0.02*	−0.19***	0.05***	0.002	−0.02**	0.01
	(0.01)	(0.03)	(0.02)	(0.003)	(0.01)	(0.03)
treatment x post x initial credit score (Z)	–	–	–	–	0.08***	−0.001
					(0.02)	(0.06)
post x initial credit score (Z)	–	–	–	–	0.05***	0.09*
					(0.004)	(0.05)
Fixed Effects	individual	individual	individual	individual	individual	individual
	ZIP3-year	ZIP3-year	ZIP3-year	ZIP3-year	ZIP3-year	ZIP3-year
Adj. R-squared	0.1674	0.1470	0.1424	0.0690	0.1693	0.2429
Observations	1,372,961	193,551	390,501	781,372	1,372,961	158,920
Baseline Rate	0.120%	0.430%	0.080%	0.015%	0.120%	0.099%

Panel B: Indicator for Severe Derogatory Accounts

	(1)	(2)	(3)	(4)	(5)	(6)
subsample	all	$S < 620$	$620 < S < 720$	$S > 720$	all	outside of Barnett
treatment x post	0.004*	−0.04***	0.03***	0.004**	0.003**	−0.005
	(0.002)	(0.004)	(0.002)	(0.002)	(0.002)	(0.007)
treatment x post x initial credit score (Z)	–	–	–	–	0.01***	0.015*
					(0.001)	(0.008)
post x initial credit score (Z)	–	–	–	–	0.01***	−0.006
					(0.003)	(0.006)
Fixed Effects	individual	individual	individual	individual	individual	individual
	ZIP3-year	ZIP3-year	ZIP3-year	ZIP3-year	ZIP3-year	ZIP3-year
Adj. R-squared	0.2751	0.1852	0.1830	0.1590	0.2772	0.3566
Observations	1,372,961	193,551	390,501	781,372	1,372,961	158,920
Baseline Rate	0.108	0.309	0.109	0.026	0.108	0.086

Table 9: Long-Run Credit Score Effects

Note: The unit of observation is an individual-year in which two years are considered, 2005 (pre) and 2015 (post). Columns (1) through (4) present results using the full sample of individuals. Columns (5) through (8) present results for only individuals who reside outside of the Barnett Shale area. The variable *treatment* is an indicator for whether the individual received royalty or bonus payments as part of our sample from the Barnett Shale between 2005 and 2015. The variable *post* is an indicator for whether the individual-year observation is in 2015. Individuals who are not treated are matched controls (propensity score matching on ZIP3, 2005 credit score, and length of credit history) drawn from the control sample from Experian. The interaction *treatment x post* captures the average difference in the change in credit scores between those receiving mineral payments and those in our control sample. Standard errors clustered by ZIP3 in parentheses. *, **, and *** indicate statistical significance at the 10%, 5% and 1% level respectively.

	Full Sample				Resides Outside of Barnett			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
treatment x post	10.03***	9.52***	8.86***	9.03***	12.00***	11.45***	9.55***	8.90***
	(0.83)	(0.77)	(0.79)	(0.75)	(1.05)	(1.00)	(1.21)	(1.29)
post	7.74***	7.59***	10.07*	–	2.59	2.05*	4.45***	–
	(1.44)	(1.45)	(1.77)		(1.08)	(1.04)	(1.21)	
treatment	3.55***	3.55***	–	–	−0.52	−0.51	–	–
	(0.32)	(0.34)			(0.68)	(0.64)		
Fixed Effects	none	ZIP3	individual	individual	none	ZIP3	individual	individual
				ZIP3-year				ZIP3-year
Adj. R-squared	0.0070	0.0152	0.6988	0.6997	0.0042	0.0325	0.7022	0.7094
Observations	1,647,856	1,647,856	1,647,856	1,647,856	186,274	186,274	186,274	186,274

Table 10: Long-Run Credit Score Effects – Heterogeneity by Initial Credit Score and Initial Income

Note: The unit of observation is an individual-year in which two years are considered, 2005 (pre) and 2015 (post). In Panel A, the results are from subsamples based on initial credit score (Subprime $S < 620$, columns (1) and (2); Near prime $620 < S < 720$, columns (3) and (4); Prime $S > 720$, columns (5) and (6)). In addition, the even columns in Panel A consider only individuals who reside outside of the Barnett Shale. In Panel B, the results are from estimating the specification on individuals within each quintile of the income distribution in 2005. Panel C presents the estimate on *treatment x post* using observations within a double sort on initial income and initial credit score. The variable *treatment* is an indicator for whether the individual received royalty or bonus payments as part of our sample from the Barnett Shale between 2005 and 2015. The variable *post* is an indicator for whether the individual-year observation is in 2015. Individuals who are not treated are matched controls (propensity score matching on ZIP3, 2005 credit score, and length of credit history) drawn from the control sample from Experian. The interaction *treatment x post* captures the average difference in the change in credit scores between those receiving mineral payments and those in our control sample. Standard errors clustered by ZIP3 in parentheses. *, **, and *** indicate statistical significance at the 10%, 5% and 1% level respectively.

Panel A: Heterogeneity by Initial Credit Score

	Subprime Credit ($S < 620$)		Near Prime Credit ($620 < S < 720$)		Prime Credit ($S > 720$)	
	(1)	(2)	(3)	(4)	(5)	(6)
treatment x post	15.13***	18.27***	10.75***	14.40***	8.17***	7.45***
	(0.57)	(5.06)	(0.58)	(4.57)	(1.39)	(1.50)
Fixed Effects	individual	individual	individual	individual	individual	individual
	ZIP3-year	ZIP3-year	ZIP3-year	ZIP3-year	ZIP3-year	ZIP3-year
Adj. R-squared	0.3912	0.4657	0.2303	0.2938	0.2925	0.3768
Observations	246,163	21,188	242,067	22,679	659,145	79,585

Panel B: Heterogeneity by Initial Income

	Bottom Quintile	2nd Quintile	3rd Quintile	4th Quintile	Top Quintile
	(1)	(2)	(3)	(4)	(5)
treatment x post	17.57***	11.62***	7.36***	4.05***	1.46*
	(0.68)	(0.60)	(1.48)	(1.22)	(0.79)
Fixed Effects	individual	individual	individual	individual	individual
	ZIP3-year	ZIP3-year	ZIP3-year	ZIP3-year	ZIP3-year
	credit bin-year	credit bin-year	credit bin-year	credit bin-year	credit bin-year
Adj. R-squared	0.6882	0.7124	0.6999	0.6871	0.6556
Observations	329,637	347,809	338,367	316,365	315,678

Panel C: Double Sort by Initial Credit and Initial Income

	Subprime	Near Prime	Prime	Subprime - Prime
	(1)	(2)	(3)	
Low Income	16.03***	12.91***	12.56***	3.47***
	(0.68)	(0.60)	(1.48)	(1.27)
High Income	4.36***	3.69***	3.55***	0.81
	(0.68)	(0.60)	(1.48)	(2.06)
Low - High	11.67***	9.22***	9.01***	
	(1.29)	(1.48)	(2.05)	

Table 11: Long-Run Credit Score Effects – Heterogeneity in Payments, Split by Initial Credit Quality

Note: The unit of observation is an individual-year in which two years are considered, 2005 (pre) and 2015 (post). To focus on payments with a long enough horizon to affect the credit history, we restrict attention to the subsample of individuals who receive their first payment before 2009. In these specifications, the variable *treatment* is replaced by a series of indicators for the total mineral payments received from Barnett Shale production between 2005 and 2015. The baseline category is very small aggregate payments ($< \$5,000$). The variable *post* is an indicator for whether the individual-year observation is in 2015. The interaction *treatment bin x post* captures the average difference in the change in credit scores between those receiving very small mineral payments and those in the specified payment bin. When they are included, characteristic bin-year fixed effects, the bins are constructed from the sample quintiles of the characteristic in 2005. Standard errors clustered by ZIP3 in parentheses. *, **, and *** indicate statistical significance at the 10%, 5% and 1% level respectively.

	Subprime Credit ($S < 620$)		Near Prime Credit ($620 < S < 720$)		Prime Credit ($S > 720$)	
	(1)	(2)	(3)	(4)	(5)	(6)
post x payment $\in \{5k, 20k\}$	7.31***	4.28***	8.52***	5.18***	4.43	2.64
	(2.68)	(1.41)	(3.28)	(1.64)	(3.20)	(2.21)
post x payment $\in \{20k, 50k\}$	7.96*	5.22	9.90***	5.57***	3.21	1.69
	(4.18)	(3.80)	(1.31)	(1.98)	(3.57)	(2.74)
post x payment $\in \{50k, 100k\}$	7.17**	4.80	11.86***	7.29***	0.84	−0.29
	(3.16)	(2.98)	(3.58)	(2.75)	(3.80)	(3.18)
post x payment $\in \{100k, 1mm\}$	5.74	3.15	12.05***	7.67***	2.78	1.97
	(4.15)	(4.27)	(2.04)	(1.53)	(3.32)	(2.99)
post x payment $\geq 1mm$	2.74	0.13	6.02	0.90	3.88	3.31
	(8.91)	(9.41)	(4.78)	(4.47)	(3.82)	(2.89)
Fixed Effects	individual	individual	individual	individual	individual	individual
	ZIP3-year	ZIP3-year	ZIP3-year	ZIP3-year	ZIP3-year	ZIP3-year
	credit bin-year	credit bin-year	credit bin-year	credit bin-year	credit bin-year	credit bin-year
		age bin-year		age bin-year		age bin-year
		inc bin-year		inc bin-year		inc bin-year
		acreage bin-year		acreage bin-year		acreage bin-year
Adj. R-squared	0.3825	0.3905	0.2266	0.2386	0.3111	0.3260
Observations	100,608	100,608	136,954	136,954	257,376	257,376

7 Appendix: Examples of Raw Data

Figure 9: Example of Raw Mineral Appraisal Roll

Note: This figure presents an example of the raw data from the tax appraisal rolls. We processed the raw text into our mineral payments data by using appraisal rolls to merge with production data in order to compute precise values for monthly mineral rights payments.

OWN/GEO	NAME AND ADDRESS	LEASE# PROPERTY DESCRIPTION		OPERATOR/JURISDICTION	VALUE
68713592		5947 HIGHTOWER # 2H KELWAT G1 A-1010 MANN W SUR RRC-09-259285 KELWAT-.3967	.000138 RI - 281.460 ACRES	CHESAPEAKE OPER LLC 00-01-70-71-56-32	20 *** 220 *
137480 67449212	AARON DAVID 4021 J RENDON RD BURLESON TX 76028-3629	5236 BIG DADDY # 1H G1 A-1341 RAMEY R R SUR RRC-09-257711	.000115 RI -- 342.320 ACRES	CHESAPEAKE OPER LLC 00-01-53-14-70-71-73	130
66505607		7308 BOBCAT # 1H G1 A- 425 DAVIS S SUR RRC-09-265910	.000141 RI - 349.010 ACRES	CHESAPEAKE OPER LLC 00-01-02-45-70-71	420
66505615		7539 BOBCAT # 2H G1 A- 425 DAVIS S SUR RRC-09-269124	.000071 RI - 349.010 ACRES	CHESAPEAKE OPER LLC 00-01-02-45-70-71 *****	200 750 *
20506 13301667	AARON DAVID & MARGARET 4021 J RENDON RD BURLESON TX 76028-3629	2820 RAFAEL UT #A 1H G1 A-1263 RENDON J SUR RRC-09-240685	.002230 RI -- 392.800 ACRES	XTO ENERGY INC 00-01-59-74-70-71-72	940
13301691		2916 RAFAEL UT #B 1H G1 A-1263 RENDON J SUR RRC-09-243133	.002230 RI - 457.600 ACRES	XTO ENERGY INC 00-01-59-74-70-71-72	980
13301705		3721 RAFAEL UT #B 2H G1 A-1263 RENDON J SUR RRC-09-246148	.002230 RI - 457.600 ACRES	XTO ENERGY INC 00-01-59-74-70-71-72	1,870
13301675		2821 RAFAEL UT #B 3H G1 A-1263 RENDON J SUR RRC-09-241008	.002230 RI - 457.600 ACRES	XTO ENERGY INC 00-01-59-74-70-71-72	2,110
61139378		5894 RAFAEL UT #B 4H G1 A-1263 RENDON J SUR RRC-09-260498	.002230 RI - 459.690 ACRES	XTO ENERGY INC 00-01-59-74-70-71-72	1,820
61139386		5895 RAFAEL UT #B 5H G1 A-1263 RENDON J SUR RRC-09-260500	.002230 RI - 459.690 ACRES	XTO ENERGY INC 00-01-59-74-70-71-72	1,160
13301683		2822 RAFAEL UT #B 6H G1 A-1263 RENDON J SUR RRC-09-241353	.002230 RI - 459.690 ACRES	XTO ENERGY INC 00-01-59-74-70-71-72	2,820
61139394		5896 RAFAEL UT #B 7H G1 A-1263 RENDON J SUR RRC-09-2260582	.002230 RI - 459.690 ACRES	XTO ENERGY INC 00-01-59-74-70-71-72	660 12,360 *
18382	AARON DELVIN E & AMY T 620 BLUFF SPRINGS RD FORT WORTH TX 76108-7600	2845 BARONE 1H G1 A 1661 WILCOX J (PARKER CO) RRC-09-	.002930 RI -- 84	GRAND OPERATING INC	0

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Figure 10: Example of a Mineral Rights Lease

Note: This figure presents an example of a mineral rights lease, with key information highlighted. We processed a large sample of these leases to augment our tax appraisal data set, as well as to compute estimates of lease bonus payments.