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

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January 5, 2018

Disclaimer

- The views expressed here are those of the author and do not represent the views of the Federal Reserve Bank of Kansas City or the Federal Reserve System.

Background

- Understanding how consumers respond to income and wealth shocks is a core topic in economics

- Consumer theory indicates that consumers spend income differently depending upon whether they view increases as permanent or transitory (Jappelli and Pistaferii, 2010)
  - Anticipated vs. unanticipated, transitory vs. permanent

- Economists have used abrupt changes in income taxes or tax breaks to measure changes in consumption (Shapiro and Slemrod, 2003; 2009)

- Researchers can also leverage natural experiments that allow for the estimation of differential effects of responses across space and time

Motivation

- Domestic oil and gas production began to increase rapidly in the mid-2000s

- By 2014, oil and gas production combined increased 40 percent compared to a decade earlier (EIA, 2015)

- Drilling increased 60 percent over the same period (Drillinginfo)

Motivation

- Value of onshore U.S. O&G production increased about $140 billion from 2009-14

- Development largely occurred in rural areas of the country representing potentially different levels of shocks to the local economy that may be less economically diverse

- Development translated into labor market shocks with increased demand directly and indirectly from the extraction sector
  - increases in employment and wage and salary income in these areas (see Marchand and Weber, 2017)
  - increases in royalty income to mineral right owners (Brown et al., 2016a,b)

- It is unclear how consumers living in areas which experienced the boom reacted

Recent Literature on Resource Boom

- Allcott and Keniston (2017) estimate positive spillovers to local manufacturing sector

- Hausman and Kellogg (2015) and Bartik et al. (2017) quantify welfare gains from shale gas development

- Feyrer et al. (2017) consider the geographical extent of spillovers

- Implications on the housing market via environmental exposure, e.g. groundwater dependent homes (Muehlenbachs et al. 2015)

- Decreased default risk on home mortgages (McCollum and Upton, 2016; Cunningham et al. 2017)

Research Questions

- Despite a significant literature on labor market effects from oil and gas development and an emerging literature analyzing royalty income streams, very few studies have looked directly at consumption

- This paper addresses two empirical questions:
  - How did personal consumption as measured by consumer debt respond to oil and gas development for the average county?

  - What was the marginal propensity to consume out of debt from shocks to wage income via drilling activity?

Preview of Results

- On average, differences in consumer debt peaked in 2015 with an additional $840 per capita in counties with shale endowment and increased drilling

- Shocks to local wages via drilling revealed a marginal propensity to consume from debt of 0.4

- The marginal propensity to consumer was over four times larger in previously undeveloped areas

- Finding is consistent with consumers viewing income from new development shocks as:
  - transitory in previously developed areas
  - relatively more permanent in previously undeveloped areas

Research Question 1

- How did personal consumption as measured by consumer debt respond to oil and gas development for the average county?

Average Consumer Response of Shale Development

- The categories are auto debt and consumer finance including credit and retail cards and the sum of the two categories

- Estimating (1) for each debt category reveals how the difference in average debt between shale and non-shale counties evolved year by year as shown by:

$$C_{it} = \alpha_i + \gamma_t + \sum \beta_t (O\&G\ Growth_i \times Year_t) + \theta_k X_{it-1}^k + \varepsilon_{it}, \quad (1)$$

- where α and γ are county and year fixed effects

- θ is a vector of coefficients from county-level control measures in X related to industrial composition, net-migration, and average credit scores

- The $O\&G\ Growth_i$ binary variable is credibly exogenous to county-specific shocks (other than those related to shale development)

Research Question 2

- What was the marginal propensity to consume out of debt from shocks to wage income via drilling activity?

Estimating the Marginal Propensity to Consumer

- To determine how shocks to wage income affects consumer debt on the margin, estimate a panel model where the average per person level of debt is regressed on changes in wages per worker:

$$\Delta C_{it} = \alpha_i + \gamma_t + \lambda \Delta Wages_{it} + \theta_k X_{it-1}^k + \varepsilon_{it}, \tag{2}$$

- where α and γ are county and year fixed effects

- λ measures the response of debt from changes in wages

- θ is vector of coefficients from the same county-level control measures in equation 1

Drilling Intensity

- Change in wages from drilling activity depends upon the intensity of development

- Address the potential endogeneity of wage shock via an instrumental variables that exploits drilling intensity based upon the change in the number of wells drilled (spudded) and the average depth of drilling

$$\Delta Wages_{it} = \alpha_i + \gamma_t + \sigma \Delta Wells_{it} + \mu Depth_{it} + \theta_k X_{it-1}^k + \varepsilon_{it}. \quad (3)$$

- drilling and depth of drilling are expected to be positively correlated with increases in wages

- depth of drilling varies by county and time

O&G Growth Counties

- Intersect with shale or tight oil play
- Had increased drilling between q1:2000 and q4:2014
- County-quarter-level totals of wells spudded from Drillinginfo

County Classification
■ Shale
□ Non-Shale
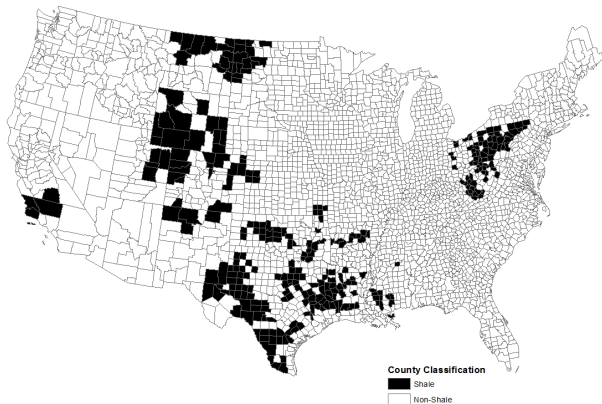
Consumer Credit Panel Data

- Direct measures of consumption are not available at the local level

- Federal Reserve Bank of New York Consumer Credit Panel was used as a proxy

- Panel includes detailed Equifax credit-report data for a unique longitudinal quarterly panel of individuals and households - q1:2000 to q2:2016

- Nationally representative 5 percent random sample of individuals with a SSN and a credit report (11-12 million individuals each quarter)

- Tabulated county-quarter consumer debt averages as well as credit score and net migration rates
    - Address information is dynamic
    - Close relationship between CCP vs. ACS Domestic In/Out-Migration Rates

Wage Income and Industrial Structure

- Trends in consumer debt may differ by county due to differences in industrial composition and the relative performance of the industry at a given point in time

- Data from the Bureau of Labor Statistics, Quarterly Census of Employment and Wages was used to construct measures of industrial structure

- Share of total employment were made from mining, manufacturing, construction, and service sector employment

- Wage income is measured as average quarterly wages per worker

Difference in Total Consumer Debt per capita

$$C_{it} = \alpha_i + \gamma_t + \sum \beta_t (O\&G\ Growth_i \times Year_t) + \theta_k X_{it-1}^k + \varepsilon_{it}$$
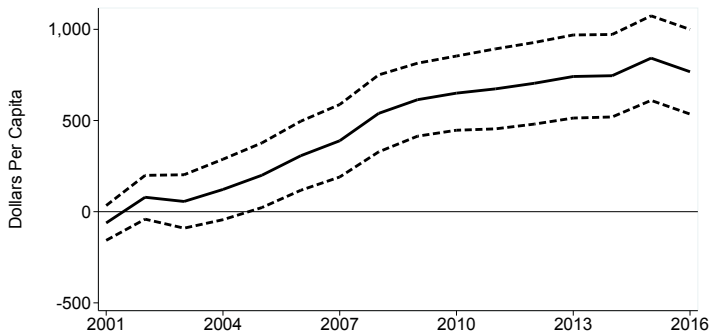
Note: Dashed lines represent 95 percent confidence interval

Differences in Debt

- Economically large differences in consumer debt between O&G growth and nongrowth counties, only emerged in the late 2000s, corresponding to widespread shale development

- By 2015, the average credit score holder had $840 additional consumer debt versus those in non-shale counties
  - 13 percent increase over the average nongrowth county debt holder in 2000

- Nearly 60 percent of the total response came from growth in auto debt by 2015
  - The contribution of auto debt grew over time, representing only 33 percent in 2006

- Suggests consumers became more comfortable with any increases in income they experienced and were willing to make larger purchases

Could the differences be driven by migration?

- People may have moved to areas with oil and gas activity because of their job or hopes of finding a job

- Often oil and gas workers are from another area

- Does this explain the difference in average debt?

- To answer this I re-tabulated the debt measures using only consumers who did not move from the previous quarter

- Re-estimated the model with the nonmover sample
  - Coefficients were only 2-3 percent smaller (e.g., \$830 vs.\$842 per capita)

First Stage Results: Change in Wages

- $\Delta Wages_{it} = \alpha_i + \gamma_t + \sigma\Delta Wells_{it} + \mu Depth_{it} + \theta_k X_{it-1}^k + \varepsilon_{it}$

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

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

IV Estimates: Change in Consumer Debt

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

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

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

Spatial Spillovers

- Possible local spatial spillovers from neighboring counties with development

$$\Delta C_{it} = \alpha_i + \gamma_t + \lambda \Delta Wages_{it} + \phi W \Delta Wages_{it} + \theta_k X_{it-1}^k + \varepsilon_{it}, \quad (4)$$

  - where W is a weight matrix containing information about whom is a neighbor of whom
  - ϕ is measure of local spatial spillovers from drilling in neighboring counties

- Equation contains two endogenous variables; instrument using the change in wells drilled and average depth of drilling and spatial lags of those measures
- Results quantitatively similar to previous specification

Influence of Historical Oil and Gas Development

- Changes in consumer debt may have evolved differently in areas depending upon whether they had previously experienced booms and busts in oil and gas development

- To account for this, I use information from historic geospatial data on oil and gas wells from the U.S. Geologic Survey (0.25 mile by 0.25 mile grids)

- I split the sample using a variable on the percent of the county that ever had an oil or gas well as of 1980
  - Above 75th percentile - previously developed
  - Below 75th percentile - previously undeveloped

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

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

Second Stage Results: Previously Undeveloped Counties

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

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

Did Migration Drive the Marginal Effects?

- Where people who moved into drilling areas more responsive to changes in drilling activity?

- Answer: Not really
    - Total consumer debt mpc was 11 percent lower for nonmover sample
    - Auto debt response was around 7 percent lower for nonmover sample

- Overall, migration into or out of drilling areas seems to have had little effect on consumer debt response

Conclusion

- On average, consumer debt increased at a peak of $840 per capita in counties with shale endowment and increased drilling (1.7 percent of mhhi in 2015)

- Shocks to local wages via drilling revealed a marginal propensity to consume from debt of 0.4

- Consumers in previously developed areas tend to view income shocks from new development as transitory relative to previously undeveloped areas
  - Consumers may do a better job of internalizing that booms in development often give way to busts if they have previous experience

  - In new areas of development, irrational exuberance of good times may give way to higher default on debt during bust