Economic Shocks, Targeted Transfers, and Local Public Goods: Evidence from US Shale Gas Boom*

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Abstract

Over the last 10 years, shale gas development in the US has generated large income shocks in many areas of the country, but how these shocks have affected local governments is unknown. Using shale gas production data at the county level between 1996 and 2012, we show that shale gas boom significantly increased own-source revenues for local governments. We also find Republican-leaning counties tend to receive more intergovernmental revenues from state governments, mostly governed by Republicans, when shale gas booms occur. On the spending side, the shale gas boom has mainly increased non-educational spending and salaries; we find insignificant and smaller impacts on education spending and salaries. Using political and demographic characteristics of counties as proxies for preferences, we mainly find interactions between preferences and state rather than local resource booms. Our results suggest the importance of the relative level of policy discretion across levels of government in the allocation of revenue from natural resources.

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1 Introduction

Over the last 10 years, the technological innovation known as "fracking" has created an oil and natural gas boom, generating large income shocks in many areas of the United States. Anecdotal evidence is abundant. Fracking transformed the status of the inhabitants of the small town of Cotulla, Texas from near-poverty to overnight wealth. Nearly every student in the community's elementary schools now has an iPad, students ride to school in brand-new buses, and parents are no longer required to support the cost of school supplies (Chumley 2014). In Midland, a thriving West Texas oil town, housing has become as expensive as in New York City, and the town was ranked at the top of income growth among metropolitan areas between 2008 and 2012 in the U.S (Galbraith 2012).[1]

There are extensive studies on how wealth from oil or other natural resources affects economic growth, corruption, and government spending in countries where the political system is not fully institutionalized.[2] Recent research in political economy demonstrates that non-tax revenue sources, such as federal-government transfers or natural resource revenues, do not increase productive government spending, such as investments in infrastructure or education (Brollo et al. 2013; Caselli and Michaels 2013; Gadenne 2016; Martinez 2016).

Yet it is striking how little research has been done on this topic in the context of the United States, despite the fact that the recent fracking boom is one of the largest innovations in the history of US energy development.[3] There is a burgeoning literature on the effect of fracking on local economic outcomes, such as growth in wages and employment (Weber 2012; Allcott and Keniston 2014; Weber 2014; Fetzer 2014; Feyrer, Mansur, and Sacerdote 2017), property values (Muehlenbachs, Spiller, and Timmins 2015), en-

[1] Bureau of Economic Analysis, "Real Personal Income for States and Metropolitan Areas, 2008-2012," April 24, 2014 (http://www.bea.gov/newsreleases/regional/rpp/2014/rpp0414.htm).

[2] See Frankel (2010) for a survey of literature on the resource curse.

[3] There is a small set of papers that examine the effect of resource boom on economic growth in the U.S. See: Papyrakis and Gerlagh (2007); Goldberg, Wibbels, and Mvukiyehe (2008); Michaels (2010); James and Aadland (2011); Clay and Weckenman (2014); Douglas and Walker (2015).

vironmental impacts (Knittle, Metaxoglou, and Trindade 2015), student achievement (Marchand and Weber 2015), and changes in voters' preferences for political candidates (Fedaseyeu, Gilje, and Strahan 2015). However, scholars have paid relatively little attention to how large and unexpected shocks in revenue affect government spending, which is fundamentally related to the question of public goods provision.[4]

Examining the effect of fracking on local public goods provision in the US presents a unique opportunity to investigate the interaction between state and local governments. Currently, there is little federal regulation of hydraulic fracturing, and state governments have the main authority to regulate this activity (Rahm 2011). States also collect taxes and fees from fracking, and many states redistribute tax revenues to local governments (Brown 2013).[5] Therefore, state transfers to local governments under their jurisdiction plays an important role in local public goods provision in general, but also in the specific case of fracking.

Local governments, which also collect their own taxes and fees from fracking activities that take place in their own jurisdiction, spend roughly $1.6 trillion per year to provide a variety of public services, accounting for 9.2% of total GDP (Jerch, Kahn, and Li 2016). Further, the types of services that local governments provide, such as public education, policing, and fire protection, are the most salient public goods provisions for many of their citizens (Trounstine 2010). Hence, to fully understand the welfare effect of fracking, it is important to understand how local governments translate revenues from fracking into spending.

In this paper, we investigate how revenue shocks generated by the shale gas boom affect

[4]Exceptions are Newell and Raimi (2015) who examine the statutory paths through which fracking may translate into local revenue, and Bartik et al. (2016) who examine the effect of fracking on local public finance outcomes within counties in shale play areas.

[5]State differs in how to impose taxes on oil and gas, although most states with fracking sites collect severance tax or impose various fees. Allocation of revenues from revenues from fracking facilities also varies by states. For example, in West Virginia, 90 percent of revenues from oil and gas are allocated to the state general fund and no oil and gas producing county may receive less than a non-producing county. In Texas, 25% deposited in the Foundation School Fund and 75% deposited in the General Revenue Fund. States also vary in the control given to municipalities over the use of funds. For state-specific tax and allocation policies, see Brown (2013).

the interaction between state and local governments, how this interaction in turn impacts local public goods provision. Using county-level shale gas production data between 1996 and 2012, we first test whether shale gas production increased local government revenues at the county level. Second we analyze how revenue shocks, both from state transfers and own revenue increase from fracking, in turn affect patterns of local government spending.

We find that fracking production, both at the local and the state level, significantly increased own-source revenues for local governments. A one-standard deviation change in fracking value is associated with a five to seven percent change in own-source revenue. Second, we find Republican-leaning counties receive more intergovernmental revenues from their state governments, mostly governed by Republicans, when shale gas booms occur. This effect holds we control for the county's own fracking production, and when we interact local and state production. This suggests that party control in the state government has significant implications for the distribution of government budgets (Ansolabehere, Gerber, and James M. Snyder 2002; Ansolabehere and James M. Snyder 2006).

For spending, we find that significant amounts of revenue increases in local government translated into spending increases in non-education policy areas; in contrast, there is no meaningful effect on education spending. Employment in local governments did not increase, but the amount of government budgets spent on salaries for government employees significantly increased. The majority of these salary increases were derived from non-education sectors of local governments.

We also examine interactions between local political preferences and local and state fracking. Democratic vote share, union density, and the percentage of white residents to capture preferences. Of these moderators, only Democratic vote share exhibits a significant interaction with local fracking: in counties that lean Democrat, the impact of local fracking on education spending was higher than in counties that lean Republican. Public sector unions exhibit no interaction with local or state fracking. Regarding state fracking, areas with a higher proportion of white residents see a more positive impact of

state fracking on education spending, relative to areas with a smaller proportion of white residents.

Overall, our results suggest that fracking revenues are translated into increases in non-education spending, and for salaries for current employees in local governments. From these results, it is difficult to conclude whether this resource boom has increased local public goods provision or benefited the public. Our results do contrast somewhat with existing evidence, mostly from countries with less mature institutions, that non-tax revenues often lead to rent-seeking or corruption (Tornell and Lane 1999; Brollo et al. 2013; Ross 2014).

That local preferences moderate state fracking, but generally do not moderate local fracking, also suggests the importance of variation in policy discretion across levels of government. Fracking activities are currently regulated by the individual states and the federal government has very limited authority here (Burford 2012). Therefore, state governments have much discretion in how to collect revenues from fracking activities, and how to allocate the extra revenue to local governments. Our results suggest politicians use this discretion to funnel more resources to "loyal voters" (e.g., Cox and McCubbins 1986).

In contrast, local government officials in the US face more institutional constraints, and it is often claimed that municipal governments are greatly constrained in their decisions to raise revenues and to spend (Peterson 1981; Ferreira and Gyourko 2009; Gerber and Hopkins 2011). The fact that local demographics are not associated with spending patterns suggests the importance of these constraints in general, and in the particular case of the allocation of revenues from resource booms. This is in stark contrast with studies based on data from Brazilian municipalities that show that municipal officials use revenues to compensate their patrons (Monteiro and Ferraz 2012; Caselli and Michaels 2013). Our findings suggest the degree of discretion given to policymakers plays a significant role in the distribution of public expenditures.

2 The Fracking Boom in the United States

The US has experienced an extraordinary shale gas boom over the last ten years. Shale gas accounted for only 1.6 percent of total US natural gas production in 2004, but in 2010, that number rose to 23.1%.[6] Dependency on imported energy had been one of US policymakers' major concerns, but the recent shale revolution changed the discourse on US energy independence. In 2014, the Energy Information Agency (EIA) estimated that total US recoverable natural gas resources were 2,327 trillion cubic feet and current US reserves of natural gas represented an estimated 70 years' worth of supply (Brown 2014).

Interest in shale gas by the US government started in the late 1970s after a series of energy crises. The US government funded R&D programs and established tax credits that incentivized private firms to invest in technologies for shale gas extraction. Between 1978 and 1992, the Department of Energy invested about $137 million in the Eastern Gas Shale Program.[7] The technological innovations of hydraulic fracturing and horizontal drilling made shale gas extraction viable. Hydraulic fracturing, informally referred to as "fracking," is an oil and gas-well development process that typically involves injecting water, sand, and chemicals under high pressure into a bedrock formation via the well. This process is intended to create new fractures in the rock as well as increase the size, extent, and connectivity of existing fractures.[8] As Figure 1 presents, this technological innovation has dramatically changed the volume of oil and gas extraction from horizontal drilling since 2005.

Supporters and opponents of fracking have debated the effect of the shale gas boom on local economies and the environment. While supporters emphasize the positive effect of fracking on wages and employment, opponents raise concerns about the environmental effects of fracking. While these debates are ongoing, there is a growing body of scholarly

[6] Shale gas refers to natural gas that is trapped within shale formations.
[7] http://energy.gov/fe/science-innovation/oil-gas-research/shale-gas-rd
[8] energy.usgs.gov

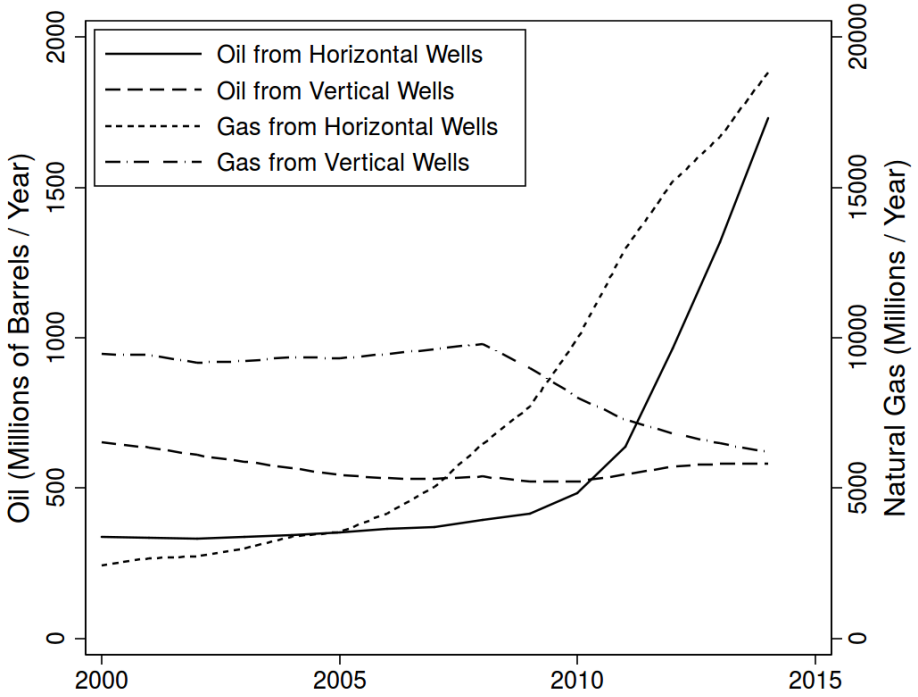

Figure 1: Production of Oil and Gas by Drilling Type. This figure presents the total barrels of oil and gas production in a given month from wells by different types of drilling: vertical vs. horizontal.

work systematically examining the impact of fracking on various outcomes.

First, scholars examine how fracking changed the wages and employment in affected localities. Fetzer (2014) estimates that every oil and gas-sector job creates about 2.17 other jobs and personal income increases by 8% in counties with at least one unconventional oil or gas well. Feyrer, Mansur, and Sacerdote (2017) estimate that every million dollars of oil and gas extracted produces $666,000 in wage income, $61,000 in royalty payments, and 0.78 jobs within the county. Allcott and Keniston (2014) find that despite local labor shortages and wage increases, the manufacturing sector does not suffer from resource booms.

Second, studies examine the consumer welfare and environmental consequences of the fracking boom. Hausman and Kellogg (2015) find that the shale gas revolution led to an increase in the welfare of natural gas consumers by significantly reducing gas prices.

Knittle, Metaxoglou, and Trindade (2015) find that the almost 70% drop in the price of natural gas between 2008 and 2012 translated into a reduction in CO_2 emissions. However, some express other concerns about the environmental such as water contamination from shale gas production. Using data on the properties sold in Pennsylvania and New York between 1995 and 2012, Muehlenbachs, Spiller, and Timmins (2015) find that groundwater-dependent homes are negatively affected by nearby shale gas development, while homes dependent on piped water experience a small increase in property value.

While studies on the resource curse in developing countries tend to focus on its effect on government behaviors, there is relatively little research on this topic regarding the shale gas boom in the US. However, new oil and natural gas development have brought opportunities and challenges to local governments. While increases in economic activity can bring more revenues from taxes and royalties, increases in population and heavy-truck traffic impose substantial challenges to local governments by incurring costs in road management and providing services. Newell and Raimi (2015) examine how oil and gas production generates revenues for local governments in eight states where shale gas development has been most active. Via an examination of possible statutory pathways, they estimate that local government revenue could theoretically range from 1 percent to nearly 10 percent of total production value, with substantial variation across states.

Although Newell and Raimi (2015) shed light on the revenue impact of fracking booms in municipal governments, they do not provide a comprehensive picture of how resource booms from fracking affect local public goods provisions. Does fracking increase both own-sourced revenues from taxes and intergovernmental revenues from state government? How much of the increased revenues translate into local government spending? If spending increases, do all types of spending increase at the same rate? Or does revenue generated by resource booms increase only a certain type of spending? Do political institutions influence the translation from revenue to spending? By studying the effect of the shale gas boom, both on revenue and spending in local governments, we aim to provide answers

to issues of local public goods provisions from resource booms in the US.

3 Data

We collect oil and gas production data at the county level from 1996 to 2012 from Drillinginfo.com, an energy information service firm. Drillinginfo.com provides county level oil and gas production data at a detailed level for each month. It provides the number of reported producing wells and it also indicates whether a property was drilled horizontally or vertically. We focus on wells that used the horizontal drilling technique to calculate the total productions of oil and gas from fracking. We use the annual spot prices for crude oil in dollars from the US Energy information Administration to calculate the value of fracking generated within each county.[9] Figure 2 shows the county-level cumulative value of new oil and gas production from 1996 to 2012. The Appalachian Basin (Marcellus shale play) in PA and NY, the Ft. Worth Basin (Barnett shale play) in TX, and the Williston Basin (Bakken shale play) covering ND and MT show the most active shale gas and oil development. Figure 3 presents trends in value from new production by state between 1996 and 2012. Twenty-four states have had experience in production from fracking.

Our local government public finance data comes from the Census of Governments (COG), a project of the US Census Bureau that collects revenue and expenditure data for more than 90,000 local governments every five years, in years ending in two and seven. We use the COG data for years 1997, 2002, 2007, and 2012. We aggregate the revenue and spending data for all types of governments within the same county boundary - cities, counties, school districts, special districts - at the county level. We collect demographic information at the county level from the 1990, 2000 and 2010 Censuses.

We are interested in how local voters' political preferences or the characteristics of local governments affect spending for public goods provisions when resources generate positive

[9] https://www.eia.gov/dnav/pet/pet_pri_spt_s1_a.htm

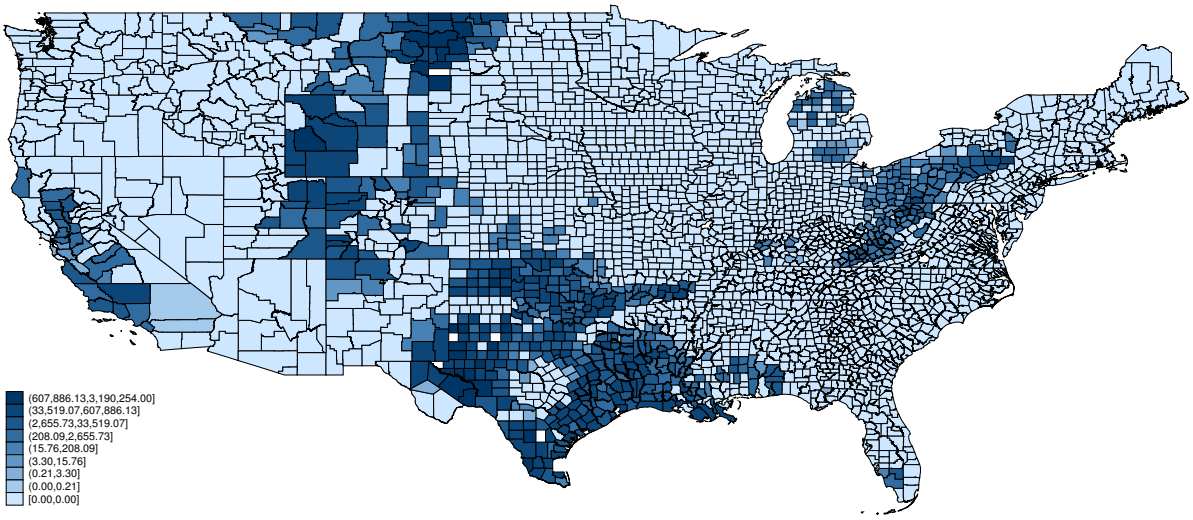

Figure 2: Cumulative value from new production, by county, 1996-2012.

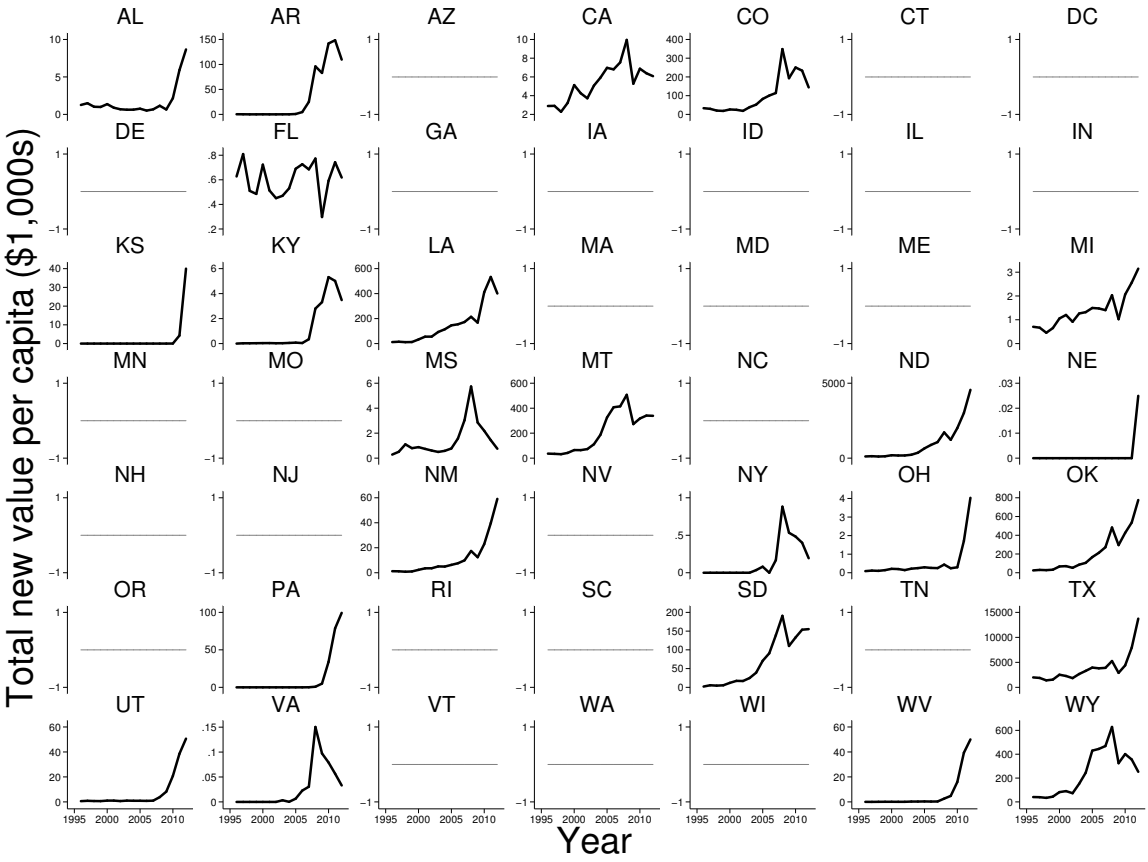

Figure 3: Trends in value from new production, by state, 1996-2012.

revenue shocks. To measure voter preferences, we use the county level Democratic vote share for the presidential race in 2000. We use union membership among local government employees to test whether the strength of public sector unions has any influence on the types of spending increases from shale gas-driven revenue increases.

State and local governments employed 19.3 million people in 2012, over 13 percent of total employment (Jerch, Kahn, and Li 2016), and public-sector workers had a union membership rate of (35.2%) over five times higher than that of private-sector workers (6.7%).[10] Some scholars point out that public sector unions are major interest groups, and unions tend to increase the costs of government by increasing their own salaries and benefits (Moe 2011; Anzia and Moe 2015). To investigate whether public-sector union density is associated with specific types of spending, we use the percent of local government employees in the county who belong to a union from the Census of Governments, 1987: Employment Statistics.[11] Unfortunately, we are aware of no available data on local government unionization after 1987. Following Anzia and Moe (2015), we code counties as unionized if some non-zero portion of local employees in the county were covered by a union contract.

[10]Bureau of Labor Statistics, "Union Membership Summary," January 28, 2016 (http://www.bls.gov/news.release/union2.nr0.htm).

[11]1987 is the last year that the Census published data on local government level union density. The Current Population Survey (CPS) provides public sector labor union membership by metropolitan statistical areas (MSA) but this is not granular enough for us to match with individual local governments. However, using a county - MSA relationship file, we examined the correlation between the public sector union density data in 1987 by the Census and the most recent MSA level public sector union density from the CPS and the correlation is highly correlated (r = 0.69).

4 Results: Local Public Goods Provision

To examine the relationship between fracking and fiscal outcomes, we estimate the following regression:

$$\begin{aligned} \mathrm{Y}_{jst} &= \beta_1 * \text{Local Fracking}_{jt} + \beta_2 * \text{State Fracking}_{st} + \sum_{k=1}^{K} \alpha_k * \mathrm{x}_{jt}^{k} \\ &\quad + \text{County}_j + \text{Year}_t + \varepsilon_{jst} \end{aligned}$$

where Y_{jst} is revenue or spending in county j in state s in year t, expressed as the five-year percentage change * 100; Local Fracking$_{jt}$ is the natural log of the total new value from production, per capita, in county j in year t; State Fracking$_{st}$ is the natural log of the total new value from production, per capita, in state s in year t; the K x variables represent controls; County$_j$ and Year$_t$ are fixed effects for county and year; and ε_{jst} is an error term. We cluster standard errors at the state-year level, as clustering at the county level would overstate the amount of variation in state fracking.[12] We also express all independent variables in standard deviations, such that coefficients can be read as the change in Y associated with a one-standard deviation change in X.

First, we investigate the relationship between fracking activities and local government revenues.[13] There are several revenue sources for local governments related to oil and gas development. State governments collect severance taxes or leasing revenues and they may or may not allocate it to local levels. Local governments can collect ad-valorem property taxes, sales and use taxes, and receive direct payments for production on local government land (Newell and Raimi 2015). Also, changes in housing values induced by shale gas development could affect the property tax revenues that local governments collect.

Table 1 presents the results of the effect of fracking on revenues. We include both a

[12] Results are robust to clustering at the county level.

[13] For the fracking and state revenue, see Table A2 in Appendix B.

	Own source revenue			Inter-governmental revenue		
	(1)	(2)	(3)	(4)	(5)	(6)
Local fracking	5.77**	5.83**	4.46		1.38	-1.53
	(2.02)	(2.02)	(2.68)		(2.03)	(2.48)
State fracking		3.62**	3.64	4.25***	4.27***	4.31
		(1.26)	(2.40)	(1.27)	(1.28)	(3.86)
Local X state fracking			0.94			2.00
			(1.56)			(1.76)
Population	-81.47***	-79.08***	-79.42***	-46.14**	-46.25**	-46.96*
	(13.67)	(13.64)	(14.42)	(15.61)	(15.66)	(18.18)
Share 65+	-2.35	-2.21	-2.14	-4.93	-4.88	-4.73
	(2.71)	(2.70)	(2.64)	(2.95)	(2.93)	(4.27)
Share white	2.44	2.51	2.48	-6.48	-6.40	-6.47
	(5.14)	(5.14)	(3.92)	(10.28)	(10.23)	(7.42)
Share Hispanic	-0.27	0.06	-0.09	10.03	10.11	9.79
	(4.64)	(4.62)	(6.45)	(10.83)	(10.88)	(14.74)
Share with college degree	2.43	2.65	2.72	3.87	3.94	4.11
	(3.05)	(3.06)	(2.38)	(4.01)	(4.03)	(4.53)
Median family income	13.91***	13.32***	13.11***	10.80**	10.67**	10.21*
	(2.67)	(2.66)	(2.87)	(3.39)	(3.30)	(5.15)
Unemployment	1.44	1.68	1.66	0.72	0.73	0.68
	(1.96)	(1.95)	(1.61)	(3.16)	(3.17)	(2.34)
Constant	7.51***	8.54***	8.56***	17.09***	17.13***	17.18***
	(1.28)	(1.31)	(1.53)	(2.44)	(2.47)	(2.85)
Sample size	9,297	9,297	9,297	9,297	9,297	9,297

Table 1: All specifications include county and year fixed effects. State-year clustered standard errors in parentheses. * p<0.05, ** p<0.01, *** p<0.001.

county j's own fracking value as well as the total fracking from the state where the county j is located to examine whether different fracking activities have different revenue effects. We divide the revenues into two types: own source revenues and inter-governmental revenues; the latter represents transfers from federal and state governments. A one-standard deviation change in fracking value in its own county is associated with a five to six percent change in own-source revenue (columns (1) and (2)). Local fracking activities do not appear to increase transfers from state governments (column (5)). However, when there are active statewide fracking activities take place, intergovernmental transfers from state governments to local governments increase (column (5)).

	Own source revenue			Inter-governmental revenue		
	(1)	(2)	(3)	(4)	(5)	(6)
Local fracking	0.19		-14.64*	18.74**		-31.41*
	(3.28)		(6.72)	(6.40)		(14.25)
Local fracking X Dem vote	14.49		41.14**	-38.74**		54.97
	(8.23)		(15.68)	(13.84)		(29.10)
State fracking		6.26	8.03		21.51*	21.72**
		(4.24)	(4.23)		(9.39)	(7.23)
State fracking X Dem vote		-2.96	-9.94		-41.11*	-38.79**
		(8.74)	(8.63)		(18.20)	(13.59)
Local X state fracking			6.28			21.29**
			(3.37)			(6.89)
Local X state X Dem vote			-11.48			-37.81**
			(7.94)			(14.37)
Share 65+	-4.76	-4.94	-4.17	-7.95	-8.22	-6.11
	(2.99)	(2.99)	(2.80)	(4.25)	(4.30)	(3.89)
Share white	15.09**	15.35**	14.20*	1.53	0.76	-0.99
	(5.50)	(5.18)	(5.44)	(7.39)	(7.31)	(8.48)
Share with college degree	2.52	2.29	2.77	3.66	3.28	4.26
	(2.35)	(2.34)	(2.36)	(4.33)	(4.19)	(4.42)
Unemployment	-2.46	-2.35	-1.78	-2.49	-1.91	-0.77
	(1.95)	(1.91)	(1.86)	(2.76)	(2.58)	(2.66)
Constant	8.86***	9.05***	8.79***	14.90***	15.39***	13.10***
	(1.26)	(1.26)	(1.75)	(1.77)	(1.78)	(1.69)
Sample size	9,207	9,207	9,207	9,207	9,207	9,207

Table 2: All specifications include county and year fixed effects. State-year clustered standard errors in parentheses. * p<0.05, ** p<0.01, *** p<0.001.

We next examine whether state governments exercise their discretion when they allocate revenues from statewide fracking activities to local governments by including an interaction between fracking activities and county-level Democratic vote share. Table 2 present the results. There is some evidence that democratic counties with local fracking collect more revenue (columns (1) and (3)). However, the interactions with state fracking are much stronger. Columns (4) through (6) suggest more Democratic areas receive less intergovernmental revenue in high-fracking states, relative to more Republican areas in such states.

Next, we investigate the relationship between fracking local government spending. We

	Ed spending	Non-ed spending	Ed salaries	Non-ed salaries
	(1)	(2)	(3)	(4)
Local fracking	1.98	5.23*	1.10	2.43***
	(1.09)	(2.26)	(0.95)	(0.61)
State fracking	6.70*	9.01*	0.17	7.04*
	(2.62)	(3.63)	(3.67)	(2.81)
Constant	13.89***	17.54***	7.44***	14.52***
	(1.43)	(1.85)	(1.34)	(1.51)
Sample size	9,287	9,297	8,248	9,296

Table 3: All specifications include county and year fixed effects. State-year clustered standard errors in parentheses. * p<0.05, ** p<0.01, *** p<0.001.

divide local expenditures into education spending and non-education spending.[14] We also examine how increases in fracking activities affect local government salaries.[15] Table 3 presents the results. A one-standard deviation change in local fracking is associated with a four percentage change in total non-education spending, and has no effect on education spending. State fracking shows a similar pattern, but with a larger effect, about five percentage points. Regarding salaries, fracking only appears to increase the salaries for local government employees who work in non-education roles. In case of salaries, state fracking activities have much stronger effect that own fracking activities.[16]

Previous research suggests that demographic and political characteristics of a community are associated with public goods provision and local government spending patterns (Easterly and Levine 1997; Alesina, Baqir, and Easterly 1999; Gilligan and Matsusaka 2001; Besley and Case 2003; Anzia 2011; Moe 2011; Anzia and Moe 2015). We examine whether this holds when there is a positive income shock to local governments. In additional specifications, we interact the *Local Fracking* and *State Fracking* variables with county-specific political and demographic variables. These are the share of the county

[14]We make this distinction by first summing (1) total expenditures and (2) total educational expenditure within a county. We then examine (2) versus (1) - (2).

[15]We distinguish education salaries from noneducation salaries by summing up (1) total salaries within a county and (2) total salary spending by school districts within a county. We then examine (2) versus (1) - (2).

[16]Table A1 in Appendix A presents the results on the effect of fracking on employment of local governments. Fracking has no effect on the employment.

that votes Democratic, as measured by the Democratic share of the two-party vote in the 2000 election; the percent of local government employees in the county who belong to a union; and the percent white population in the county.

Table 4 presents the results with the interaction terms included. Columns (1) through (3) present the results on educational spending and columns (4) through (6) present the results on non-educational spending. Democratic leaning counties tend to spend more on education if fracking occurs in their own county, but there is no effect from the interaction of political orientation of a county and statewide fracking activities. Democratic vote is not, however, associated with non-education spending patterns. Public sector unions exhibit no interaction with local or state fracking. Regarding racial composition, counties with higher share of white tend to spend more on education if there are statewide fracking activities, but local fracking activities are not associated with any spending patterns.

5 Conclusion

Over the past decade, a large literature analyzing the effect of natural resource booms on economic growth has developed (Ross 2001; Sachs and Werner 2001). The key question is: What are the conditions under which a government has an incentive to provide public goods to improve the welfare of its citizens? Studies investigating this question based on data from less-developed countries present evidence that when revenue increases come from non-tax-based sources, revenue shocks create incentives for politicians to engage in rent-seeking behaviors, and therefore, they do not necessarily increase the provision of public goods (Brollo et al. 2013; Caselli and Michaels 2013; Gadenne 2016; Martinez 2016).

The US has experienced oil and shale gas booms over the last decade due to an extraction method called "fracking," and this has fundamentally transformed many communities. Like resource booms in other countries, fracking has generated unprecedented

	Education spending			Non-education spending		
	(1)	(2)	(3)	(4)	(5)	(6)
Local fracking	-3.63	0.80	11.96*	6.69	6.69***	24.53
	(2.75)	(1.48)	(5.90)	(5.78)	(1.98)	(16.41)
State fracking	8.14*	6.33*	-10.52	14.04*	5.36	-7.39
	(3.84)	(2.71)	(7.84)	(6.02)	(3.23)	(14.25)
Local fracking X Dem vote	11.94*			-7.09		
	(5.59)			(12.24)		
State fracking X Dem vote	-9.24			-21.61		
	(6.82)			(11.84)		
Local fracking X Union		0.36			-5.60	
		(2.13)			(3.78)	
State fracking X Union		-3.81			-0.17	
		(2.93)			(4.52)	
Local fracking X Share white			-12.60			-24.10
			(6.88)			(17.47)
State fracking X Share white			16.97*			14.36
			(8.26)			(16.50)
Population	-56.20**	-52.55**	-58.32***	-85.69***	-80.61***	-89.32***
	(17.16)	(18.24)	(16.95)	(19.39)	(18.72)	(19.10)
Share 65+	-1.29	-0.70	-1.22	1.32	1.04	1.34
	(3.17)	(3.09)	(3.10)	(4.12)	(4.16)	(4.10)
Share white	-3.53	-2.73	-3.04	0.51	1.71	0.67
	(5.04)	(5.21)	(4.99)	(5.27)	(5.25)	(5.46)
Share Hispanic	-3.59	-2.59	-1.59	11.47	9.54	14.54
	(7.68)	(7.69)	(7.49)	(7.49)	(6.97)	(7.40)
Share with college degree	0.02	0.62	-0.17	-2.20	-4.58	-1.99
	(2.88)	(2.98)	(2.87)	(4.68)	(4.09)	(4.67)
Median family income	7.92**	7.73*	7.77**	20.12***	20.48***	20.13***
	(3.01)	(3.01)	(2.85)	(5.56)	(6.05)	(5.71)
Unemployment	-1.45	-1.79	-1.45	-0.31	-0.55	-0.23
	(1.50)	(1.67)	(1.49)	(1.28)	(1.44)	(1.29)
Constant	10.92***	10.49***	11.46***	13.67***	11.69***	14.67***
	(1.74)	(1.82)	(1.69)	(2.78)	(2.50)	(2.66)
Sample size	9,197	8,946	9,287	9,207	8,955	9,297

Table 4: All specifications include county and year fixed effects. State-year clustered standard errors in parentheses. * p<0.05, ** p<0.01, *** p<0.001.

levels of income increases to local US governments. Despite fracking's significant effect on local government revenues, it is striking how little research has been done to analyze its

effect on the behaviors of local governments that provide essential public goods, such as public education and law enforcement. The link between resource booms and economic growth hinges critically on the behavior of governments that can control decisions about public goods provisions.

Using detailed data on oil and gas production from fracking at the county level, this paper provides the first systematic analysis of the effect of the recent energy booms on spending by local governments in the US. Shale gas booms have generated a significant amount of revenue increase in counties where fracking activities have taken place. Counties that produce shale gas and oil increased their own source revenue, and this pattern is more salient in Democratic-leaning counties. State governments also contribute to revenue increase in local governments, but the patterns of inter-governmental transfers are strategic. While it is reported that states redistribute tax revenues from fracking to oil- and gas-producing municipalities to assist local government and transfer state general funds to the rest of non-oil producing counties based on population density (Brown 2013), we find that state governments do not necessarily transfer more funds to fracking counties. For both fracking and non-fracking counties, state governments run by Republicans tend to send more transfers to republican leaning counties. This suggests that the party control of state government, which has the main authority on fracking-related policies, makes a difference in the allocation of government income generated by resource boom.

We also find that local governments increased non-educational spending and salaries for their public employees in non-educational sector when revenues from fracking increases, and the effect is stronger if revenue increase comes from state transfers. While the link between revenue increases from local fracking activities and spending patterns does not vary much by the density of public sector unions and the demographic composition at the county level, the relationship between revenue from state fracking activities and spending patterns varies by political and demographic characteristics of the county. This suggests that while elected officials in local governments and voters have little discretion in deciding

how to spend their increased own source revenues, our results suggest that political and demographic variables have more influence on spending patterns when revenue increases mainly come from transfers from the upper-level government. Overall, the results support the idea that discretion matters in the allocation of government revenue.

Our results present a mixed picture on the relationship between revenue increases from energy booms and local public goods provision in the US. On one hand, local governments significantly increased their spending on non-education policy areas. However, we do not see the same pattern for educational spending, which is considered to be a productive expenditure.[17] Local governments also increased the amount of their budgets spent to compensate their employees when they did not increase total employment. This suggests that local governments increased salaries and benefits for their current employees. When we further analyze whether the salary increases came from the education or non-education sectors of the government, we found that the majority of salary increases were derived from non-education sectors of local governments. To fully understand the effects of spending increases from energy booms on citizens' welfare, we need more information about how those citizens experience the newly provided local public goods.

[17] Marchand and Weber (2015) study how the shale gas boom in Texas changed school financing and labor market incentives, and as a result, how these two mechanisms affected student achievement. They find that despite providing schools with abundant resources, shale gas development has had a negative impact on student achievement because a widening private-public sector wage gap in boom areas increased teacher turnover and the percentage of inexperienced teachers in the classroom. Cascio and Narayan (2015) also find that fracking has increased high school dropout rates of male teens because fracking increased demand for low-skill labors.

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Appendix A. Impact on Local Government Employment

	Total employees	Education Employees
	(1)	(2)
Local fracking	1.16	-0.05
	(0.66)	(0.80)
State fracking	0.24	1.97
	(1.07)	(1.55)
Population	-13.32	-22.52
	(11.14)	(15.12)
Share 65+	-0.20	-4.58
	(1.60)	(2.54)
Share white	6.51	2.22
	(3.61)	(3.53)
Share Hispanic	-0.72	0.93
	(2.61)	(4.13)
Share with college degree	-0.88	1.34
	(1.93)	(2.57)
Median family income	1.40	5.80*
	(2.08)	(2.50)
Unemployment	0.86	0.02
	(0.95)	(1.39)
Constant	-4.61***	5.48***
	(0.72)	(1.49)
Sample size	9,296	9,272

Table A1: Fracking and Local Government Employment

Appendix B. Fracking and State Severance Tax Increase

In this section we show that state fracking impacts the amount of state revenue from severance taxes. Similar to the local analysis presented in the paper, we examine changes in state revenue from the severance tax from year to year. For this analysis, we are able to use annual data on state finances from the Census. We report regressions with a lagged outcome and with state fixed effects. The results show that a one-standard deviation change in state fracking is associated with a 5-8 percentage point increase in revenues from the severance tax.

	(1)	(2)	(3)
State fracking	4.61***	6.06*	8.19**
	(1.18)	(2.85)	(2.83)
Lagged severance tax revenue	-0.01		-0.02
	(0.00)		(0.01)
Constant	-1.38	-1.44	-0.23
	(1.52)	(1.84)	(1.91)
State fixed effects		Y	Y
Sample size	816	816	816

Table A2: State-clustered standard errors in parentheses. * p<0.05, ** p<0.01, *** p<0.001.

Appendix C. Potential Explanations for Strategic Transfers from State Governments to Local Governments

We document that Republican-leaning counties tend to receive more intergovernmental revenues from their state governments, which are mostly Republican - when shale gas booms occur. There are several potential mechanisms that may explain this pattern. First, Republican-leaning counties may be counties that produce shale gas and oil; therefore, state governments assist those counties to manage costs associated with increased oil and gas production. The results presented in Table 2 do not support this idea. The coefficients on the interaction terms, *Local X state fracking* and *Local X state X Dem vote* suggest that only Republican-leaning fracking counties receive more inter-governmental transfers. If Democratic-leaning counties produce shale gas and oil, they received far fewer inter-governmental transfers. Unless drilling activities in Republican-leaning counties impose more costs on local governments than Democratic-leaning counties due to geography or infrastructure, a cost-based mechanism does not fully explain the different transfer pattern.

Second, it is possible that state governments strategically transfer government funds to prevent any local-level regulations that could prohibit fracking activities within the county's jurisdiction. Fracking involves pumping water and chemicals deep into the ground under high pressure to blast rock and release gas or oil. This activity has recently drawn attention from media, environmentalists, and the public for its potential impact on water quality and other environmental issues such as earthquakes. Governor Andrew Cuomo banned hydraulic fracking in New York State in 2014 (Kaplan 2014). Although state governments have the main authority to regulate fracking, municipal governments could control drilling companies with tools such as land use ordinances. Also, the degree of control that municipal governments have in this matter varies by state. Over the last few years, some municipal governments have attempted to ban fracking within their borders by a range of tools such as ballot initiatives or law suits against state governments and drilling companies.[1]

If a state government favors to continuing fracking activities but there is resistance from municipal governments within its boundaries, state officials might try to mitigate the local-level resistance by funneling more transfers to the municipalities that are more likely to implement bans on fracking or to sue related parties. This implies that we need to observe strategic transfers to Democratic-leaning counties. However, this mechanism is also not supported by the data as well. As Table 2 suggests, we see the opposite pattern.

The third potential mechanism is electoral politics. The extant literature suggests that resource booms can influence the incentives of politicians (Mehlum, Moene, and Torvik 2006; Robinson, Torvik, and Verdier 2006) and could even influence who comes to power (Monteiro and Ferraz 2012; Brollo et al. 2013; Carreri and Dube 2015). Aligned with the current research, it is possible that Republican-controlled state governing bodies might

[1]For an example of a government's ballot initiative of a local government, see https://ballotpedia.org/City_of_Denton_Fracking_Ban_Initiative_(November_2014). For an example of a law suit between a municipal government and a fracking company, see http://www.nortonrosefulbright.com/files/20130723-analysis-of-litigation-involving-shale-hydraulic-fracturing-104256.pdf (p.52).

send more transfers to gain electoral advantages. Fedaseyeu, Gilje, and Strahan (2015) show that the vote shares of Republican candidates in presidential, congressional, and gubernatorial elections increased after fracking booms. They attribute this to the income effect.

We present another mechanism of electoral advantage: campaign contributions. Given that states have the main authority regarding fracking activities, we focus on elections to state legislatures. We analyze campaign contribution patterns in state legislature elections from 1998 through 2012. For each cycle, we calculate the total contributions given to Democratic and Republican candidates at the state level and examine whether statewide fracking activities are associated with increases in contributions to Republican candidates.[2] We also incorporate the information on the ban of independent expenditures before the *Citizens United* decision in 2010 at the state level (Klumpp, Mialon, and Williams 2015). Twenty-two states had independent expenditures bans before the Supreme Court's decision in 2010. we run the following regression:

$$\begin{aligned} Contribution_{it} = \beta_1 * \text{Fracking}_{t-2} + \beta_2 * (\text{Fracking}_{t-2} \times \text{IE Ban}) + \beta_3(\text{IE Ban} \times \text{Post CU}) \\ + \beta_3 * (\text{Fracking}_{t-2} \times \text{IE Ban} \times \text{Post CU}) + \alpha_s + \alpha_t + \varepsilon_{ist} \end{aligned}$$

, where i indicates party, s indicates state, and t indicates election cycle. Table A3 presents the results. In the states where independent expenditures were banned before *Citizens United*, fracking activities increased the total campaign contributions both for Democrats (Column (1)) and Republicans (Column (2)), but the contribution increase was much larger for Republican candidates (Column (3)). This Republican advantage in contributions to state legislators in fracking states may be related to strategic transfers from the Republican-run state governments to counties.

[2]Data Source: Bonica (2013).

	(1) Contributions to Democrats	(2) Contributions to Republicans	(3) Ratio of Contributions to Republicans
Fracking	7018.8	1896.6	-0.000302
	(0.56)	(0.16)	(-0.81)
Fracking X IE Ban	31575.8*	121806.9***	0.000928*
	(2.09)	(7.18)	(2.27)
IE Ban X Post Citizens United	-1755092.6	-1502251.6	-0.00681
	(-1.35)	(-1.27)	(-0.20)
Fracking X IE Ban X Post Citizens United	24455.1***	117558.6***	0.000256
	(3.27)	(7.57)	(0.89)
Constant	5872919.2***	5358103.9***	0.512***
	(7.05)	(6.59)	(44.91)
State fixed effects	Y	Y	Y
Election Cycle fixed effects	Y	Y	Y
Sample Size	362	360	360
adj. R^2	0.907	0.898	0.730

Table A3: State-clustered standard errors in parentheses. * p<0.05, ** p<0.01, *** p<0.001.