Decomposing the local public fiscal response to resource windfalls

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Abstract

This paper empirically estimates the fiscal response of local governments to natural resource windfalls. The fracking boom in Texas is used to specifically identify how local governments in a developed country allocate local government windfalls. We use difference-in-difference estimations to identify impacts for both local general purpose governments, as well as local single purpose school districts. This distinction is important because of how both types of local governments are differently affected, both in terms of their revenues as well as their responsibilities with regards to (possible) negative externalities from the fracking-boom. We find that general purpose governments receive a property tax windfall, and only a very small sales tax windfall. These governments expend a considerable share of their new resources on coping with changes caused by the boom. Specifically, we see increased spending on police, judicial administration and roads. These extra expenditures however, do not exhaust the extra resources. We observe a large build-up of cash balances, and as well a reduction in the issuance of new debt. School districts appear to be following a different path, consistent with their different institutional context. Despite their reduction in state aid, we find that school districts receive a serious property tax windfall. These windfalls are used to increase capital expenditures on education. Unlike general purpose governments, we find school districts in treated counties have added on substantial new debt. This debt has the result that school districts are allowed to charge higher property tax rates than otherwise would be permitted without debt.

Keywords: Windfall, fiscal response, fracking, diff-in-diff

JEL classification: H7, L71, Q35, R51

1. Introduction

This paper is an empirical exploration of how local governments utilize financial windfalls. The example we use is the fracking boom in Texas, where the technical change in natural gas and oil extraction has led to large increases in primarily property tax revenues for local governments. The issue of how the governmental financial windfall is expended is interesting, because it reveals several new attributes of how local governments handle unexpected financial gains. There is an extensive literature on resource and exchange rate windfalls in developing economies, where absorptive capacity and corruption are major issues (e.g. Caselli & Michaels, 2013; Larraín & Perelló, 2019; Van Der Ploeg & Venables, 2011). Our goal however, is to discover insights into how local governments in a developed country context solve the more complex problem of using a resource windfall in a potentially useful manner that is possibly sustainable. That is, while permanent income may have increased, the cash flows are lumpy, and of uncertain duration. We therefore use a difference in differences strategy to isolate how local governments spend their new property tax revenues.

There are not strong public choice theories to explain how governments might allocate resources optimally over time, especially considering the extant institutional environment. Theories such as the median/representative voter model (MVM), have been oriented towards understanding how governments react to their current income. Much less is known, however, about how governments should act in a dynamic setting. For example, governmental income is equivalent to individual income in the MVM, in which case the increase in government expenditure should be dictated by the income elasticity of demand, with most of the funds returned to taxpayers.

On the other hand, if consumers are undisciplined, it is possible they would like the government to hold their savings for them. Since governments are run by individuals, however, it seems unlikely that governments would be more disciplined than individuals unless institutional constraints have been created. Further, information asymmetries or other frictions between the government and individuals might suggest that governments would rather use windfalls for the gains of the current government. For example balanced budget constraints, generally directed at limiting current expenditures to be no more than current revenue (Mahdavi & Westerlund, 2011; Westerlund, Mahdavi, & Firoozi, 2011), are generally silent in terms of savings accounts.[1] This paper is an empirical exploration of what, in fact, choices are made by governments that experience windfalls.

We conduct our analysis on local governments in Texas that have experienced a windfall in revenue from the fracking boom. The fracking boom started approximately in the year 2000, and is the result of a combination of two new technologies: horizontal drilling and hydraulic fracturing (Jackson et al., 2016; Zwick, 2018). The new technology was first used to re-drill older vertical wells but, starting in 2009, new well designs were created (Zwick, 2018). These new technologies result in land with mineral rights being much more valuable, creating a significant increase in the property tax base for local governments (Bartik, Currie, Greenstone, & Knittel, 2019). Further, constructing a well is quite labor intensive, possibly resulting in sales tax increases in the short term for localities that levy state permitted sales taxes (Zwick, 2018).

One challenge for our analysis of governmental views towards the future is that the technology of fracking also causes governmental service strains. That is, the towns where fracking is geologically possible generally have small populations, so that the large but temporary inflow of workers when a well is drilled can have significant impacts on public services. These impacts are generally temporary, however, so the longer term budgetary impacts are likely to reflect changes for the original population plus the much smaller number of new permanent residents. The evidence thus far seems to find fracking to be largely budget neutral or even positive for local governments, even concurrently with the temporary population influx, with slightly higher positive revenue effects than expenditure effects (Bartik et al., 2019; Newell & Raimi, 2015).

An important attribute of our estimation strategy is we examine both general purpose governments (counties and cities), as well as single purpose independent school districts. The importance of the

[1] Local governments have various cash accounts, sometime centralized but often located in individual administrative structures where funds are allowed to be saved. Sweeping these funds encourages end of year spending, which has its own set of management problems. Explicit saving accounts, generally called rainy day funds, are generally small and the Census of Governments does not even collect the data on their size.

distinction lies in the incidence of the windfall revenues. For example the worker influx associated with fracking has created well known problems associated with temporary residents that can be manifested by increases in demand for a variety of services. Single purpose school district governments, however, have a more direct process by which revenue is either expended on their single purpose education, or returned to taxpayers. Our empirical analysis shows that the well-known attribute of governments where money "sticks where it hits" is still valid.[2] That is, windfall tax revenues are not fully returned to taxpayers.[3] Further, we find that general purpose governments seem sensitive to the temporary nature of their new revenue by avoiding permanent commitments. This political concern constrains government behavior, and is illustrated well by our alternative institutional comparison. Surprisingly, however, we find school district governments take on new debt, so that the new tax money can be used for debt service expenditures on non-recurring capital goods. This suggests to us a potential distortion in the relative capital intensity of public service provision.[4] Finally, we find that some money is saved for the future, although doing so in cash accounts without an institutional setting may not be ideal.

Our paper proceeds as follows. We first summarize the literature on resource windfalls and fiscal responses, thereby describing the fiscal response options available to local governments. Furthermore, we highlight how general purpose governments are likely to respond differently from school districts. Subsequently, we describe the data we use for the empirical analysis. Specifically, fracking is only appropriate in certain geological contexts, and we describe how this represents an exogenous increase in local resources. We also utilize Census of Government detailed data on revenues, expenditures, and the capital account. We follow the empirical strategy as laid out in Bartik *et al.* (2019), and use difference in differences estimation for local governments that are within geologic areas where fracking

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[2] This feature was originally referred to as the "flypaper effect," and applied to local governmental receipt of external grant revenues (Oates, 1972). One interesting aspect of the flypaper effect was the discussion as to whether it is a result of spending requirements internal to the grant, or to general government behavior (Craig & Inman, 1986). That we find it here powerfully suggests it is a feature of government behavior in general.

[3] The exception is utility charges, but these may be tax expenditures for low income assistance rather than general,

[4] There are new risks as well, if the windfall resource flow does not last as long as the debt service payments.

methodologies are effective over the years 1997-2017. This is followed by a discussion on the implications of our results for how institutional constraints impact governmental usage of windfall resources. A final section summarizes and concludes.

2. Fracking Windfalls and Possible Government Responses

The purpose of our empirical investigation is to build a set of "stylized facts" for understanding how governments have responded to new revenues from an exogenous source. Our empirical example is to use local governments in Texas that are located in geologic areas where the new oil recovery technique called "fracking" can be used. Fracking is the combination of using horizontal drilling with hydraulic fracturing (Jackson et al., 2016; Zwick, 2018) that opens up the opportunity of accessing previously unreachable oil and gas minerals.[5] (Wang & Krupnick, 2015). Our strategy is to use a difference in differences empirical specification to compare local governments in areas where fracking can occur to those without any such possibilities. We examine government revenues by source, expenditures by category, as well as government deficits (surpluses) and debt. As discussed in the introduction there are few, if any, theories that clearly describe theoretical expectations for government treatment of windfall revenues. We believe the stylized facts we present here will be helpful in developing such theories.

The spectrum of government responses will be interesting in differentiating possible theories predicting government behavior. One limitation on such theories is that individual behavior in response to windfalls is not fully understood, as there is still a large and active literature (e.g. Augenblick, Niederle, & Sprenger, 2015). Governments are required to form expectations over the duration of windfalls, as well as their size over time. There are many embedded shadow fixed costs, such as for example the political difficulty in stopping a program once it is started. Further, especially school districts need to understand the impacts of what appear to be local windfalls if state aid is reduced in response to local revenue. Finally, institutional administrative details may impact the governmental choices concerning

[5] Besides fracturing oil and gas, the new technology also opened up new opportunities in sand mining. This is not part of our analysis. However, another paper found that it is associated with lower population growth, positive income effects, and no employment growth effects (Deller & Schreiber, 2012).

expenditures in the current budget, subject to balanced budget constraints, compared to the capital budget.

In some sense, school districts might be expected to operate very similar to the general purpose governments. They have essentially the identical electorate, and are serving the same population. There are two important differences, however, that might impact the governmental response. One is that the subset of the population which is served by school districts is likely to be less transient, since presumably children would generally be from less mobile households. The other is that school districts are more directly regulated by the state government. One area of regulation is in the teachers' labor market, where there are limits on who can be hired, in some terms of their compensation, and in the production function through limits to class sizes. The other important area for our purposes is the impact of state financial aid. State aid is generally income conditioned, and school districts may allocate budgets differently than general purpose governments if there are impacts on the "implicit tax" in state aid formulas.

The fracking-boom terminology already suggests a boom-bust cycle associated with it. This is substantiated by the structure of the fracking activities. The creation of a well takes between three to six months on average, during which, at peak time, around 900 workers are needed for only a short period of time. Once the well is drilled, however, the change in the permanent workforce generally results in only 13 full-time employees for a year (Zwick, 2018). This activity, however, generates substantial local incomes. For example (Christopherson & Rightor, 2014; Fetzer, 2014; Feyrer, Mansur, & Sacerdote, 2017; Weber, 2012) estimate each million dollars of new production creates $80.000 in wage income and $132.000 in royalty and business income within a county (Feyrer et al., 2017).

The other aspect of the fracking technology is that there are costs to the local population. There are some potential environmental effects on both the water supply, and potential earthquakes. Bartik *et al.* (2019) estimate the willingness-to-pay for negative externalities of fracking at around $2.500 per capita, although it is heterogenous running from practically $0 to $10,000. The other costs come from the temporary nature of much of the drilling work. To the extent the temporary workforce consists of primarily younger unattached males, some social costs may be incurred. In addition, the local transportation network may be more heavily utilized. Thus, we will compare the increase in public expenditures in areas that potentially may be impacted by the actual fracking work to categories that are likely to primarily benefit the local incumbent population.[6] The following section discusses literature related to the different fiscal categories. This is followed by a discussion on the difference between general purpose governments and school districts.

2.1. Fiscal response to windfalls

This section examines the categories of the public sector fiscal environment. Specifically, we will first examine how both the property and sales tax revenues have changed in response to the presence of fracking.[7] Second, we will examine expenditures in the two different types of governments by category. And finally, we will discuss how the capital side of the public sector budget might change.

2.1.1. Revenues (windfalls)

Property taxes are the main source of revenue for local general purpose governments, although they also are able to use the sales tax to some extent. In appropriate geologic areas, the invention of fracking would be expected to result in increased property tax base (Weber, Burnett, & Xiarchos, 2016).[8] Alternatively, there is also evidence of reductions in property values due to the risk of groundwater contamination (Boxall, Chan, & McMillan, 2005). Muehlenbachs, Spiller, and Timmins (2016) find small positive house price changes within two kilometers of a well, but a negative effect if the house is dependent on well water. Another possibility is that the property tax system may have serious lags in re-assessments, in which case changes in tax revenue may not occur during the time period of our study.

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[6] It would be interesting if there were straightforward ways to measure public sector output to determine those where an increase in expenditure would keep output per capita about constant, to those categories where increased expenditure results in an increase in output per capita. Absent such measures, our examination will be somewhat ad hoc.

[7] Unfortunately, we are unable to distinguish between changes in the tax rate and the tax base for the property tax. Our assumption for the property tax is that without a change in the tax base there would be no change in the tax rate. For the sales tax, local governments are able to add up to 1% to the state sales tax, but the state government determines the tax base.

[8] The value changes will be on the owner of the mineral rights, which are sometimes separated from the owner of the surface rights.

Further, if the duration of the wells is short, the value may be extracted before re-assessment (Zwick, 2018).

The population growth effect associated with fracking also means that local public revenues may increase due to an increased tax base (Christopherson & Rightor, 2014; Newell & Raimi, 2015), although this does not have to translate into increased per capita revenues. This can occur due to sales taxes from more people, or because population pressure increases property values. Further, if local incomes increase then both sales may rise, and housing improvements may increase property values. (Christopherson & Rightor, 2014; Newell & Raimi, 2015).[9]

2.1.2. Savings and Capital Expenditure

The Permanent Income Hypothesis (PIH) would suggest that local governments should use savings to hold constant the level of resource wealth, with consumption being equal to the interest on the stock of wealth (Venables, 2010). Local governments do not generally have savings accounts, however, so there may be institutional factors working against savings. Bautista et. al. (2020), however, find that governments can save through general cash accounts.

Another potentially relevant institutional feature is the balanced budget constraint under which local governments operate. This charter feature requires that current expenditures do not exceed current revenue. Generally capital goods are exempt from this requirement. The balanced budget constraint, however, does not require that expenditures consume all current revenue.

An additional attribute is that politicians, and indeed taxpayers, may be impatient to the extent that their internal discount rate exceeds market interest rates. If this is the case, there may be some pressure to expend new resources on current account categories. A more moderate possible response is to increase

[9] Through interviews with local governmental officials, Newell and Raimi (2015) show that the local public revenue effects of fracking may differ across states. For Texas, they find no severance tax, impact fee, or in-kind-transfers from the oil and gas companies. They do find that affected counties in Texas profit from increased property taxes, and affected municipalities source more sales tax, and fee-for-service or lease revenues. Bartik *et al.* (2019) find that the fracking boom increased property tax revenues, and sales tax revenues.

capital spending, so that at least the extra expenditures are distributed over the life of the capital assets. This response might also be considered to counter uncertainty over the length in time of the windfall.

Finally, the median (representative) voter models suggest that assets to be saved should be returned to taxpayers so households can solve their optimal lifetime problems. The flypaper effects literature, however, is one that suggests that governments may not be as flexible as the median voter model assumes. While there are not yet many models that incorporate all of these various features into a model of government behavior, our examination of how the tax windfalls from fracking are used will help establish the relative importance of savings, capital expenditure, and impatience in explaining government behavior.[10]

2.1.3. Utilities

Another governmental choice which has occurred in especially developing countries is that windfall resources could be used for subsidies, and replace public charges for service. Most of the local general purpose governments in Texas operate water and sewerage systems, and some operate additional facilities. We will therefore examine whether utility charges change in local governments experiencing the fracking boom.

2.1.4. Use to combat "congestion"

One interesting question that has been frequently addressed in the literature on the effects of the fracking boom is whether the incumbent population is better off, or whether the new population and industrial activity congests existing public services. Our study cannot directly address this question since we do not have data on public output, but we can present some suggestive evidence on the possibilities. The increased population as well as industrial activity resulting from the fracking-boom may mean that increased local government spending does not result in increased public service outputs, but the new spending on services and infrastructure is used to support the increase of population and industry (Newell & Raimi, 2015; Zwick, 2018). Abramzon *et al*. (2014) estimates that each hydraulically-fractured well in Pennsylvania was responsible for damage to local roads between $13,000 and $23,000

[10] Craig, et. al. (2016) have recently tested a buffer stock model of government behavior, which incorporates a trade-off between impatience and risk aversion from running out of public funds.

per capita. To the extent transient workers are different demographically, for example younger and more male, spending priorities may change (Jacquet, 2009; Zwick, 2018). These spending changes may or may not result in equal benefits per capita to the incumbent population. What we can test, however, is whether funds are expended on other categories that are more likely to benefit current residents, such as parks and community development, and capital spending.

2.2. General purpose governments vs. school districts

One advantage of our data is that in addition to general purpose governments, we include single purpose school districts. These governments generally are responsible for K-12 education, and are independent of any other government. That is, independent school districts are governed by their own elected school board, set their own property tax rates within the rules set by the state, and have the authority to issue debt. They are financed on average almost equally by property taxes, and grants from the state government. As in most states, state education aid is granted per student inversely to local wealth, so the prospect of reductions in state aid will mitigate the impact of any increases in local incomes (Biolsi & Craig, 2020).

It is unclear what the relationship between windfall resources and education expenditures should be. On the one hand, increased revenues may free up money to invest in education. On the other hand, the literature on the resource curse shows how there may be a negative relationship. The observation of countries or regions that are rich in natural resources showing relatively lower economic growth because of a decline in educational attainment has been well documented (Cockx & Francken, 2016; Weber, 2014). Typically, empirical studies on the resource curse use cross-country studies (Auty, 2001; Cockx & Francken, 2016; Sachs & Warner, 2001; Van Der Ploeg, 2011), but there is also growing within-country evidence (James & Aadland, 2011; Papyrakis & Gerlagh, 2007). That is, as the local population is less incentivized to invest in education, local public education expenditures may simply decline as a result of a decline in demand.

There are three ways in which we would expect general purpose governments and school districts to differ in how they are fiscally affected by fracking, stemming from their differences in: (1) revenue composition, and (2) responsibilities. These differences are discussed in detail below.

2.2.1. Revenue composition

The revenue composition of both types of local governments differ. We find that school districts source nearly all their revenues through property tax and intergovernmental transfers. Conversely, general purpose governments source their revenues through more varied components, including large revenue shares from sales taxes, charges and utilities.

Fracking activities may differentially affect the revenue sources. Presumably, property tax increases primarily accrue to local land owners, whereas additional sales tax funds may be from the temporary population influx. In that case, one could see how the property tax windfalls may be of longer-term than those from other revenue sources. Therefore, a general purpose government may find half of its windfalls to be relatively short-term from the population influx, whereas school districts only experience the long-term windfall through increased property taxes.

2.2.2. Responsibilities

Population influx and greater industrial activity are expected to increase demands for local public services that are the responsibility of general purpose governments. If the population influx has different demographic characteristics, police and social services may require extra spending to keep service per capita about constant. Similarly, road expenditures may need to increase to compensate for extra usage. Our estimates will help to determine if the windfalls are larger than the additional expenditures, in which case there may be resources to make local incumbent residents better off.

Conversely, school districts do not experience such costs. While, one may hypothesize the population influx to increase the number of students, it is not evident that this should increase expenditures per capita or per student. Empirical literature suggests that it is not uncommon for school districts to generate extra revenues over time. Davis and Ferreira (2017) describe how the U.S. public schools grew by 41% in real terms from 1990 to 2009, because of a phenomena they describe as the "housing disease". This is "*a fiscal externality from local housing markets in which unexpected booms generate extra revenues, that school administrators have incentives to spend, independent of local preferences for provision of public goods*" (Davis & Ferreira, 2017). They find that school districts generally use their increased spending on instruction and capital projects, rather than increases in administrative costs. Similarly, Fraenkel and Krumholz (2020) find that school districts use additional revenue gained through new plant openings to (mostly) fund capital expenditures. They also show that school district debt is used to fund these capital expenditures. Thus, in line with those findings, we might expect school districts to use their additional revenues to fund capital expenditures.

3. Data and identification

The panel data set we construct to test the public sector consequences of resource windfalls includes county governments and cities in Texas as the general purpose governments. We start our data series in 1997, before the widespread adoption of fracking technologies, and the data run until 2017. The unit of observation in our data is the county, so the local general purpose governments are aggregated by county. Additionally, our data includes the activities of the single purpose independent school districts.[11] The fiscal activity is aggregated to the county level to match the available data on fracking activity.[12]

Data on the fiscal components comes from the quinquennial (in years ending in 2 and 7) Census of Government Finance, and from the Annual Surveys of State and Local Government Finance, of the US Census Bureau. This has local public fiscal data for independent local governmental entities. We have interpolated the data in the Annual Surveys using constant percentage change in-between the Census data years to form a complete panel. We collapse the general purpose and separately, school districts, to form fiscally standardized counties in line with the work on Fiscally Standardized Cities Database by the Lincoln Institute of Land Policy (Langley, 2016) and Bartik *et al.* (2019). This means that we collapse the general purpose local governmental entities (counties and municipalities) into one fiscally standardized general purpose government. Similarly, we aggregate all the school districts into one entity per county. Intergovernmental transfers between local governments are deducted from total revenues, total expenditures and total intergovernmental transfers in order to avoid double counting. The fiscal components are measured in (real 2015) $1000 per capita.

[11] Other special district governments are omitted, both because they vary in function and because they are not universal.

[12] This also has the advantage that our results are reduced form from governmental interaction.

Table 1 below presents the means for the general purpose governments, differentiated by whether they are treated, in the sense of being in geologic zones with high fracking activity. There are 20 counties in these zones, and 420 counties outside of these zones. The counties in the zones are shown in the table to have about 48% higher property tax revenues than those outside, suggesting they were already in relatively oil rich areas. Thus, the windfall revenues from fracking might be interpreted in the face of already declining revenues from decline in conventional oilfield activity.

The higher property tax levels in the treated counties is shown in Table 1 to be spread rather evenly throughout the expenditure categories. Further, the debt levels in these counties are lower than those in the treated counties. Further, there is more cash in the *other funds* category, which is the unencumbered cash within the government.

Table 2 shows a similar distinction for school districts. Total revenues are about 35% higher than in the untreated counties. Part of the smaller increment can be seen in the much smaller level of state aid for schools in the treated counties, reflecting the equalizing nature of the state aid formula. The limitations on equalization in the state aid formula, however, can be seen by the much larger difference in mean revenues at the end of the sample compared to the beginning.

The most interesting difference in the means that we explore in our statistical analysis below is in the capital account. While capital outlays in the treated counties on average are higher than in the non-treated, we see that at the beginning of the sample capital expenditures were about equal. All of the increase has occurred since the advent of the fracking windfalls. This activity is also reflected in the debt levels, which after starting from much lower debt levels in the treated counties, total debts in the treated counties become much larger than in the non-treated.

Table 1: Sample means for the General Purpose Governments ($000's per capita, 2015 dollars)

	Treated			Non-treated		
Variable	1997-2017	1997	2017	1997-2017	1997	2017
Total revenues	1.787	0.742	3.349	1.205	0.574	1.887
Property tax	0.627	0.229	1.368	0.408	0.182	0.743
Sales tax	0.150	0.048	0.268	0.130	0.058	0.224
Intergovernmental	0.294	0.091	0.843	0.120	0.039	0.174
State aid	0.175	0.034	0.584	0.074	0.027	0.122
Charges	0.380	0.182	0.444	0.220	0.113	0.323
Utilities	0.183	0.090	0.262	0.188	0.101	0.258
Water	0.106	0.055	0.153	0.101	0.055	0.158
Electricity	0.054	0.023	0.073	0.075	0.039	0.090
Gas	0.023	0.012	0.035	0.012	0.008	0.010
Transit	0.001	0.000	0.001	0.000	0.000	0.000
Total expenditures	1.605	0.677	2.546	1.156	0.542	1.809
By type						
Current operations	1.363	0.591	2.149	0.977	0.466	1.548
Capital outlay	0.195	0.059	0.328	0.129	0.050	0.189
Construction	0.138	0.028	0.287	0.090	0.027	0.141
Salaries & wages	0.512	0.257	0.594	0.362	0.189	0.547
By purpose						
Welfare & health	0.207	0.122	0.328	0.117	0.056	0.168
Public welfare	0.019	0.004	0.034	0.021	0.009	0.036
Public safety	0.389	0.130	0.472	0.244	0.098	0.451
Police	0.148	0.059	0.243	0.138	0.060	0.247
Correctional facilities	0.198	0.054	0.163	0.069	0.020	0.149
Infrastructure & utilities	0.406	0.183	0.639	0.368	0.190	0.516
Highways	0.185	0.075	0.391	0.139	0.072	0.231
Sewerage	0.051	0.023	0.049	0.047	0.024	0.064
Utilities	0.158	0.081	0.184	0.172	0.092	0.206
Community	0.120	0.061	0.166	0.086	0.047	0.112
Parks & rec	0.053	0.019	0.080	0.032	0.014	0.044
Other expenditures	0.481	0.182	0.938	0.341	0.151	0.561
Financial adm	0.078	0.044	0.102	0.056	0.033	0.072
Judicial adm	0.095	0.025	0.180	0.064	0.025	0.125
Interest on debt	0.031	0.015	0.043	0.031	0.015	0.038
Outstanding debt	0.862	0.273	1.196	1.011	0.346	1.504
Debt issued	0.135	0.027	0.053	0.150	0.032	0.095
Debt retired	0.115	0.043	0.204	0.157	0.031	0.167
Cash holdings	1.010	0.315	2.637	1.217	0.367	2.289
Offsets to debt	0.066	0.047	0.138	0.405	0.101	0.463
Bond funds	0.076	0.025	0.102	0.095	0.033	0.140
Other funds	0.856	0.238	2.364	0.660	0.209	1.585
# Observations	420	20	20	4767	227	227

Note: the unit of observation is the county, where general purpose governments (counties and municipalities) are aggregated net of local transfers. The data are per capita, in real terms. Treated counties are those counties which are identified as fracking counties based on their geological composition, see figure 2 (using (Bartik et al., 2019). *Untreated counties are the remaining counties.*

Table 2: Sample means for the School Districts ($000's per capita, 2015 dollars)

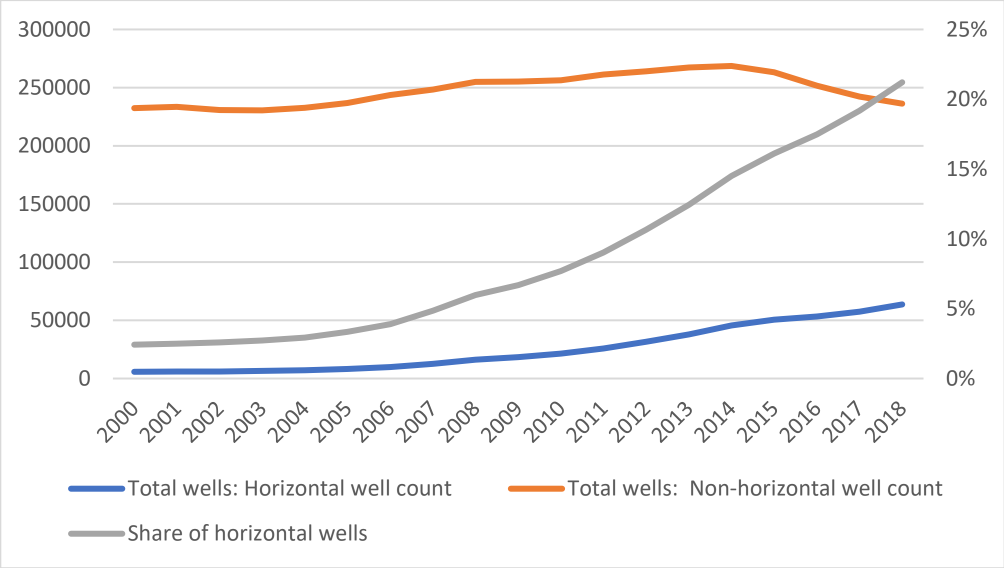
	Treated			Non-treated		
Variable	1997-2017	1997	2017	1997-2017	1997	2017
Total revenues	2.569	1.044	4.354	1.900	0.985	2.653
Property tax	1.709	0.484	3.164	0.891	0.404	1.261
Intergovernmental	0.735	0.483	0.971	0.880	0.500	1.203
State aid	0.718	0.471	0.945	0.848	0.479	1.158
Total expenditures	2.623	1.030	4.511	1.948	0.975	2.829
By type						
Current operations	1.583	0.855	2.261	1.471	0.805	2.051
Capital outlay	0.373	0.119	0.536	0.241	0.115	0.455
Construction	0.323	0.080	0.475	0.198	0.082	0.401
Salaries & wages	1.044	0.603	1.403	0.983	0.565	1.297
By purpose						
Elementary & sec educ	2.512	1.003	4.263	1.810	0.923	2.607
Interest on debt	0.067	0.008	0.157	0.050	0.012	0.096
Outstanding debt	1.801	0.154	4.481	1.244	0.225	2.596
Issued debt	0.397	0.023	0.792	0.231	0.037	0.366
Retired debt	0.219	0.013	0.741	0.134	0.022	0.282
Cash holdings	1.573	0.312	3.141	1.049	0.382	1.652
Offsets to debt	0.043	0.006	0.143	0.032	0.011	0.092
Bond funds	0.464	0.031	1.206	0.243	0.055	0.373
Other funds	1.066	0.275	1.792	0.773	0.316	1.186
# Observations	420	20	20	4767	227	227

Note: The unit of obsercation is the county, where single purpose school districts are aggregated to the county net of local transfers. The data are per capita, in real terms. Treated counties are those counties which are identified as fracking counties based on their geological composition, see figure 2 (using (Bartik et al., 2019). Untreated counties are the remaining counties.

We use the advent of fracking in Texas to model our windfall governmental revenues. That is, drilling had been declining in many Texas oil counties for a couple of decades. The expectation was that this trend would continue as the oil and gas became more difficult and expensive to extract. The invention of horizontal-hydraulically fractured oil and gas wells reversed this trend. To insure that the windfall revenues are orthogonal to the fiscal behavior of local governments, we employ the Rystad identification as developed by Bartik et. al (2019).

The fracking-boom is evidenced by the growth in the share of horizontal wells as shown in Figure 1. Non-horizontal wells, as shown in the top line, are about constant over the period 2000-2018 where the number of wells is indicated on the left-hand side axis. In contrast, horizontal wells (fracking) as shown in the bottom line start from virtually zero in the year 2000, and increase dramatically over this period (again, the number of wells in on the left-hand side axis). The grey line shows the share of the total that are horizontal as indicated on the right-hand side axis, which increases to over 20% of the total wells.

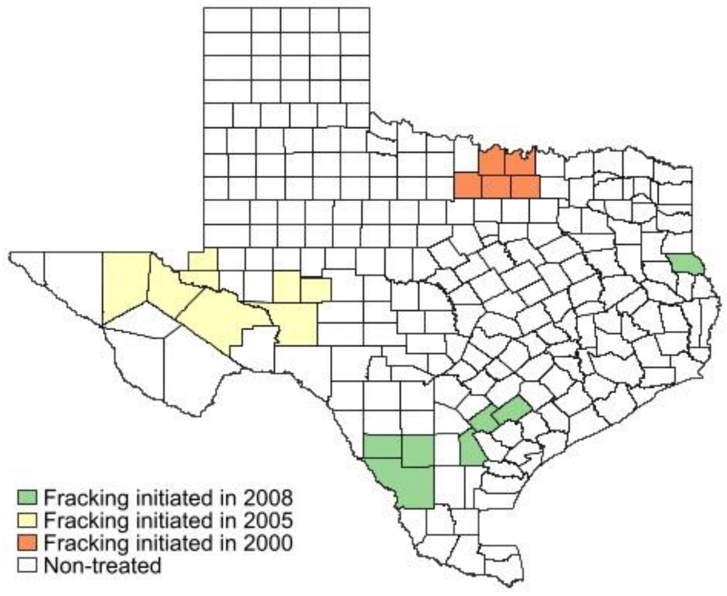
Figure 1: Hydraulically fractured horizontal wells accounted for most new oil and natural gas wells in Texas



Authors own elaborations using data from the Texas Commission on Environmental Quality (U.S. Energy Information Administration, 2019).

The drilling activity underlying the data in Figure 1 is driven much more by geology than by governmental action. Nonetheless, to insure that this is true, the diff-in-diff estimations use the Rystad identification as developed by Bartik *et al.* (2019). The identification comes from the Rystad Energy prospectivity index, which *"captures the potential productivity of different portions of shale plays based on a nonlinear function of the different geological inputs"* (Bartik et al., 2019). Bartik *et al.* (2019) aggregate the Rystad prospectivity index up to the county level and subsequently divide the counties in each shale play into Rystad score quartiles. This identification has the benefit of ensuring exogeneity as it is constructed from the geological features of the area. The identification from Bartik *et al.* (2019) has been applied here, and results in the counties where fracking is geologically worthwhile may be found in Figure 2.

Figure 2: Treated counties from application of Bartik et al. (2019)



Note: The prospectivity score classification comes from Bartik et al.(2019). The authors of this paper created this map with the prospectivity score classifications just for Texas for the sake of this paper. The top quartile represents those counties as "fracking counties". The remaining categories identify the various shale-plays or no shale-plays.

We decompose the fiscal effects into the effects on general purpose governments and school districts, where general purpose governments consist of county and municipal governments. We do this by summing up the local public finance data for each specific type of local governmental entity in a given county. We leave special districts out of the analysis given that the types of special districts may vary widely making it difficult to interpret.[13]

Texas is home to some of the least populous counties in the country, such as Loving County, and King County which only have populations of around 100 and 300 respectively. Similar to Feyrer *et al.* (2017) we exclude the least populated counties because the results are sensitive to the inclusion of these counties. Especially Loving County is found to be an outlier affecting our results[14]. However, instead of using the

[13] We did perform estimation on special districts finding no significant effects.

[14] Loving County has a big oil industry, which appears to have been affected by the fracking-boom. Total revenues per capita increased from around 15 thousand real USD per capita in 2000 to around 55 thousand in 2008, which has been slowly declining ever since.

2% threshold like Feyrer *et al.* (2017), we use a threshold of a population of 1000 (in the year 2000) as to also exclude McMullen county which is also found to be an outlier heavily affecting the results. Our threshold means that we exclude 7 out 254 counties, or around 2.75%. **Error! Reference source not found.** shows the population per county in 2000, as well as the counties that are excluded from the estimations.

4. Estimation strategy

The estimation follows the work of Bartik et al. (2019). This means that we start with the following equation for outcome fiscal component y, in county c, shale play p, and year t:

(1) $y_{cpt} = \mu_{pt} + \gamma_c + \delta(\mathbf{1}[Post - fracking]_{pt} * \mathbf{1}[Rystad\ top\ quartile]_{\boldsymbol{c}}) + \boldsymbol{\epsilon_{cpt}}$

The equation includes year-by-play fixed effects (μ_{pt}) and county fixed effects (γ_c). *Post-fracking* equals 1 in the year that fracking initiated and all subsequent years. The *Rystad top quartile* is the identification as used by Bartik *et al.* (2019). It has a value 1 when the maximum prospectively value within county *c*, is in the top quartile for counties in shale play *p*.

The fiscal outcomes we will pursue include the revenue, expenditure, debt and cash outcomes for each type of government aggregated at the county level. For general purpose governments both sales tax and property tax revenues are important. For school districts only the property tax is relevant, although we also examine for state aid offsets due to the potentially higher tax base. We examine both current and capital spending, and by category. Furthermore, we examine cash holdings, as well as debt and the associated cash accounts. The cash accounts include bond funds, which are borrowed funds being held until spent on capital projects, as well as offsets to debt, which are sinking funds to be used to repay bond principal when the bonds mature. Finally, we examine other cash held, which among other uses includes essentially saving.

Given that fracking was initiated at different points in time in the various shale plays, there is a difference in the number of years pre- and post-fracking for the shale plays. A shale play is a specific geologic feature which is conducive to the fracking technology. This means that a county located in a shale play which initiated fracking in 2000, has 3 years pre-fracking and 17 years post-fracking in our dataset.

However, counties where fracking initiated in 2008, show 11 years pre- and 9 years post-fracking. This creates an unbalanced dataset and means that we have a balanced dataset for 3 years pre-fracking, and 9 years post-fracking.[15] An indicator is included for the observations that fall outside this time-frame:

(2) $$y_{cpt} = \mu_{pt} + \gamma_c + \delta_1(\mathbf{1}[Post - fracking]_{pt} * \mathbf{1}[Rystad\ top\ quartile]_{\boldsymbol{c}}) + \delta_2(\mathbf{1}[Unbalanced\ sample]_{ct} * \mathbf{1}[Post - fracking]_{pt} * \mathbf{1}[Rystad\ top\ quartile]_{\boldsymbol{c}}) + \epsilon_{cpt}$$

5. Results

We first present the results for how general purpose governments have been affected by the windfall resources associated with fracking. Our interest is in whether any of the resources are saved, and in how government expenditures have changed. We are also interested in whether the changes affect only the current budget, or are carried over into the capital budget. The second set of results will be for school districts. Our interest here is whether these single purpose governments essentially mirror general purpose governments, or whether the interaction with the state government causes differences.

The estimates we present below are the standard diff-in-diff specification as presented in equation 2 to explore how budgets have changed for communities affected by fracking. We present results for two specifications, one with standard fixed effects for years and county, the other introduces in addition play by year fixed effects. While our local governments are already aggregated by county, these latter terms capture variation in the level of fracking activity that is likely to be correlated across counties.[16] We first present results for general purpose governments, and then present the separate estimates for school districts.

5.1. General purpose governments

Table 3 shows the difference in differences (DID) estimation results concerning revenue for the general purpose governments. We find that the addition of the play by year fixed effects does not significantly alter the qualitative or quantitative results. We find that *total revenues* increase significantly by $544

[15] That is, all the shale plays have at least three years pre-fracking, and all the shale plays have at least nine years after fracking has been initiated.

[16] Each play, or geologic formation, covers several counties.

per person annually for local governments impacted by extensive fracking activity. The increase in revenues is shown to be mostly (44%) generated through increases in the *property tax*. Surprisingly, we find that grants from the state government also rise, although only marginally significant at conventional levels. We also find a significant but much smaller impact of sales tax revenues, amounting to about 1/6 of the tax increase from property.

Table 3: Difference in differences estimation results for revenue by general purpose governments

	Time FE		Play-year FE	
Variable	Coef.	Std. Err.	Coef.	Std. Err.
Total revenues	0.535**	(0.225)	0.544***	(0.201)
Property tax	0.237**	(0.100)	0.267***	(0.0882)
Sales tax	0.0418**	(0.0211)	0.0325	(0.0219)
Intergovernmental	0.159	(0.104)	0.171*	(0.103)
State aid	0.0927	(0.0733)	0.101	(0.0712)
Charges	0.106	(0.0857)	0.0839	(0.0837)
Utilities	-0.0161	(0.0186)	-0.0283	(0.0223)
Water	-0.00320	(0.00813)	-0.00354	(0.00809)
Electricity	-0.0164	(0.0162)	-0.0305	(0.0196)
Gas	0.00339	(0.00386)	0.00567	(0.00376)
Transit	8.23e-05	(0.000226)	5.15e-05	(0.000261)
County FE	Yes		Yes	
Time FE	Yes		Play-year	
Play-year FE	No		Yes	

*Note: robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1. Even though the coefficients are shown below one another, they represent separate estimations. The estimations use equation 2:* $y_{cpt} = \mu_{pt} + \gamma_c + \delta_1(\mathbf{1}[Post - fracking]_{pt} * \mathbf{1}[Rystad\ top\ quartile]_{\boldsymbol{c}}) + \delta_2(\mathbf{1}[Unbalanced\ sample]_{ct} * \mathbf{1}[Post - fracking]_{pt} * \mathbf{1}[Rystad\ top\ quartile]_{c}) + \epsilon_{cpt}$*. Separate control strategies are used as indicated in the table. The errors are clustered at the county level. The total number of treated counties are 20, with 227 non-treated counties. Data runs from 1997-2017. Fracking initiated at different times in different shale-plays (2000, 2005, and 2008). This results in 420 treated observations and 4767 non-treated observations.*

One interesting finding relative to the windfall resource literature is that we find small negative coefficients on charges from utilities, although the findings are statistically insignificant. This suggests that windfall resources are not being used to subsidize the fee-for-service operations of local government. Indeed, the charges for other services are found to increase rather substantially, about $106 per person, although also not close to being statistically significant. The conclusion, however, is that there are substantial public fiscal gains, and these gains are not being used to subsidize governmental enterprise activity.

Table 4 presents the DID results for the expenditure categories. The results are largely similar for both sets of fixed effects results. We find that total public expenditure in the general purpose governments rises significantly as a result of the windfall from the fracking boom, about $400 per capita. About 70% of the increase in resources shown in Table 3 is spend on current expenditures, with the remainder being spent on capital. Additionally, however, the results also imply an increase in the budget surplus. Total revenue in Table 3 is shown to rise by about $535, while expenditures are found to rise by about $400. This suggests that we should find a significant buildup of cash within the government, which as we discuss below in Table 6 where we find that *Other Funds* increases.

Table 4: Difference in differences estimation results for expenditure categories by general purpose governments

	Time FE		Play-year FE	
Variable	Coef.	Std. Err.	Coef.	Std. Err.
Total expenditures	0.377*	(0.200)	0.409**	(0.182)
By type				
Current operations	0.277*	(0.165)	0.296**	(0.149)
Capital outlay	0.106*	(0.0614)	0.110*	(0.0603)
Construction	0.0772	(0.0598)	0.0860	(0.0599)
Salaries & wages	0.119*	(0.0705)	0.148**	(0.0589)
By purpose				
Welfare & health	0.00269	(0.0543)	-0.0230	(0.0557)
Public welfare	0.00644	(0.0180)	-0.00234	(0.0256)
Public safety	0.168	(0.139)	0.194	(0.137)
Police	0.0144	(0.0173)	0.0338**	(0.0149)
Correctional facilities	0.145	(0.136)	0.149	(0.136)
Infrastructure & utilities	0.0520	(0.0493)	0.0454	(0.0526)
Highways	0.0584**	(0.0292)	0.0586*	(0.0304)
Sewerage	0.00444	(0.0137)	0.000493	(0.0147)
Utilities	-0.0156	(0.0197)	-0.0185	(0.0226)
Community	0.0207	(0.0140)	0.0237*	(0.0139)
Parks & rec	0.0202*	(0.0113)	0.0187*	(0.0105)
Other expenditures	0.133**	(0.0639)	0.168***	(0.0589)
Financial adm	0.0106	(0.0123)	0.0178	(0.0130)
Judicial adm	0.0487***	(0.0172)	0.0492***	(0.0157)
Interest on debt	-0.000763	(0.0104)	0.00834	(0.00942)
County FE	Yes		Yes	
Time FE	Yes		Play-year	
Play-year FE	No		Yes	

*Note: robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1. Even though the coefficients are shown below one another, they represent separate estimations. The estimations use equation 2:* $y_{cpt} = \mu_{pt} + \gamma_c + \delta_1(\mathbf{1}[Post - fracking]_{pt} * \mathbf{1}[Rystad\ top\ quartile]_c) + \delta_2(\mathbf{1}[Unbalanced\ sample]_{ct} * \mathbf{1}[Post - fracking]_{pt} * \mathbf{1}[Rystad\ top\ quartile]_c) + \epsilon_{cpt}$*. Separate control strategies are used as indicated in the table. The errors are clustered at* *the county level. The total number of treated counties are 20, with 227 non-treated counties. Data runs from 1997-2017. Fracking initiated at different times in different shale-plays (2000, 2005, and 2008). This results in 420 treated observations and 4767 non-treated observations.*

Looking at the individual categories, we see significant increases in police and judicial administration, consistent with some of the commentary on the social impacts of transient workers. Also consistent with the pressures from increased industrial activity, we see that road and highway spending has increased by about $58 per capita. On the other hand, we also see that spending on parks and recreation increased by $20 per capita, or more than double the 1977 mean from Table 1.

The other interesting result in the expenditure table is that salaries and wages are found to rise by $119 per capita. Unfortunately, we do not have the data to decompose this number into employees versus wages. On average it would be expected that wages would rise due to the increased labor demand, and further there would be pressure on the number of workers. The other possibility, of course, is that part of the result is rent-seeking by government workers, to the extent that the resource windfall is not being returned to taxpayers. It is possible that weak support for this hypothesis is provided because *other expenditures* shows a significant increase, only part of which is judicial. Thus the central administration of the government could be expanding beyond what would normally be desired by taxpayers.

The evidence against the rent seeking hypothesis is that despite the increase in wages and salaries, the means from Table 1 show that the 1997 difference between the treated and non-treated communities is smaller in 2017 than in 1997. Unless there is some type of competition between governments where taxpayers mis-perceive the tax price, or some type of copycatting process, it would seem the decreased disparity between labor costs might be more market driven.

The DID results in Table 5 report on whether the debt portfolio of local governments is changing due to the resource windfall. The first column indicates potentially lower *outstanding debt* for general purpose governments exposed to the fracking boom, but the addition of play by year fixed effects shows there is no effect. The result that does carry through for both specifications, however, is that governments exposed to the resource windfall issue less new debt. This finding is consistent with the overall results from Table 4, which showed higher capital spending in exposed governments. The expenditure increase of $106 is statistically equivalent to the $161 decrease (or $126 decrease) in new debt issued. Thus, one way the exposed governments appear to be trying to put money into savings is by reducing their debt load.[17]

Table 5: Difference in differences estimation results for debt by general purpose governments

	Time FE		Play-year FE	
Variable	Coef.	Std. Err.	Coef.	Std. Err.
Outstanding debt	-0.392	(0.252)	-0.0466	(0.144)
Debt issued	-0.161**	(0.0697)	-0.126**	(0.0561)
Debt retired	-0.0622	(0.113)	0.0596	(0.0430)
County FE	Yes		Yes	
Time FE	Yes		Play-year	
Play-year FE	No		Yes	

*Note: robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1. Even though the coefficients are shown below one another, they represent separate estimations. The estimations use equation 2:* $y_{cpt} = \mu_{pt} + \gamma_c + \delta_1(\mathbf{1}[Post-fracking]_{pt} * \mathbf{1}[Rystad\ top\ quartile]_{\boldsymbol{c}}) + \delta_2(\mathbf{1}[Unbalanced\ sample]_{ct} * \mathbf{1}[Post-fracking]_{pt} * \mathbf{1}[Rystad\ top\ quartile]_{\boldsymbol{c}}) + \epsilon_{cpt}$. *Separate control strategies are used as indicated in the table. The errors are clustered at the county level. The total number of treated counties are 20, with 227 non-treated counties. Data runs from 1997-2017. Fracking initiated at different times in different shale-plays (2000, 2005, and 2008). This results in 420 treated observations and 4767 non-treated observations.*

Table 6 shows the DID results on the decomposed *cash holdings*. While we find no significant effect on total *cash holdings*, we do find *bond funds* to decrease significantly. *Bond funds* are borrowed assets that have not yet been spent on their intended capital project. The reduction in these funds is consistent with the reduction in debt issued from Table 5.

The other result in Table 6 is that *Other Funds* are shown to be higher, although the statistical significance is weak in the play-by-year results, and zero in the other. *Other funds* have been found to function at least in part as savings for state governments in Bautista et.al. (2020), and may be serving such a function here for general purpose governments.

[17] To the extent that debt service expenditures is a form of user charge on future residents of governmental assets, it is possible that overall efficiency actually falls. This would be an institutional cost of insufficient savings institutions.

Table 6: Difference in differences estimation results for cash by general purpose governments

	Time FE		Play-year FE	
Variable	Coef.	Std. Err.	Coef.	Std. Err.
Cash holdings	-0.347	(0.311)	0.0363	(0.132)
Offsets to debt	-0.364	(0.271)	-0.0523	(0.0728)
Bond funds	-0.0569**	(0.0226)	-0.0755**	(0.0363)
Other funds	0.0873	(0.142)	0.164*	(0.0984)
County FE	Yes		Yes	
Time FE	Yes		Play-year	
Play-year FE	No		Yes	

*Note: robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1. Even though the coefficients are shown below one another, they represent separate estimations. The estimations use equation 2:* $y_{cpt} = \mu_{pt} + \gamma_c + \delta_1(\mathbf{1}[Post - fracking]_{pt} * \mathbf{1}[Rystad\ top\ quartile]_c) + \delta_2(\mathbf{1}[Unbalanced\ sample]_{ct} * \mathbf{1}[Post - fracking]_{pt} * \mathbf{1}[Rystad\ top\ quartile]_c) + \epsilon_{cpt}$. *Separate control strategies are used as indicated in the table. The errors are clustered at the county level. The total number of treated counties are 20, with 227 non-treated counties. Data runs from 1997-2017. Fracking initiated at different times in different shale-plays (2000, 2005, and 2008). This results in 420 treated observations and 4767 non-treated observations.*

5.2. School districts

We estimate the DID model of equation 2 for school districts separately from the general purpose governments. One reason to do so is that workers with children may have a different attachment to the community. If, as seems likely, people with children are more attached to the community than those without children, school districts may follow a fiscal policy path more in line with the desires of longer term residents than general purpose governments. Another possibility is that school districts receive a significant share of their resources from the state government. State aid, however, is income conditioned, and there can be a variety of implicit resource taxes that impact resource use by school districts. As discussed below, the provisions with respect to debt apparently are important at understanding school district behavior.

Table 7 presents the overall resource results for school districts. Our two estimators have more disparate results than usual, but nonetheless are clear that the significant increase in school district revenue arises because the increases in property taxes are only incompletely offset by reductions in state aid. These results are evident in the Table 2 means of the school district data as well. We see in Table 2 that state aid is broadly equal to property taxes for school districts in 1997 with only a relatively small difference in the share paid by state government between the treated and untreated counties. By the end of our period, however, the state share of education paid by the state has fallen to about 23% for the treated counties. There is a much smaller decline in the state share for the untreated counties.

Table 7: Difference in differences estimation results for revenue by single purpose school districts

	Time FE		Play-year FE	
Variable	Coef.	Std. Err.	Coef.	Std. Err.
Total revenues	1.101***	(0.296)	0.741**	(0.338)
Property tax	1.223***	(0.312)	0.848**	(0.348)
Intergovernmental	-0.145**	(0.0633)	-0.109*	(0.0641)
State aid	-0.134**	(0.0626)	-0.0957	(0.0640)
County FE	Yes		Yes	
Time FE	Yes		Play-year	
Play-year FE	No		Yes	

*Note: robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1. Even though the coefficients are shown below one another, they represent separate estimations. The estimations use equation 2:* $y_{cpt} = \mu_{pt} + \gamma_c + \delta_1(\mathbf{1}[Post - fracking]_{pt} * \mathbf{1}[Rystad\ top\ quartile]_{\boldsymbol{c}}) + \delta_2(\mathbf{1}[Unbalanced\ sample]_{ct} * \mathbf{1}[Post - fracking]_{pt} * \mathbf{1}[Rystad\ top\ quartile]_{\boldsymbol{c}}) + \epsilon_{cpt}$*. Separate control strategies are used as indicated in the table. The errors are clustered at the county level. The total number of treated counties are 20, with 227 non-treated counties. Data runs from 1997-2017. Fracking initiated at different times in different shale-plays (2000, 2005, and 2008). This results in 420 treated observations and 4767 non-treated observations.*

Table 8 presents the school district DID results for general categories of expenditures. Like the revenue results, our two estimators have a relatively high difference, although the difference is not statistically significant. Irrespective, however, the expenditure increases of about $1,000 per capita indicate a very large windfall for school districts. This figure is despite the offset from reductions in state education aid as shown above. We find that capital spending is about one-fourth of the total expenditure increase, which is quite comparable to what we found for general purpose governments. The largest increase is found for intergovernmental transfers, although it is only weakly significant. These transfers are nearly all going to the State government with the purpose of being used for elementary and secondary education.

Unlike the general purpose governments, however, we find that very little, if any, of the extra expenditures is going for salaries and wages. It is possible that state regulatory restrictions on compensation and class size are reflected in this result. At face value, however, this suggests that the increase in current expenditures is going for extra inputs to assist teachers and students.

Table 8: Difference in differences estimation results for expenditure categories by school districts

	Time FE		Play-year FE	
Variable	Coef.	Std. Err.	Coef.	Std. Err.
Total expenditures	1.154***	(0.291)	0.782**	(0.337)
By type				
Current operations	0.0731*	(0.0422)	0.0586	(0.0500)
Capital outlay	0.299***	(0.0691)	0.216***	(0.0758)
Construction	0.294***	(0.0674)	0.216***	(0.0735)
Intergovernmental	0.753***	(0.222)	0.486*	(0.258)
Salaries & wages	0.0324	(0.0277)	0.0477	(0.0309)
By purpose				
Elementary & sec educ	1.164***	(0.287)	0.816**	(0.334)
Interest on debt	0.0294***	(0.0104)	0.0226**	(0.0110)
County FE	Yes		Yes	
Time FE	Yes		Play-year	
Play-year FE	No		Yes	

*Note: robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1. Even though the coefficients are shown below one another, they represent separate estimations. The estimations use equation 2:* $y_{cpt} = \mu_{pt} + \gamma_c + \delta_1(\mathbf{1}[Post - fracking]_{pt} * \mathbf{1}[Rystad\ top\ quartile]_{\boldsymbol{c}}) + \delta_2(\mathbf{1}[Unbalanced\ sample]_{ct} * \mathbf{1}[Post - fracking]_{pt} * \mathbf{1}[Rystad\ top\ quartile]_{\boldsymbol{c}}) + \epsilon_{cpt}$. *Separate control strategies are used as indicated in the table. The errors are clustered at the county level. The total number of treated counties are 20, with 227 non-treated counties. Data runs from 1997-2017. Fracking initiated at different times in different shale-plays (2000, 2005, and 2008). This results in 420 treated observations and 4767 non-treated observations.*

The Table 9 results which report the level of debt, show a clear distinction between the behavior of school districts and general purpose governments. While both types of governments are estimated to spend about one-quarter of their windfall revenues on capital goods, we see that school districts actually have increased their *outstanding debt*. We believe the state financing rules are driving this result. For example, the school district property tax rate is made up of two parts, maintenance and operations (M&O), and interest and sinking fund (I&S). There are limits on the M&O property tax rate a district may levy set by the state ($1.04 per $100 valuation). In addition, however, a district is permitted to levy up to an additional $0.50 per $100 valuation for I&S. Thus if a school district is permitted to borrow in a referendum by its taxpayers, it can lock in the higher tax rate to make its debt service payments. A government interested in preventing the return of funding to the taxpayers could pursue this strategy, therefore, and be insured that at least for the life of its borrowing it will receive the additional funding. The capital spending will still be for schools, but given the state tax limit restrictions, a school district can be assured of the increase in funding by dispersing it through borrowing.

Table 9: Difference in differences estimation results for debt by school districts

Variable	Time FE Coef.	Std. Err.	Play-year FE Coef.	Std. Err.
Outstanding debt	0.958***	(0.274)	0.700**	(0.293)
Issued debt	0.328***	(0.0879)	0.238**	(0.0943)
Retired debt	0.116**	(0.0579)	0.0788	(0.0602)
County FE	Yes		Yes	
Time FE	Yes		Play-year	
Play-year FE	No		Yes	

*Note: robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1. Even though the coefficients are shown below one another, they represent separate estimations. The estimations use equation 2:* $y_{cpt} = \mu_{pt} + \gamma_c + \delta_1(\mathbf{1}[Post - fracking]_{pt} * \mathbf{1}[Rystad\ top\ quartile]_c) + \delta_2(\mathbf{1}[Unbalanced\ sample]_{ct} * \mathbf{1}[Post - fracking]_{pt} * \mathbf{1}[Rystad\ top\ quartile]_c) + \epsilon_{cpt}$*. Separate control strategies are used as indicated in the table. The errors are clustered at the county level. The total number of treated counties are 20, with 227 non-treated counties. Data runs from 1997-2017. Fracking initiated at different times in different shale-plays (2000, 2005, and 2008). This results in 420 treated observations and 4767 non-treated observations.*

Table 10 is the final set of results for school districts, and it presents the restricted and unrestricted cash holdings. We see that the supplemental cash holdings of the treated school districts are divided between restricted and unrestricted accounts. Specifically, *bond funds* are found to increase significantly, which represent unspent proceeds from bond issuance. A somewhat larger amount is in unrestricted *Other funds*, which could be at least partially used for savings.

Table 10: Difference in differences estimation results for cash by school districts

Variable	Time FE Coef.	Std. Err.	Play-year FE Coef.	Std. Err.
Cash holdings	1.126***	(0.263)	0.838***	(0.281)
Offsets to debt	0.00365	(0.0106)	-0.00737	(0.0123)
Bond funds	0.497***	(0.0995)	0.371***	(0.115)
Other funds	0.625***	(0.183)	0.474**	(0.192)
County FE	Yes		Yes	
Time FE	Yes		Play-year	
Play-year FE	No		Yes	

*Note: robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1. Even though the coefficients are shown below one another, they represent separate estimations. The estimations use equation 2:* $y_{cpt} = \mu_{pt} + \gamma_c + \delta_1(\mathbf{1}[Post - fracking]_{pt} * \mathbf{1}[Rystad\ top\ quartile]_c) + \delta_2(\mathbf{1}[Unbalanced\ sample]_{ct} * \mathbf{1}[Post - fracking]_{pt} * \mathbf{1}[Rystad\ top\ quartile]_c) + \epsilon_{cpt}$*. Separate control strategies are used as indicated in the table. The errors are clustered at the county level. The total number of treated counties are 20, with 227 non-treated counties. Data runs from 1997-2017.*

Fracking initiated at different times in different shale-plays (2000, 2005, and 2008). This results in 420 treated observations and 4767 non-treated observations.

6. Discussion

Our estimation of how local governments respond to a resource windfall helps to reveal several aspects of government behavior. Our specific questions concern the ability of local governments to navigate their institutional constraints to provide a form of savings, and to avoid some of the "resource curse" issues that have been especially prevalent in developing country contexts. Our understanding is enhanced by the strong identification provided by using the technical change in oil and gas extraction technology through fracking.

Our results are in three areas. First, our difference in differences estimation illustrates clearly that indeed there is a significant property tax gain to both general purpose governments, and to single purpose independent school districts. Second, we see that while general purpose governments are having to cope with increased expenditures in areas affected by the fracking boom, the boom has nonetheless provided resources over and above these requirements. We find, however, that both sets of governments have attempted to generate savings. The interesting and stark difference is that general purpose governments have shifted so that capital spending is funded internally. School districts, however, have adopted new debt to fund capital projects, which appears to be a strategy to lock in higher overall tax rates.

We believe our results suggest that savings mechanisms are lacking for local governments. That is, as stated at the outset, the PIH suggests that when resource wealth is converted into financial wealth, total government expenditure should change very little. To accomplish this, however, it would seem that a sovereign wealth fund mechanism would be useful, including with rules about how much of windfall financial resources should be deposited there rather than expended. Lacking such a mechanism, we see that both types of governments have greatly increased their cash holdings. Whether these governments are able to maintain discipline on the use of these funds is an interesting question that will get revealed over time.

The other question that underlies understanding governmental behavior is the objective function of the two different types of governments. The general purpose governments seem to be building their cash reserves without increasing spending in every area. School districts, on the other hand, are pursuing a different strategy seemingly consistent with a revenue maximizing government, so that the extra resources are locked in through debt finance. Whether that characterization is fair requires further study, and for sure it is not clear that school districts are not following the wishes of their constituency.

7. Conclusion

Our paper has examined how local governments in Texas have responded to the fracking boom in oil and gas extraction in Texas. We have used the geology of the state to provide strong identification of areas impacted by the boom. This allows us to use a difference in differences estimation procedure to examine how the exogenous fiscal windfall has been used by local governments. We examine two separate sets of governments, general purpose county and city governments, and school districts.

We find that general purpose governments receive a property tax windfall, and only a very small sales tax windfall. These governments expend a considerable share of their new resources apparently on coping with changes caused by the boom. Specifically, we see increased spending on police, judicial administration and roads. These extra expenditures however, do not exhaust the extra resources. We observe a large build-up of cash balances, and as well a reduction in the issuance of new debt.

School districts appear to be following a different path, consistent with the different institutional context. Specifically, school districts are heavily regulated by the state government. Further, almost half of their pre-boom financing comes from the state, but in an equalizing package. Despite the reduction in state aid, however, we find that school districts receive a serious property tax windfall. Unlike general purpose governments, however, we find school districts in treated counties have added on substantial new debt. This debt has the result that school districts are allowed to charge higher property tax rates than otherwise would be permitted without debt.

One of the interesting sub-texts to our findings is that local governments in this example appear to be relatively disciplined, especially compared to their developing country counterparts. For example, we do not find evidence that charges for utilities have been dropped. Only school districts are observed to increase their debt, we find general purpose governments are using their windfalls to cut debt despite increases in capital spending. Despite this evidence, some of the potential distortions from the public sector are also in evidence. For example, it is a debatable proposition as to whether any savings should occur in the public sector, or instead whether these saved funds should be returned to taxpayers.

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