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The Political Economy of Local Fracking Bans

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Abstract

Concerns about harmful effects arising from the increased use of hydraulic fracturing (fracking) to extract underground fuel resources has led to efforts to ban the practice. Many townships in western New York, which lies above the gas-rich Marcellus shale formation, have enacted bans or moratoria. Using spatial econometric techniques, we examine factors related to townships' choice to adopt fracking bans and document the importance of spatial dependence when analyzing fracking bans. We find education levels, the poverty rate, and veterans groups are associated with an increased probability of a township banning or putting a moratorium on fracking.

JEL Codes: H73, Q48, R52

Key Words: fracking bans, spatial autocorrelation

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1 Introduction

In recent years, there has been rapid growth in the use of hydraulic fracturing ("fracking"), a process in which water and chemicals are forced into shale formations lying deep underground in order to release natural gas trapped in the shale formations. However, using fracking to extract previously unavailable underground fuel resources has been controversial. Proponents tout local economic benefits such as jobs created by drillers, wider economic benefits arising from cheaper natural gas, and reduced carbon emissions relative to other fuels such as coal (Joskow, 2013; Hefner, 2014). Opponents, on the other hand, argue that fracking leads to underground tremors, heavy truck traffic near drilling sites, and environmental harms such as contaminated water (Vengosh et al., 2014). The water pollution claims are depicted in the 2010 movie *Gasland*, which shows flammable faucet water allegedly contaminated by fracking.

The perception that fracking is environmentally harmful has led to efforts to ban the practice (Brady and Crannell, 2012). Although fracking bans have been proposed in various parts of the country (Rahm, 2011; Brady and Crannell, 2012), New York state has been a hotbed of regulatory activity at both the state and local level (Wegener, 2013). Local governments in New York have been particularly active in enacting fracking bans or moratoria (Podolny, 2013). The primary reason that the anti-fracking movement has been so active in New York is that the western part of the state lies above the Marcellus shale, a formation that has proven rich for fracking in neighboring Pennsylvania (Jacquet, 2012). Fearing that their state might see the high level of fracking activity that has occurred in neighboring Pennsylvania, many New York localities used local zoning laws to pass bans or moratoria (Podolny, 2013; Wegener, 2013). In December of 2014, New York Governor Andrew Cuomo announced that the state would become the first state to prohibit high-volume hydraulic fracturing (Kaplan, 2014).

In this paper, we analyze the pattern of fracking bans imposed in New York townships through a political economy lens. While there is a small literature on the political economy of environmental policies related to energy (Joskow and Schmalensee, 1998; Bernauer and Koubi, 2009; Wiener and Koontz, 2012), the political economy of fracking bans has received little attention. Papers such as Davis (2014) and Ritchie (2014) discuss the legal issues surrounding local regulation of fracking while Davis (2012) shows how pro-fracking interests, seeking a regulatory environment most favorable to their position, have sought to have fracking regulated at the state level while anti-fracking advocates have sought to use federal regulation to impede fracking. To our knowledge, however, there are no existing empirical studies examining factors related to localities choosing to whether or not to ban fracking.

In determining the social, political, and economic factors driving municipalities in New York State to pass a ban or moratorium on fracking, we make two important contributions. The first contribution is to public policy debate surrounding fracking bans. Our positive empirical approach, while taking no normative stance, clearly informs ongoing public policy battles regarding fracking in states such as Colorado, Ohio, and West Virginia (Goho, 2012; Minor, 2013). For example, our results show that the percentage of college educated citizens is positively associated with local bans or moratoria. Our second contribution is that we show that spatial dependence exists in the adoption of laws related to energy policy. Not accounting for spatial dependence can cause non-spatial papers to provide incorrect estimates of the marginal effects of explanatory variables (LeSage and Pace, 2009; Hall and Ross, 2010; Holloway et al., 2014). This finding is especially important for scholarship building off the regional policy diffusion model (Wiener and Koontz, 2012), but is also important for any paper using a law or policy as an explanatory variable.

Our paper proceeds as follows. Section 2 briefly surveys the literature on the political economy of public policy adoption, including the theoretical basis for the regional diffusion of such policies. The next section describes the data and the Bayesian Spatial Durbin approach employed, while Section 4 presents the empirical results. We conclude with some thoughts on our results and the implications of our paper for the overall literature on policy adoption literature as well as ongoing fracking debates.

2 The Political Economy of Public Policies

Many papers have examined public policy thorough a positive political economy lens. Topics studied include determinants of states diesel fuel tax rates (Decker and Wohar, 2007), congressional voting on foreign aid (Milner and Tingley, 2010), and the spread of medical marijuana laws (Hall and Schiefelbein, 2011). Joskow and Schmalensee's (1998) analysis of valuable sulfur dioxide emissions permits to electric utilities, Bernauer and Koubi's (2009) examination of the relationship between political institutions, competing interests, and air quality, and studies of local governments in Massachusetts adoption of so-called smart growth policies (Hawkins, 2014a) and subdivision bylaws (Hawkins, 2014b) are examples of political economy papers focusing on the political economy of environmental or land use policies.

A key, though sometimes unstated, assumption underlying many political economy analyses is the median voter model. The intuition of the model is straightforward; when voting on a single issue such as the amount of educational funding in a community, the person whose preferences lie in the middle of the distribution of voters' preferences will be the decisive voter. In practice, voters often must choose among candidates espousing bundles of issues rather than confronting a single issue referendum so the median position on any particular issue becomes murky. Nonetheless, the median voter model's assumption that an increasing presence of people favoring a particular policy increases the likelihood of that policy being adopted provides the bedrock of many empirical political economy analyses.

In recent years, a recognition that decisions in one polity can be affected by neighboring jurisdictions has been increasingly incorporated in positive political economy studies. For example, Dincer et al. (2014) find that a state's renewable fuel portfolio standard is influenced by standards adopted in neighboring states; however, their OLS estimation is based on an average of neighbors' policies and thus misses spatial autocorrelation in the error term. Similarly, Wiener and Koontz (2012) examine state policies toward small scale wind power generation, paying particular attention to the role of policy diffusion from one state to state. Likewise, Chupp (2014) applies spatial methods to examine Senators' influence on their colleagues' votes and finds that Senators having the most influence on their colleagues receive larger political contributions. We now turn to analyzing fracking bans while explicitly incorporating the possibility of spatial dependence across townships.

3 Data and Empirical Approach

To analyze the local adoption of fracking bans among townships in the shale region of western New York state, we estimate a spatial Durbin probit model with the dependent variable taking a value of 1 if the township has enacted a fracking ban and 0 otherwise. We limit ourselves to western New York since that is the region where the Marcellus Shale and Utica Shale formation exist within the state. Bans or moratoria in western New York have been cataloged by the organization FracTracker Alliance and we utilize its data as of October 9, 2014 in our analysis.[1] There are 586 observations in the dataset, and Table 1 contains summary statistics for all variables. All data are for the most recent year available.

The explanatory variables are motivated primarily by the putative costs and benefits of fracking. On the cost side, fracking opponents argue that it can harm water supplies and that fracking produces heavy truck traffic transporting supplies to drill sites. If this is the case, then townships with large endowments of water resources should be more likely

[1] Map of municipal movements against fracking at: http://www.fractracker.org/map/us/new-york/moratoria/.

Table 1: Summary Statistics

	Mean	Minimum	Maximum	Std Dev
Square Miles of Water	0.95	0.00	42.92	2.81
Borders PA	0.06	0.00	1.00	0.25
Industrial Parcels (%)	0.96	0.00	13.93	2.02
Population Density	304.69	1.50	9586.02	821.16
Unemployment Rate (%)	7.06	0.80	27.40	3.13
Poverty Rate (%)	11.92	1.50	54.20	6.23
Bachelors Degree or Higher (%)	20.56	2.50	70.40	10.31
African-American (%)	1.85	0.00	41.15	4.07
Veterans (%)	11.81	1.88	29.44	2.98
Ban or Moratorium	0.23	0.00	1.00	0.42

Number of observations = 586.

to enact a fracking ban. Likewise, townships with high population density might also favor banning fracking because there would potentially be more people within close proximity of a fracking site and more people adversely affected by traffic to fracking sites. Hence, the model includes population density as measured by people per square mile and the square miles of water coverage within each county as regressors. Both variables are hypothesized to be positively related to fracking bans. On the other hand, areas that have industrial activity might already be used to pollution, noise, and truck traffic so these areas might be less likely to ban fracking. To control for this effect, the model includes the percentage of parcels that are industrial and this measure is expected to have a negative coefficient. The data used to calculate these three variables was obtained from the U.S. Geological Survey and calculated using ArcGIS.[2]

On a local level, the primary benefit that supposedly arises from fracking is an increase in jobs and income from increased wages and drilling royalties (Hastings et al., 2015). Ceteris paribus, these factors should be more appealing to economically depressed areas. Hence the model includes the unemployment rate and the poverty rate. If economically depressed areas are less likely to ban fracking then the unemployment rate and the poverty

[2]All explanatory variables except for the three obtained from the U.S. Geological Survey were obtained from the U.S. Census Bureau.

rate should be negatively related to fracking bans. While unemployment and poverty in New York townships are related (correlation coefficient = 0.43), they may capture different features of the economic health of an area. The unemployment rate is more of a short-term measure of economic well-being, while the poverty rate is a better measure of persistently low incomes and lack of geographic mobility.[3]

The perceived costs and benefits of fracking are also motivated by information. The percentage of a township's population over the age of 25 with a bachelor's degree or higher is included because studies have shown that a clear link in the United States between education and knowledge about public affairs (Jerit et al., 2006). For example, the educated take more away from newspaper coverage than the non-educated according to Jerit et al. (2006). Moreover, studies have also shown a strong relationship between educational attainment and environmental concerns (Ostman and Parker, 1987; Guagnano and Markee, 1995). We therefore expect a positive relationship between college education and fracking bans as the college educated are more likely to be informed about the overall costs and benefits of fracking and have more favorable attitudes towards environmental issues and regulation.[4] The other information-related variable is whether the locality is in a county bordering Pennsylvania. There has been much fracking in Pennsylvania; many New York residents living in areas near the Pennsylvania border might have personally observed the advantages or disadvantages associated with fracking. Theoretically, this relationship is ambiguous.

Finally, we include the percentage of residents that are African-American and the percentage that are veterans to account for possible special interest group effects. As pointed out by Olson (1965), some groups have lower costs of organizing than others.

[3]For example, a high poverty area can have low unemployment if many workers have migrated elsewhere or left the labor force. See Cebula and Vedder (1973) and Cebula et al. (2014b) for migration in response to economic opportunity and business cycle concerns, respectively.

[4]It is also possible that college educated individuals are more likely to have jobs unassociated with fracking and thus might be voting in a more parochial manner. Our aggregated data does not allow us to separate between these hypotheses.

Groups that form for other reasons, such as social interests, might find themselves with common political interests. The common social interest therefore reduces the transactions costs of a political interest group organizing. For example, the church in the African-American community has frequently played an important role in political mobilization (Calhoun-Brown, 1996). Similarly, the Veterans of Foreign Wars (VFW) hall or American Legion post often can be a starting point for political discussion and activism (Whisman, 1993; Ainsworth, 1993). Our *a priori* view is that areas with a greater percentage of African-Americans or veterans will find it easier to mobilize activity for or against a ban or moratoria should such sentiment be correlated with membership in either group. Thus our hypothesized relationship is theoretically ambiguous for both of these variables.

A look at the map of townships adopting fracking bans or moratoria exhibits geographic clustering. To get at the spatial relationship among observations we employ a spatial autoregressive probit model (Lacombe and LeSage, 2013). This type of model has been used in a number of empirical studies where policies in a location are not independent from neighboring locations (Leeson and Dean, 2009; Hall and Ross, 2010; Hall et al., 2012; Crowley, 2012). In addition to these studies, Lacombe and LeSage (2013) is an excellent introduction to these models, including their interpretation. We estimate a version of the spatial autoregressive probit model called the Durbin model (LeSage and Pace, 2009). In vector form, the model can be expressed as:

$$y = \rho W y + X\beta + W X\gamma + \epsilon \tag{1}$$

where y is a $n \times 1$ vector representing the latent unobservable propensity that a municipality has adopted a ban. Wy is the "spatial lag" of the dependent variable. W is a $n \times n$ matrix representing the spatial relationship among New York townships in our sample. For each municipality in the sample, the matrix specifies each town's "neighbors" with a 1, and 0 otherwise. Each row is normalized so that each row sums to 1. As a result, the

$n \times 1$ vector Wy consists of an average of the neighboring townships propensity to adopt fracking bans or moratoria, resulting in an explicitly modeling of the interdependence that exists in municipal-level public policy outcomes as hypothesized in the regional policy diffusion and yardstick competition models (Hall and Ross, 2010; Wiener and Koontz, 2012).

For notational convenience, the independent variables are represented by the design matrix X. The WX term is therefore the product of all independent variables multiplied by the spatial weight matrix. While the Wy term can be thought of as the weighted average of the surrounding jurisdictions dependent variable, the WX term is the weighted average of the surrounding jurisdictions independent variables. The spatially weighted explanatory variables capture any spillovers across jurisdictions that are not captured by a jurisdiction's own explanatory variables. As a result, ρ and γ, if significant, represent spatial autocorrelation in the adoption of a ban or moratorium and the error term, respectively.[5] In the presence of spatial autocorrelation in the dependent variable or error term, the estimation of the spatial Durbin model reduces bias by eliminating spatially omitted variable bias (LeSage and Pace, 2009; Hall and Ross, 2010).

4 Empirical Results

The spatial Durbin probit model was estimated using Bayesian maximum likelihood methods and the results are reported in Table 2. The spatial parameter ρ is statistically significant at the 1 percent level, indicating spatial autocorrelation in the decision to adopt a fracking ban. Similarly, the spatial lags of industrial parcels, the unemployment rate, poverty rate, and African-Americans are statistically significant, evidence that these variables are not independent across observations as well. While we can look at the results

[5] In our empirical section, we calculate separate coefficients for each of the spatially lagged independent variables, some of which may be significant, which would be evidence of spatial autocorrelation in the error term.

in Table 2 for statistical significance, these coefficient estimates cannot be interpreted directly because the partial derivative with respect to a given independent variable is a nxn matrix rather than a scalar (LeSage and Dominguez, 2012). The diagonal elements of the nxn matrix represent the direct feedback effects and the off-diagonal elements represent the indirect effects of a change in each independent variable. Lacombe and LeSage (2013) provides an intuitive explanation of these direct and indirect effects in the context of spatial probit models.

What we can say is that a district's poverty rate is positively related to the adoption of a fracking ban or moratorium at the 10% level of statistical significance, while the percentage veterans is negatively related at the same level of statistical significance. The result for poverty has the opposite sign of what was expected. Perhaps the poverty rate is reflecting not the desire for increased economic opportunity, but is correlated with negative views towards market activity (Caplan, 2002). Our geographic variables and other economic variables are not statistically significant by conventional standards. The percentage of township residents with a bachelors degree or higher is positively related to the likelihood of a ban or moratorium being adopted at the 1% level. Townships with more educated voters are more likely to adopt fracking bans or moratoria. Whether this is because of information effects, concerns about environmental issues, or because more educated voters are less likely to be employed in fracking-related occupation, we cannot say given the level of aggregation of our data.

In order to interpret the magnitude of our regression results, we calculate the direct, indirect, and total effects. Direct effects can be interpreted as own effects - how does a change in a township's unemployment rate effect its propensity to adopt a fracking ban or moratorium? Indirect effects are the spillover effects of a change in unemployment. How does a change in township A's unemployment rate affect the probability of adopting a ban or moratorium in neighboring townships? The total effects are just the sum of these two effects. The direct, indirect, and total effects for each of the explanatory variables

Table 2: The Determinants of Local Fracking Bans: SDP Results

	Coefficient	Std Dev	P-Value	
Constant	0.1857	0.896	0.42	
Square Miles of Water	-0.0219	0.032	0.26	
Borders PA	-0.4513	0.439	0.15	
Industrial Parcels (%)	-0.0913	0.106	0.19	
Population Density	0.0001	0.000	0.11	
Unemployment Rate (%)	-0.0159	0.025	0.27	
Poverty Rate (%)	0.0207	0.014	0.06	*
Bachelors Degree or Higher (%)	0.0206	0.008	0.01	***
African-American (%)	-0.0131	0.019	0.24	
Veterans (%)	-0.0416	0.026	0.06	*
W-Square Miles of Water	0.0534	0.046	0.12	
W-Borders PA	0.3903	0.495	0.22	
W-Industrial Parcels	-0.2141	0.141	0.06	*
W-Population Density	-0.0001	0.000	0.36	
W-Unemployment Rate	-0.1157	0.057	0.02	**
W-Poverty Rate	0.0543	0.032	0.05	**
W-Bachelors Degree or Higher	0.0088	0.016	0.28	
W-African-American	-0.0937	0.041	0.01	**
W-Veterans	-0.0332	0.052	0.26	
ρ	0.4693	0.105	0.00	***

Notes: The dependent variable is a binary variable equaling 1 if a municipality adopted a ban or moratorium and 0 otherwise. SDP stands for Spatial Durbin Model. *** denotes significant at 1(%) level; ** significance at 5(%) level; and * significance at 10(%) level. The number of observations equals 586.

are presented in Table 3.

Table 3: Direct, Indirect, and Total Effects From SDP Model

	Direct	Indirect	Total
Square Miles of Water	0.0074	0.0063	0.0137
Borders PA	-0.0146	-0.0108	-0.0254
Industrial Parcels (%)	-0.0734	-0.0608	-0.1341
Population Density	0.0000	0.0000	0.0000
Unemployment Rate (%)	-0.0315	-0.0259	-0.0575
Poverty Rate (%)	0.0179	0.0146	0.0325
Bachelors Degree or Higher (%)	0.0070	0.0056	0.0127
African-American (%)	-0.0256	-0.0211	-0.0467
Veterans (%)	-0.0180	-0.0148	-0.0327

Notes: The dependent variable is a binary variable equaling 1 if a municipality adopted a ban or moratorium and 0 otherwise. SDP stands for Spatial Durbin Model. See text for further discussion of interpretation of direct, indirect, and total effects from SDP models.

The economic magnitude of the effects of the statistically significant variables are small when looking at the direct effects. A one standard deviation increase in the percentage of township residents with a bachelors degree is directly associated with a 7.21% increase in the probability of adopting a ban or moratorium.[6] The indirect effects (or "spillover" effects) of more education are almost of equal size, however, meaning that once they are taken into account the total effects of education on bans or moratoria in a region are nearly twice as large. A one standard deviation increase in the percentage of adults with a bachelors degree in township i is associated with a 13% total increase in the likelihood of a fracking ban or moratorium. It is important to note that these indirect effects are spillovers on neighboring jurisdictions. Thus while these total effects are real and important to the entire region, the effects of changes in township i are only the direct effects.[7]

Turning to the other statistically significant variables, we see that the direct effects of

[6] $10.31 \times 0.0070 = 0.072$.

[7] Even if local policymakers only care about the direct effects of explanatory variables, it is still important to use spatial approaches where appropriate in order to not mistakenly attribute indirect marginal effects to direct explanatory variables.

a one standard deviation increase in the poverty rate is associated with an 11% increase in the probability of a fracking ban or moratorium.[8] The indirect effect of poverty is also positive, leading the total effect of a one standard deviation increase in the poverty rate to equal 20%.[9] The percentage of township residents that are veterans is associated with a decreased likelihood of a ban or moratorium, with a one standard deviation increase in veterans percentage being directly associated with a 5.36% decline in the probability of having a ban.[10] Once spillover effects are take into account, the total effect is nearly 10%.[11]

5 Conclusions

Our most notable finding is the importance of education, poverty, and veterans groups in the probability of a township banning or putting a moratorium on fracking. We have also highlighted the importance of taking into account spatial autocorrelation in both political economy models and any empirical work regarding fracking. Given the geographically related nature of shale gas deposits, any work related to fracking is likely to have to deal with spatial autocorrelation either in the dependent variable or the error term.

In addition to this highlighting the political economy factors that were important to fracking bans or moratoria in New York state, our analysis contributes to the literature on energy policy by showing the importance of employing spatial econometric methods. Important political economy papers in the energy arena that might benefit from revisiting using spatial methods include Mixon Jr (1995), Upadhyaya et al. (1997), and Cebula et al. (2014a). Non-political economy papers on energy demand and consumption such as Apergis and Payne (2009) might have spatial autocorrelation given the spatial correlation

[8] $6.23 \times 0.0179 = 0.1115$.
[9] $6.23 \times 0.0325 = 0.2024$.
[10] $2.98 \times -0.018 = -0.0536$.
[11] $2.98 \times -0.00327 = -0.097$.

in incomes across geographic observations.

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