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LETTER

NIMBY, YIMBY, or something else? Geographies of public perceptions of shale gas development in the Marcellus Shale

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Abstract

Much research exists on how social-psychological factors (e.g. political ideology), proximity to development, and contextual factors (e.g. state in which one resides) drive public attitudes toward various types of energy development. Yet, scholars have only recently begun to explore how these factors interact to create unique geographies of perception that defy the simplistic explanations suggested by not-in-my-backyard or yes-in-my-backyard labels. Using precisely geocoded well and survey data, we explore the interplay of political ideology, proximity and place in the context of public attitudes toward unconventional oil and natural gas development (UOGD) in the Marcellus Shale region of southern New York and northern Pennsylvania. For our full sample and similar to findings from recent national surveys on attitudes toward energy development, we found that respondents closer to UOGD were more supportive of it, a relationship that was moderated by political ideology with liberals or moderates located closer to UOGD more supportive than those located further away. However, when we examined these moderation effects within states, a different story emerged. For New York respondents, proximity did not appear to have a differential effect on conservatives vs. liberals/moderates. However, for Pennsylvania respondents, we observed opposing effects: conservatives were more supportive further away from development, while liberals/moderates were more supportive closer to development. Our results thus both reaffirm and challenge existing scholarship, highlighting the potential for middle range theorizing about geographies of perception in energy development.

1. Introduction

Much research exists on how social-psychological factors (e.g. political ideology), proximity to development, and contextual factors (e.g. state in which one resides) drive public attitudes toward various types of energy development (Devine-Wright 2005, Boudet *et al* 2014, 2018, Clarke *et al* 2015, Evensen and Stedman 2016, Junod *et al* 2018, Boudet 2019). However, scholars have only recently begun to explore how these factors interact to create specific 'geographies of perception' (Devine-Wright 2005, Evensen and Stedman 2016, Junod *et al* 2018, Boudet 2019, Craig *et al* 2019). Borrowing from Haggerty *et al*'s (2018) concept of 'impact geographies' and similar to the idea of 'risk perception shadows' (Stoffle *et al* 1993), we define 'geographies of perception' as spatially bounded areas with unique combinations of historical, contextual, experiential and political factors that interact to shape public attitudes toward energy development.

We explore this phenomenon in the context of public attitudes toward unconventional oil and natural gas development (UOGD), colloquially referred to as hydraulic fracturing or fracking,[7] in

[7] What to call unconventional energy extraction has been a contested issue, and what it is called can shape public opinion (Clarke *et al* 2015, Evensen 2016, Stoutenborough *et al* 2016). In popular press, it is often referred to as 'fracking'—a term

the Marcellus Shale region of southern New York and northern Pennsylvania.[8] We extend existing research in several ways.

First, we focus on the state rather than national-level, not simply because the Marcellus Shale is limited to a particular region of the country, but also because the interactive effects, while discernable at the national-level, may not capture heterogeneity at smaller geographies. That is, these effects may vary across states—emerging or failing to emerge—due to place-based social, political, economic, and other dynamics. With active development ongoing in Pennsylvania and a state-wide ban in New York, the trajectory of UOGD in these two states, as well as the public and political discourse that has helped shape it, have markedly diverged (Brasier *et al* 2011, Stedman *et al* 2012, Jacquet *et al* 2018). Second, we include more precise measures of proximity by combining geocoded survey respondent location (via postal addresses) with UOGD well location data. Our resultant proximity measures are more accurate than estimates typically applied in similar research, which often relies on coarser measures like residence in/proximity to a shale play or less precise measures of respondent location (Boudet *et al* 2016, 2018, Clarke *et al* 2016). Overall, we take a more nuanced approach to studying public attitudes toward UOGD by considering how political polarization about shale gas development varies by both proximity and place.

1.1. Political ideology and public attitudes toward energy development

The relationship between political ideology and public support/opposition toward fossil fuel-based energy development, including UOGD, is well-demonstrated. Those with more liberal political ideologies and/or Democratic political affiliations are often less supportive, while those with more conservative political ideology and/or Republican political affiliations offer greater support (Boudet *et al* 2014, Davis and Fisk 2014, Clarke *et al* 2015, 2016, Evensen and Stedman 2016, Thomas *et al* 2017). Numerous explanations are suggested, such as elite cues, underlying values, and risk perceptions, for this polarization (see Davis and Fisk 2014, Clarke *et al* 2016).

1.2. Geographic proximity and public attitudes toward energy development

Geographic proximity to existing and/or proposed energy development is another often-explored predictor of public attitudes toward such development, but empirical studies have produced conflicting findings. Perhaps the best-known hypothesis is opposition based on a not-in-my-backyard (or NIMBY) response. NIMBY thinking suggests that those most proximate to proposed development will oppose it for reasons of self-interest, such as potential negative impacts on safety, health, and/or property values (Bell *et al* 2005, Schively 2007, Cotton 2013, Braun 2017). Despite scholarship that has largely debunked oppositional motives as purely self-interested (Ellis *et al* Devine-Wright *et al* 2007, Devine-Wright 2009, 2017), the NIMBY label endures. In contrast, a growing body of literature has directly challenged the NIMBY hypothesis, finding that those most proximate to actual energy development are *more* supportive (Hoen *et al* 2011, Gravelle and Lachapelle 2015, Alcorn *et al* 2017, Boudet *et al* 2018, Firestone and Kirk 2019), leading to a host of competing labels, including yes-in-my-backyard (YIMBY) (Smith and Marquez 2000) and please-in-my-backyard (PIMBY) (Brinkman and Hirsh 2017, Jerolmack and Walker 2018).

Why might those most proximate to development be more supportive? First, companies may be more likely to propose development in areas that support it (McAdam and Boudet 2012). Those who oppose a particular development may choose to move away should it occur and/or those who support it may move in for jobs or business opportunities. Another explanation is that the real and/or perceived benefits from such development are expected to outweigh its costs, particularly in the early phases of development when research on public attitudes is most likely to occur (Boudet *et al* 2016, 2018, Bugden *et al* 2016, Bugden and Stedman 2019, Zanocco *et al* 2019). Moreover, underlying values related to political ideology, property rights and self-reliance, combined with distrust of 'liberal' opponents and government regulation, can lead some residents to support landowner choice to lease mineral rights, despite limited personal benefits from UOGD (Jerolmack and Walker 2018). Finally, contentious case studies may attract more research attention than cases where support is widespread. Such attention may skew our understanding of 'typical' (oppositional) responses to energy development proposals when acceptance or quiescence may be more common (McAdam and Boudet 2012).

Regardless of the reasoning, conflicting findings suggest that proximity's effect on UOGD attitudes may be more nuanced than NIMBY, YIMBY, or other labels allow (Junod *et al* 2018, Craig *et al* 2019, Zanocco *et al* 2019). We therefore consider how proximity may interact with political ideology and place to shape support/opposition.

which can engender negative reactions. We have chosen to use 'unconventional oil or gas development' (UOGD) and 'shale gas development via hydraulic fracturing' to avoid inadvertently biasing our participants, though we realize that word choice is never devoid of influence.

[8] The Marcellus Shale underlies several northeast U.S. states including Pennsylvania, New York, and West Virginia. Together with the Utica Shale located further west, these shale gas regions have helped drive an increase in U.S. domestic natural gas production over the last decade or so, comprise a sizable share of domestic production currently, and are expected to maintain a high level of production (and a large share of domestic natural gas output) over the next few decades (U.S. Department of Energy 2019).

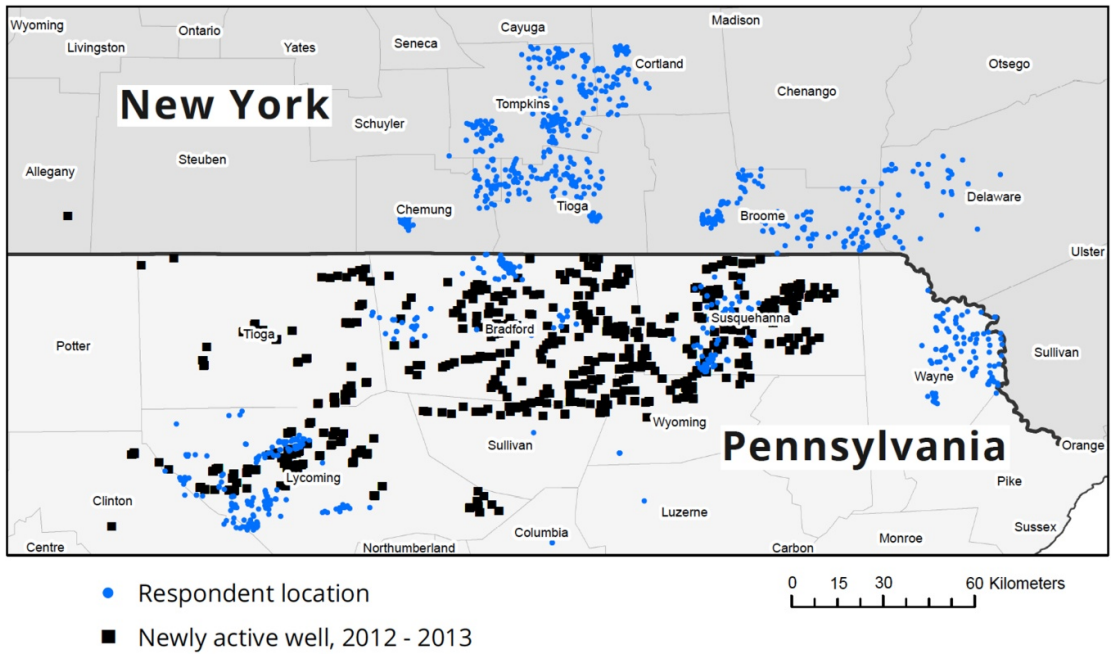

Figure 1. Geolocations of respondent residence and unconventional oil and gas wells that began active production within 1 year of survey administration in New York and Pennsylvania (2012–2013).

1.3. Place-based (contextual) factors and public attitudes toward energy development

We would be remiss not to explore the impact of place (sometimes referred to as context) in shaping public opinion toward UOGD in the Marcellus. As has been emphasized in the academic literature and popular press, Pennsylvania and New York responded in vastly different ways to UOGD (Brasier *et al* 2011, Stedman *et al* 2012, Jacquet *et al* 2018). Politicians in Pennsylvania initially welcomed and encouraged such development, resulting in a high density of UOGD, while New York currently has a moratorium—a policy that was under consideration during our data collection and put in place in 2014. However, while state policy now prohibits UOGD in New York, New York residents located within the Marcellus Shale area are located near development in Pennsylvania (figure 1).

Previous analysis of this dataset reveal that New York residents are, on average, more opposed to UOGD than Pennsylvania residents (Evensen *et al* 2014). More interesting questions for our purposes, and for which we have little existing research guidance, address the influence of state of residence on proximity-support and ideology-support relationships. Our main research question thus becomes: How do political ideology, proximity and place *interact* to shape attitudes about UOGD?

2. Methods

2.1. Survey data

We surveyed Pennsylvania and New York residents from the Marcellus Shale region about their perspectives toward energy development. We identified 34 municipalities in southern New York and 17 municipalities in Pennsylvania located within the Marcellus Shale region (figure 1) from which we then drew a stratified random sample of households (i.e. residential addresses). Next, we administered a survey protocol to these households across four waves (initial elicitation, postcard reminder, second elicitation, second postcard reminder) in October-November 2013. In total, we received 1202 completed surveys, with the sample split similarly between New York (n = 637) and Pennsylvania (n = 565), for an overall response rate of 28% (30% in NY; 26% in PA) after adjusting for undeliverable addresses.[9] We revisit this survey data six years after its original collection because it gives us the opportunity to explore proximity-opinion dynamics on a comparative, cross-state sample using geospatial UOGD data not available when this survey was originally conducted. For more information about this survey data, see supplement materials (S1) (stacks.iop.org/ERL/15/074039/mmedia).

2.2. Measures

Our dependent variable is a shale gas development[10] attitude index formed from three survey questions[11]

[9] We mailed surveys to 4998 households in our first elicitation wave and 629 of which were returned as undeliverable (345 from New York; 284 from Pennsylvania).

[10] In the survey instrument we first referred to 'shale gas development via hydraulic fracturing' and then subsequently as 'shale gas development'.

[11] We apply single question items for community, state, and national shale gas opinion as dependent variables in alternative

Table 1. Variables, descriptions, and summary statistics for full and state subsamples. For tests of state-level variable balance, see supplement materials S5.

Variable	Description	Full sample	Pennsylvania subsample	New York subsample
State	State of residence	N = 1202	N = 565	N = 637
Age	In what year were you born_____?	M = 60.0 years SD = 14.4 N = 1160	M = 60.3 years SD = 14.06 N = 547	M = 57.9 years SD = 14.7 N = 613
Sex	Please indicate your sex. 0 = Female 1 = Male	55.4% male N = 1183	57.8% male N = 559	53.1% male N = 624
Education	Please indicate your highest level of education attained. (recoded) 0 = No four-year degree 1 = Four-year degree or higher	41.1% Four-year degree or higher N = 1187	34.3% Four-year degree or higher N = 555	46.9% Four-year degree or higher N = 632
Financial contentment	How satisfied are you with your family's financial situation? 1 = Not at all satisfied → 7 = Extremely satisfied	M = 4.36 SD = 1.72 N = 1164	M = 4.50 SD = 1.69 N = 552	M = 4.24 SD = 1.74 N = 612
Political ideology	How would you describe your political views? 1 = Very liberal → 7 = Very conservative	M = 4.52 SD = 1.76 N = 1156	M = 4.75 SD = 1.67 N = 547	M = 4.31 SD = 1.80 N = 609
Distance-to-nearest well (km)	Nearest geographic distance to an unconventional well that began active production within one year of survey administration	M = 21.7 km SD = 18.1 N = 1202	M = 9.61 km SD = 13.9 N = 565	M = 32.3 km SD = 14.4 N = 637
Shale gas opinion index	Considering everything, do you support or oppose shale gas development in the following areas: In your community? In your state? In the USA? (mean composite index) 1 = Strongly oppose; 2 = Oppose; 3 = Slightly oppose; 4 = Slightly support; 5 = Support; 6 = Strongly support	M = 3.75 SD = 1.84 N = 1071	M = 4.34 SD = 1.60 N = 508	M = 3.22 SD = 1.94 N = 563

that asked about support/opposition for shale gas development in a respondent's (1) community, (2) state, and (3) nationally, oriented on an identical six-point, Likert-type scale ranging from 1 = 'Strongly oppose' to 6 = 'Strongly support'. When formed into a mean composite index, these items have excellent reliability (Cronbach's alpha = 0.97). Across the full sample, the average shale gas opinion index score was 3.75 (std. dev = 1.84), situated between 3 = 'Slightly oppose' and 4 = 'Slightly support', with respondents from Pennsylvania (mean = 4.34, std. dev. = 1.60), on average, more supportive than New York (mean = 3.22, std. dev. = 1.94; *difference-in-means*, $p < 0.001$; see supplemental materials S3 for state-level distributions). Additional tests of covariate balance between states indicate that our Pennsylvania respondents are older, more financially content, more conservative, and less educated than our New York sample at the $p < 0.05$ significance level (supplemental materials S5). For a complete listing of variables relevant to our analysis, including descriptions, question wording, summary statistics, and full and state subsamples, see table 1.

modeling (see supplement materials S11—S13) and report similar findings to models presented in this letter.

Distance-to-nearest well, described here and in greater detail in supplemental materials S2, is our measure of proximity to new UOGD. This is an 'as the crow flies' distance (geodesic) from each survey respondent's geocoded residential address to a newly active well, or wells drilled using horizontal and/or directional technologies within the Marcellus Shale that began production within one year prior[12] to survey administration (well data provided by Enverus Drillinginfo; figure 1). These well attributes have been applied in prior research to characterize new development of UOGD activities and is suited to the type of proximity-based analysis we conduct in this study (Newell *et al* 2019; Boudet *et al* 2018, Zanocco *et al* 2019). For state-level distance-to-nearest well distributions, see supplemental materials S4.

2.3. Analysis

We model shale gas opinion via multilevel linear regression analysis, a method increasingly applied in

[12] In addition to this one-year production window (September 2012–2013) for newly active development, we also characterize development across longer timeframes in complementary analysis (see supplemental materials S9) and find no substantive differences in model results.

proximity-based opinion research (for example, see Boudet *et al* 2018, Zanocco *et al* 2018, 2019) where respondents are grouped by geographies (e.g. ZIP code tabulation areas, counties, etc) to help control for the effect of unobserved contextual and place-based factors (e.g. common experiences with extractive industries, local media coverage) on shaping perspectives and beliefs. In our multilevel analysis, we modeled lower-level characteristics (i.e. fixed effects) as distance-to-nearest well, sociodemographic factors (gender, age, political ideology, education, and financial contentment) and state of residence. Higher-level characteristics (i.e. random effect intercepts) are modeled as Census county sub-division codes, which, in our sample, include the named fixed boundary designations of towns, townships, boroughs, and cities. For more information about our analytical modeling approach, see supplement materials S6. Using this multilevel modeling framework,[13] we fit models using the R package lme4 (Bates *et al*, 2014) and tested multiple model specifications, including interaction terms (i.e. moderators) and a state subsample analysis. This allows us to test the moderating (i.e. interaction) effects of ideology and proximity on shale gas opinion, as well as examine the effect of state residency.

3. Findings

3.1. Full sample results

We first considered multilevel regression models estimated with our full sample, which pooled New York and Pennsylvania respondents (table 2). Results revealed statistically significant effects ($p < 0.05$) for political ideology, proximity and state of residence (table 2: Model 1).[14] Unsurprisingly, conservative ideological leanings were associated with more support for shale development ($\beta = 0.280$; $p < 0.001$) and had the highest magnitude effect. State of residence also had a discernable effect, with those from Pennsylvania being more supportive of shale development ($\beta = 0.142$; $p < 0.05$), on average, compared to New York respondents. The coefficient on our proximity measure, distance-to-nearest well, is negative and significant ($\beta = -0.161$; $p < 0.01$), implying that, on average, respondents located further from UOGD were more opposed than those living closer. For example, respondents located 20 km away from UOGD were found to be, on average, 9.4% less supportive (or 9.4% more opposed) than those located less than 1 km away, holding all other measures constant (see supplement S7).

We next tested moderation effects of respondent's state (Pennsylvania vs. New York) and political ideology on proximity measures and shale gas opinion. For distance-to-nearest well and Pennsylvania (vs. New York), we found significant interaction effects ($\beta = -0.142$; $p < 0.05$) suggesting state-level differences: shale gas opinions among Pennsylvania respondents varied little with proximity to UOGD (table 2: Model 2; figure 2). In contrast, New York respondents were more opposed at increasing distances from UOGD.

For interactions between proximity and political ideology, we used a transformed binary ideology variable for ease of interpretation (i.e. *liberal or moderate = 0; conservative = 1*). For interaction effects between political ideology and proximity, both our proximity measure ($\beta = -0.237$; $p < 0.001$) and proximity X conservative (vs. liberal or moderate) interaction term ($\beta = 0.115$; $p < 0.05$) were statistically significant (table 2: Model 3; figure 3). While both conservatives and liberals/moderates were more opposed to shale gas development at increasing distances, distance has a stronger and more negative impact on liberals/moderates than conservatives.

3.2. Subsample results: Pennsylvania and New York

To probe state-level differences,[15] we divided our sample into Pennsylvania (N = 468) and New York (N = 517) subsamples. For the Pennsylvania baseline model (table 3: Model 4), unlike in our previous models, our proximity measure, distance-to-well, was *not* significant and had a small effect compared to other measures ($\beta = -0.032$; $p \approx 0.621$). Surprisingly, when we interacted distance-to-well with political ideology (conservative vs. liberal or moderate), distance-to-well and distance-to-well X conservative (vs. liberal or moderate) became statistically significant and had the strongest effects ($\beta = 0.282$; $p < 0.001$) in the model (table 3: Model 5). This suggests that, in Pennsylvania, the effect of proximity on support for shale gas was strongly related

[13] In addition to linear multilevel regressions, we also fit linear regression models using cluster robust standard errors (supplemental materials S10) and did not observe substantive differences in our findings.

[14] In terms of our sociodemographic controls (table 2: Model 1), males were more likely to support shale gas development than females ($\beta = 0.125$), as were those more satisfied with their financial situation ($\beta = 0.058$). Those holding a bachelor's degree or higher, compared to no bachelor's degree, were more opposed ($\beta = -0.072$). The inclusion of additional measures and/or subsampling in subsequent models does not substantially alter estimates for these measures with the exception of the New York subsample (table 3: Model 6), where financial satisfaction is not significant and low magnitude ($\beta = 0.034$; $p \approx 0.401$).

[15] As a motivation for this state subsample analysis, we tested a model with a three-way interaction that combined proximity, state, and political ideology effects (i.e. distance-to-well (km) X conservative vs. liberal or moderate X Pennsylvania vs. New York). This three-way interaction term was statistically significant ($\beta = 0.186$; $p < 0.01$; supplemental materials S8: Model 5), suggesting potential state-level heterogeneity in the relationship between political ideology, proximity, and shale gas opinion. Since three-way interaction terms are challenging to interpret in both their directionality and decomposition of main effects, we further probed this relationship by isolating state-level effects in subsample analyses of Pennsylvania and New York.

Table 2. Linear multilevel models predicting shale gas opinion using the full sample. Significance levels are: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

	Dependent variable: shale gas opinion index (strongly oppose → strongly support)		
Fixed effects	Model 1 Standardized Estimate (p-value)	Model 2 Standardized Estimate (p-value)	Model 3 Standardized Estimate (p-value)
Sociodemographic controls			
Age	−0.017 (0.552)	−0.019 (0.509)	−0.005 (0.854)
Male (vs. female)	0.125*** (<0.001)	0.125*** (<0.001)	0.133*** (<0.001)
Bachelor's degree or higher (vs. no bachelor's)	−0.072* (0.016)	−0.076* (0.011)	−0.086** (0.005)
Finances (Not satisfied → Extremely satisfied)	0.058* (0.044)	0.061* (0.034)	0.061* (0.036)
Political ideology			
Political ideology (Very liberal → Very conservative)	0.280*** (<0.001)	0.279*** (<0.001)	
Conservative (vs. liberal or moderate).			0.138** (0.002)
Proximity			
Distance-to-nearest well (km)	−0.161** (0.004)	−0.273*** (<0.001)	−0.237*** (<0.001)
Place			
Pennsylvania (vs. New York)	0.142* (0.011)	0.009 (0.907)	0.142* (0.010)
Interactions			
Distance-to-well (km) X Pennsylvania (vs. New York)		−0.142* (0.023)	
Distance-to-well (km) X Conservative (vs. liberal or moderate)			0.115* (0.019)
Intercept (unstandardized)	2.189*** (<0.001)	2.575*** (<0.001)	3.215*** (<0.001)
Random effects	*Variance*	*Variance*	*Variance*
County subdivisions (intercept)	0.15	0.13	0.15
Akaike Information Criterion	3793.627	3797.588	3828.443
N	985	985	985

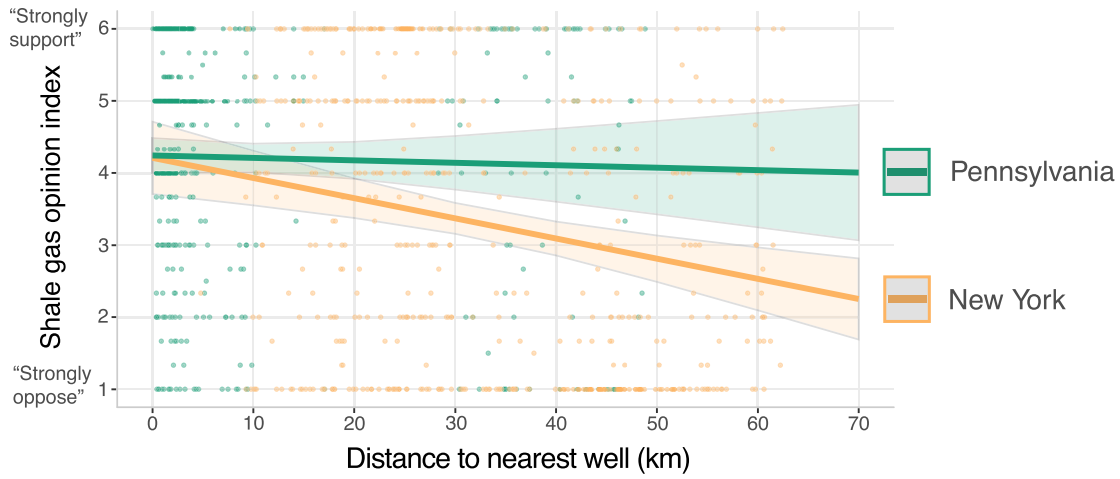

Figure 2. Interaction effect of distance to nearest well (km) and state (Pennsylvania vs. New York) on shale gas opinion (table 2: Model 2). Each point represents a combination of the respondent's distance to a nearest well (km) and score for the shale gas opinion index. Colors of points correspond to respondent's state.

Table 3. Linear multilevel models predicting shale gas opinion, with modeled interaction effects, using state subsamples for Pennsylvania and New York. Significance levels are: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

	Dependent variable: shale gas opinion index (strongly oppose → strongly support)			
	Pennsylvania subsample		New York subsample	
Fixed effects	Model 4 Standardized Estimate (*p*-value)	Model 5 Standardized Estimate (*p*-value)	Model 6 Standardized Estimate (*p*-value)	Model 7 Standardized Estimate (*p*-value)
Sociodemographic controls				
Age	−0.029 (0.507)	−0.012 (0.777)	−0.010 (0.804)	0.009 (0.833)
Male (vs. female)	0.104* (0.018)	0.105* (0.016)	0.151*** (<0.001)	0.167*** (<0.001)
Bachelor's degree or higher (vs. no bachelor's)	−0.088 (0.059)	−0.094* (0.041)	−0.075 (0.074)	−0.082 (0.056)
Finances (Not satisfied → Extremely satisfied)	0.104* (0.020)	0.120** (0.007)	0.034 (0.401)	0.026 (0.533)
Political ideology				
Political ideology (Very liberal → Very conservative)	0.284*** (<0.001)		0.293*** (<0.001)	
Conservative (vs. liberal or moderate).		0.111* (0.042)		−0.239* (0.015)
Proximity				
Distance-to-nearest well (km)	−0.032 (0.621)	−0.225** (0.005)	−0.208** (0.001)	−0.234** (0.003)
Interactions				
Distance-to-well (km) X Conservative (vs. liberal or moderate)		0.282*** (<0.001)		0.037 (0.749)
Intercept (unstandardized)	2.726*** (<0.001)	3.648*** (<0.001)	2.474*** (<0.001)	4.273*** (<0.001)
Random effects	*Variance*	*Variance*	*Variance*	*Variance*
County subdivisions (intercept)	0.12	0.11	0.12	0.16
Akaike Information Criterion	1749.350	1747.244	2067.632	2095.660
N	468	468	517	517

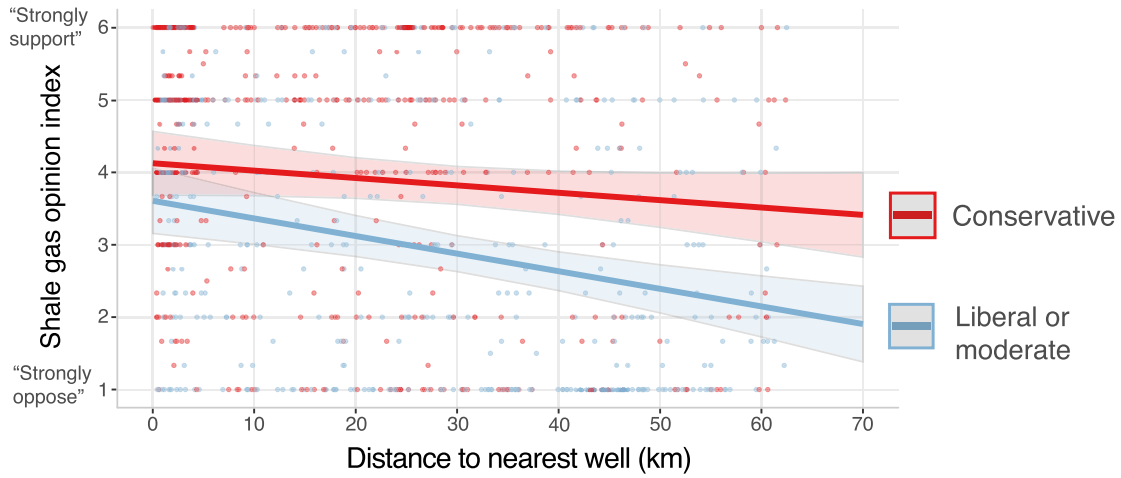

Figure 3. Interaction effect of distance to nearest well (km) and conservative (vs. liberal or moderate) on shale gas opinion (table 2: Model 3). Each point represents a combination of the respondent's distance to a nearest well (km) and score for the shale gas opinion index. Colors of points correspond to categories 'Conservative' or 'Liberal or moderate.'.

to political ideology, a relationship that is displayed in figure 4 (left) via diverging lines of *conservatives* vs. *liberals or moderates*. Conservatives who were further away from UOGD were *more* supportive of shale gas development compared to conservatives that were closer to development. For liberals/moderates in the Pennsylvania subsample analysis, this pattern was instead consistent with our full sample results: liberal/moderate support declined at further distances from development.

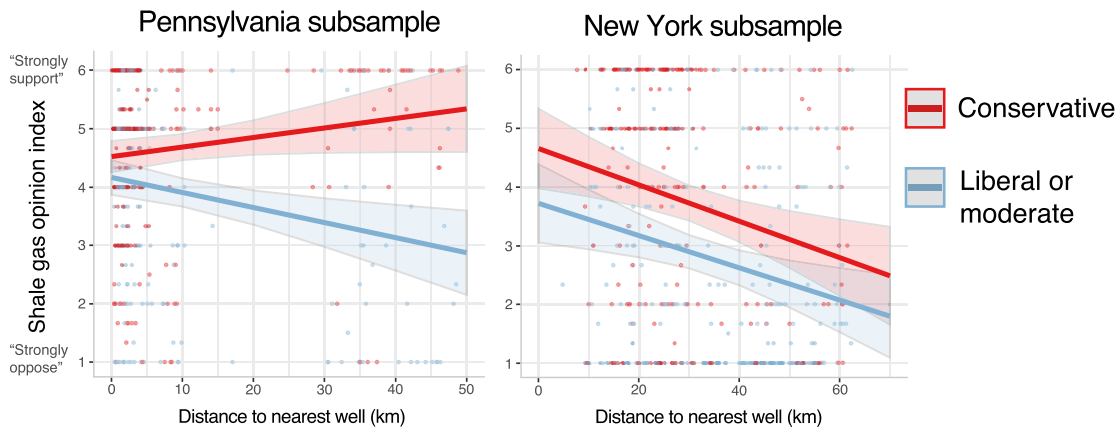

Figure 4. Effect of distance to nearest well (km) on UOGD support/opposition by political ideology group (conservative vs. liberal or moderate) and state subsample (New York or Pennsylvania) (table 3: Model 5 & 7). Each point represents a combination of the respondent's distance to a nearest well (km) and score for the shale gas opinion index. Colors of points correspond to categories 'Conservative' or 'Liberal or moderate.'.

Among New York respondents, our proximity measure, distance-to-well, was significantly related to support. However, unlike the Pennsylvania subsample analysis, the interaction effect for distance-to-well and political ideology was *not* significant with relatively low magnitude effects ($\beta = 0.037$; $p \approx 0.749$; table 3: Model 7). This result suggests that the relationship between distance and shale gas opinions among our New York respondents varied little by political ideology. This insignificant effect is demonstrated in figure 4 (right) where downward sloping lines representing the categories conservative and liberal/moderate appear nearly parallel.

4. Discussion and conclusions

Our exploration of the interactions between political ideology, proximity and place using geocoded survey responses and well locations within the Marcellus Shale region revealed both consistencies and anomalies in the geographies of perception of UOGD among respondents in New York and Pennsylvania. Consistent with previous research that explores the relationship between proximity to and opinion about development at the national-level (Boudet *et al* 2018, Zanocco *et al* 2019), we found that, on average, respondents who were located closer to UOGD offered more support for shale gas development. Moreover, our measure of respondent location was at a household's street address-level, allowing for a more fine-grained examination of geographic proximity effects than previous studies, which have often relied on relatively coarse resolution geographic data (ZIP code- or county-level). This finding validates previous work done on national scales and suggests that estimation methods using measurement approaches with different spatial resolution are robust to this proximity-support finding.

However, we found heterogenous effects at the state-level. For New York respondents, proximity to development was associated with greater support for fracking; for Pennsylvania respondents, proximity had no effect. This difference within a given oil and gas producing geographic region like the Marcellus Shale area, could help explain why, at national scales, the proximity-support relationship, while consistent, is relatively weak. It also suggests that the effect of proximity on support at national scales is not uniformly distributed among the general population and may vary by the geographic scale of analysis (Evensen and Stedman 2016).

We also found mixed results in how political ideology and proximity to UOGD interact to shape support/opposition for UOGD. For our full sample the proximity-support relationship was moderated by political ideology: liberals or moderates located closer to UOGD were more supportive than those located further away. This differed by state: for New York respondents, proximity did not appear to have a differential effect on conservatives vs. liberals/moderates. However, for Pennsylvania respondents, *conservatives* were more supportive further away from development, while *liberals* were more supportive closer to development.

Some researchers have framed similar findings of ideology-proximity-support interactions in terms of Construal Level Theory (CLT) (Trope and Liberman 2010, Mcdonald *et al* 2015, Clarke *et al* 2016, Evensen and Stedman 2016, Boudet *et al* 2018). CLT posits that the perceived psychological distance to issues, objects or events—spatially, temporally, socially and/or hypothetically—can change perceptions about them. Objects, issues or events perceived as 'near' will be thought about more concretely, drawing on local conversations, direct experiences, and/or associated emotions; those perceived

as 'far' will be thought about more abstractly, in terms of larger worldviews like political ideology; such construals can affect attitudes and behavior (Trope and Liberman 2010, Brügger 2020). To the extent geographic distance relates to psychological distance,[16] our results suggest that, as others have found (Gravelle and Lachapelle 2015, Clarke *et al* 2016), political ideology can play a larger role in shaping opinions toward UOGD at greater distances from development, but ideology's influence on proximity-support relationships may vary depending on context and analytic scale. We encourage others to continue to test CLT in a more rigorous manner than we are able to here, using robust measures of psychological distance (Brügger *et al* 2016).

Our measure of context (state of residence) is likely related to the temporal, hypothetical and social aspects of psychological distance. The two states were at very different stages of UOGD at the time of our survey—differences that affected discourse and elite cues about the issue (Evensen *et al* 2014) and likely feelings of psychological distance as distinct from geographic distance. At the time of our survey, New York had placed a temporary ban on shale gas development to consider a moratorium, ultimately enacted in December 2014. Partisan divisions on the issue were clearly established. Democrats supported a ban; Republicans opposed one. Accordingly, New York media coverage and discourse were much less about the actual impacts of UOGD and more about *whether* UOGD should occur; political brinkmanship also left little room for nuanced discussion. In Pennsylvania, with drilling already taking place, discourse and media discussions reflected the realized experience with extraction, particularly for those living closer to development (Evensen *et al* 2014, Jacquet *et al* 2018). This context makes the disparate results presented in figure 4 more understandable. The role of context may also help explain recent conflicting findings about the relationship between measures of perceived psychological distance and support for UOGD (Mayer 2016, Alcorn *et al* 2017). Future research should examine more specifically which aspects of context matter most and the role of discourse and elite cues in shaping geographies of perception (Evensen *et al* 2017). In particular, stage of development appears to be particularly important in shaping proximity-ideology-support relationships, even at a single point in time in neighboring states. Precisely geocoded, longitudinal survey data could reveal important, and perhaps more generalizable, geographies of perception as they relate to stage of development. Since the time of this survey, the issue of fracking in the U.S. has become increasingly partisan (Malin *et al*, 2019; Dokshin, 2019), which could result in a more standardized partisan divide in public opinion than our findings from this earlier stage of development.

While we leverage high resolution opinion and energy development data in this research, our approach and sample have limitations. First, we sampled residents in areas of two states with starkly different approaches toward shale gas development. While differences in state policies toward hydraulic fracturing punctuate development in a way that is amendable for understanding heterogenous effects, a larger sample covering other U.S. shale producing regions could reveal underlying relationships and provide insights into the generalizability of these effects. Second, some sociodemographic variables in our analysis—e.g. education—were unbalanced across states. The extent that this imbalance could contribute to missing and/or confounding variables is unknown. Third, at the time of the survey we did not have a good indication of the resource itself, and most importantly for New York, whether respondents were aware of nearby economically recoverable resources. Future work, therefore, could incorporate respondent distance to recognized economically recoverable resources as a proximity measure. Finally and relatedly, we only consider a single measure of proximity to development: nearest geographic distance. However, there are likely other geospatial factors that could be applied as energy development proximity measures, such as visibility from a road, connectivity to a natural resource (e.g. water supply), or distance to associated infrastructure (e.g. pipelines).

Our results both reaffirm and challenge existing scholarship. When Pennsylvania and New York samples are combined, proximity-support findings are consistent with national-level polling. However, when state samples are analyzed using techniques that account for context, a different story unfolds, one of substantial heterogeneity across states that is context dependent and may or may not be generalizable to other contexts. Our findings therefore highlight the potential for middle range theorizing (Rosa *et al* 1988) about geographies of perceptions in energy development (Haggerty *et al* 2018). A more widespread and comparative exploration of how place, proximity and political ideology combine to create patterns of perception that may reoccur in other places or at other tidevelopment: the intermes, could better inform both policy makers and the public about potential pathways to energy development and/or resistance.

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[16] See (Craig *et al* 2019) for a discussion of why geographic distance may not relate to psychological distance.

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Data availability

The data that support the findings of this study are available upon request from the authors.

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