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**MODE EFFECTS IN RESPONSE TO A
MAIL AND TELEPHONE SURVEY¹**

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Study Purpose

Surveys are commonly used by scholars, advocates, news reporters, and policy makers alike to monitor public opinion about a wide range of controversial issues, including those related to environmental/natural resources. Polls are conducted using mail, telephone, the internet, and face-to-face interviews. Moreover, in recent years, multiple modes have been employed within a single study in an effort to increase response rates (de Leeuw, 2005; Dillman, Smyth, & Christian, 2014). To what extent are respondent answers affected by the mode of data collection? Can the results of studies carried out using differing modes be directly compared to measure variations across time and/or locale? Is it meaningful to simply combine survey responses obtained by various data collection modes as if the method of data collection had no effect on how subjects responded? The current study partially addressed these questions by assessing how respondents' answers differed depending upon which of two modes of data collection (telephone vs. mail) was employed, while controlling for sampling procedures and survey content.

There are reasons to expect that how people respond to survey questions may be affected by whether these questions are delivered via telephone interviews or mail questionnaires. Interaction with an interviewer may bring social norms, such as social desirability and acquiescence, into play. Further, the interview situation introduces both time pressures and a rigid order of questioning, both of which potentially limit the subject's opportunities for reflection, recall, and review of alternative responses (de Leeuw, 2005; Dillman & Christian, 2005; Dillman et al., 2014). Some research supporting mode differences in responses suggests telephone interviews are more likely than mail questionnaires to: (1) yield socially desirable responses (Tourangeau & Smith, 1996; Tourangeau & Yan, 2007); (2) produce acquiescence effects in which subjects tend to agree or answer "yes" to questions; (3) be influenced by response order – primacy or recency effects – where the last response is more likely in telephone interviews, while the first response occurs proportionately more often in mail surveys (Krosnick, 1991; Krosnick & Alwin, 1987), or satisficing behavior (Krosnick, Narayan, & Smith, 1996). Several studies have also suggested telephone surveys are more likely than mail surveys to engender extreme positive responses, (such as the highest ratings in a customer satisfaction survey) but are not more likely to give extremely negative responses (Christian, Dillman, & Smyth, 2008; Dillman et al., 2009; Tarnai & Dillman, 1992; Ye, Fulton, & Tourangeau, 2011).

Most of the published literature addressing the question of mode effects has reported mail/telephone differences in responses; few studies have reported contradictory findings. This raises the possibility of a "file drawer" effect in which findings that fail to document differences

are deemed unworthy of publication (Sterling, Rosenbaum, & Weinkam, 1995). Moreover, much of the previous literature compared mode effects over a small number of items rather than examining differences over a wide spectrum of different types of questions (Dillman et al., 2014). This study extends existing research in this area by comparing responses to 50 identical questions asked in recent concurrent telephone and mail surveys. For this study, random samples of residents in the same geographic area were surveyed concerning their views and experiences related to natural gas development in the Marcellus Shale (Theodori, Willits, & Luloff, 2012; Willits, Luloff, & Theodori, 2013). The analysis reported here addresses the following research questions:

- 1) Do the responses of subjects who participate in a telephone interview differ from those who respond to the same questions presented in a mail questionnaire?
- 2) If mode differences in responses are present, are there consistent patterns that can be defined?
- 3) Do observed patterns persist when differences in the characteristics of respondents who participate in telephone interviews and mail surveys are controlled.

The Sample

Identical protocols were employed for drawing samples for telephone and mail surveys in the 21 counties located in core and first tier area of the Marcellus Shale region in Pennsylvania.² All counties included in the sampling frame had experienced at least some Marcellus drilling, but the density of wells varied widely. Both samples were stratified so that half of the respondents were located in areas of “high” well densities (20 to 93 wells per 100 square miles) and half were located in counties with “low” well densities (fewer than 20 per 100 square miles). Coincidentally, 50% of the total population in the 21 counties included in the sample fell in the low well-density counties, and 50% fell in the high well-density counties.³

Data collection was conducted between June 2012 and October 2012. The telephone survey used CATI software with repeated calls to each number at various times of the day and days of the week and repeated callbacks to those individuals who expressed interest in participating. Calls continued until 200 completed interviews were obtained from each of the two well-density areas for a total of 400 telephone interviews. The overall completion rate was 27%.

For the mail survey, 800 names and addresses of persons with listed telephone numbers in both the low well-density and high well-density counties were used. An initial mailing, including a cover letter and printed questionnaire, was sent to these sample members, followed by three follow-up reminder letters with duplicate questionnaires. The first 200 replies received from each of the well-density categories were included in the current analysis (27% completion rate).

² Geologists differ in their estimates of the exact size and location of the Marcellus Shale region. The current research focused on the area defined by Bernstein Research as the Central Core and Tier 1 in Pennsylvania. The Core and Tier 1 areas were defined in terms of depth, thickness, porosity, thermal maturity, and silica content of the shale – factors that play into the economics of the gas yield (Dell, Lockshin, & Gruber, 2008). In addition to the 20 counties so defined, Washington County was added to the sampling frame because of the high incidence of drilling that had already taken place there.

³ Counties included in the Low Well Density category were: Bedford, Blair, Cambria, Cameron, Centre, Clearfield, Clinton, Indiana, Lackawanna, Somerset, Sullivan, and Wayne. The High Well Density Counties included: Bradford, Fayette, Greene, Lycoming, Susquehanna, Tioga, Washington, Westmoreland, and Wyoming.

⁴ All tables are in the Appendix.

The Survey Form

The questions used in the mail and telephone surveys were identical in wording and in the instructions given to the respondents. Included were 50 separate items, presented in ten blocks or clusters (see Table 1).⁴ The items varied in format and content. One cluster dealt with behavioral items, another asked about the respondent's evaluations of self-knowledge, others dealt with perceptions of trust, sources of information, and attitudes about natural gas development. All presented "multiple-choice" responses, including 4 or 5 ordered and named categories, dichotomous answers, and 7-point continua with only the endpoints labeled.

Analysis: Research Question #1 (Are there Overall Mode Differences in Responses?)

Block 1 (5 items) asked whether the respondents had participated in specific activities related to natural gas drilling, i.e., whether they had leased land for natural gas drilling, attended a public meeting, contacted a local official, and voted for or against a candidate as a result of their position on drilling (Table 2). These were the only items considered in this analysis where respondents were asked to report on *behaviors* as opposed to *attitudes* or *opinions*. There were no statistically significant mode differences in responses for any of these five items.

Of the remaining 45 items, all of which focused on personal evaluations, opinions, or attitudes, 37 (82%) had statistically significant differences between the response distributions obtained using telephone vs. mail methodologies (Tables 3-9). *All* items in Blocks 2, 3, 5, and 6 indicated significant mode effects. Blocks 8 and 9 each had seven of eight items with significant ($p < .05$) mode differences in responses. For Block 4, three of five items had significant mode differences. For Block 10, three of six items had significant mode differences. For the single item in Block 7, the differences between the telephone and mail responses did not even approach significance ($p = .516$), and that item was deleted from the analysis which follows. Overall, these findings suggest mode effects may apply to a wide range of question types.

Analysis: Research Question #2 (What Patterns of Mode Differences Occur?)

Although not all of the significant mode differences were readily interpretable, two patterns occurred with sufficient frequency as to be noteworthy. First, (except for the single item in Block 7) for *all* 22 items with an *odd* number of response categories (those in Blocks 2, 3, 4, 5, and 6), respondents to the mail survey were more likely than telephone respondents to choose the "middle" category. This was true even for the 5 items in Block 4, where "don't know" was the fifth alternative.

Second, telephone respondents were more likely than their mail counterparts to select *both* the first and last (i.e. the most extreme) categories for 28 of the 29 items in Blocks 2, 3, 4, 8, and 9. For the Block 4 items, where "don't know" was the last response listed, telephone respondents were more likely than mail subjects to choose both "don't know" *and* the extremes of "no trust" and "a great deal of trust." While, in some measure, the selection of extreme responses by telephone subjects reflected the tendency of mail more than telephone respondents to choose the

middle category for items with an odd number of responses, it clearly represented something more. Even in Blocks 8 and 9, which had no middle category, the pattern of proportionately more telephone than mail responses at both of the extreme ends of the scales persisted. What distinguished these items from the others? In terms of format, all of the items in Blocks 2, 3, 8, and 9 (and Block 4 if the “don’t know” response is ignored) were unipolar, with responses ranging from low to high on a particular attribute. Thus, it seems that unipolar response categories are more likely to elicit extremely high or low responses from telephone respondents than from subjects in mail surveys.

There was some evidence that mail survey participants were more likely to acquiesce in their answers to items in Blocks 5 and 6 by selecting the positive answers of “very important” or “agree/strongly agree.” However, these patterns were much less pronounced and less common than the mode differences discussed above. Moreover, the significant mode differences for the yes/no items in Block 9 failed to reveal a pattern of greater or less acquiescence (yes-responses) among telephone respondents relative to the answers given by mail participants.

Analysis: Research Question #3 (Are Mode Effects Significant and Persistent when Adjusting for Differences in Sample Composition?)

To assess whether the observed tendency of mail surveys to elicit a greater proportion of “middle” responses than telephone surveys was statistically significant, responses to the items with seven and five response categories (those in Blocks 2, 3, 4, 5, and 6) were recoded so that the “middle” category was coded “1” and all remaining categories were coded “zero.” Logistic regressions then tested both: (1) the overall (bivariate) relationships between mode (mail=0; telephone=1) and these recoded responses; and (2) multiple logistic regression models incorporating respondent’s gender, age, education and income level as covariates. A significant, negative relationship between mode and response in these analyses would support the tendency of mail respondents to choose the “middle” category more often than did telephone respondents.

Although the study design sought to obtain comparable samples for the two modes (samples were drawn from the same source and both included only cases with telephone access), the final data sets differed in terms of gender, age, education, and income level distributions (Table 10). The mail sample contained a significantly larger proportion of males, was somewhat older, more likely to have higher education, and had higher incomes than did the telephone sample. As a result, it seemed possible that the observed difference between the telephone and mail survey responses might reflect differences in sample composition rather than mode differences *per se*. To explore this possibility, the effects of gender, age, education, and income were statistically controlled and the adjusted relationships of survey mode (telephone vs. mail) addressed.

Of the 22 items in Blocks 2, 3, 4, 5, and 6, ten of the mode effects were significant at the bivariate level, and 11 were significant when the effects of gender, age, education, and income were controlled (Table 11). Consistent patterns of mode differences in both the bivariate and multivariate were found in each of the Blocks in these analyses.

A similar procedure was used to assess the significance of the second observed pattern of mode differences. That is, response categories were recoded to focus on the tendency of telephone, more than mail, respondents to choose “extreme” answers from a series of ordered categories (Table 12). Previous analysis described this tendency for items in Blocks 2, 3, 8, and 9. Block 4 items were somewhat problematic. Although five response categories were presented, only the

first four were ordered from low-to high; the fifth was “don’t know.” Moreover, fewer than 8 percent of the subjects chose the “don’t know” category. As a result, although the Block 4 items were included here, those respondents selecting “don’t know” were omitted.

For all of these analyses, the lowest and highest response categories were combined for each item to form a category of “extreme” responses (code=1), with the remainder recoded into a “mid-range” category (code=0). Thus, positive relationships of these variables with mode (mail=0; telephone=1) here would support the suggestion that telephone surveys, relative to those using mail procedures, have a greater likelihood of extreme responses.

Of the 29 items included in these five Blocks, 25 had significant mode differences in the expected direction in both the bivariate analysis, and all 25 retained that significance when the effects of gender, age, education and income were controlled.

Conclusions/Discussion

What can be concluded from these findings? First, it is clear that responses to telephone and mail surveys can and do differ over a wide range of question areas. Of the 50 items included in the current surveys, 37 provided evidence of significant mode differences in responses.

Items dealing with respondents’ *behaviors* (rather than their opinions, attitudes, or evaluations) showed no such significant mode effects. This suggests factual questions asking about subjects’ personal characteristics and what they do or do not do may not be affected by mode of survey delivery, whereas perceptions and evaluations may be more susceptible. However, such a conclusion should be embraced with caution. The behavioral items were limited in number (only five) and all utilized dichotomous (yes/no) response categories. Whether the use of more items and/or a larger number of response categories reflecting the importance, degree, or frequency of participation would result in different findings remains uncertain.

More than 80% of the items dealing with respondents’ perceived knowledge, opinions about sources of information, feelings of trust, and other views indicated differences in mail and telephone responses. Previous research has suggested telephone surveys, when compared with mail surveys, tend to present: a greater tendency for “recency effects” (a disproportionate selection of the last offered category) whereas mail surveys exhibited “primacy effects” (disproportionate selection of the first category). And, telephone surveys have been reported to be associated with acquiescence effects in which subjects tend to disproportionately “agree” in telephone interviews; and “social desirability” effects where telephone respondents select answers they see as most socially acceptable). This study presented no clear evidence to support these suggested mode effects.

The current analysis was consistent with previous research in that telephone subjects were less likely than mail respondents to choose “middle” response categories when an odd-number of answers to bipolar questions were presented. And, to an even greater extent, telephone respondents were more likely than mail survey subjects to choose extreme answers (Christian et

al., 2008; Dillman et al., 2009; Tarnai & Dillman, 1992; Ye et al., 2011). However, while prior research has reported only a greater tendency of telephone respondents to embrace the extreme “positive” end of scale, the current analysis found concentrations at *both* the lowest and highest ends of the ordered responses. These findings suggest mode effects may be more complex than currently thought and may depend upon not only question content, but response formats as well. Although future studies are needed to assess both the frequency of and circumstances under which mode differences occur, practical problems confront the researcher *today* concerning how to minimize mode differences and account for their effects in ongoing research studies that increasingly use mixed mode designs (Willits, Luloff, & Theodori, 2014). An understanding of the nature of mode effects is the first step in devising data collection procedures to minimize such problems. Thus, in the current analysis, the finding that the use of an odd number of response categories encouraged mail more than telephone respondents to respond in terms of the “middle” category suggests that, when appropriate, it may be preferable to utilize an even number of response categories, with or without an opportunity for a “no opinion” response either preceding the item or as the last of the series of response categories. Use of such a format would also allow for addressing the question as to whether the factors related to having an opinion differ from those determining the direction and degree of that opinion. Perhaps the tendency for responses from telephone surveys to reflect more extreme answers could partially be reduced by including additional response categories on the survey and combining extreme answers with adjacent categories for analytic purposes. Similarly, when ordered responses are numerically scored, the heterogeneity of variances in responses occasioned by telephone respondents disproportionately choosing extreme scores may be reduced or eliminated by standardizing the obtained scores. Research on the effectiveness of simple changes such as these in reducing mode effects is needed.

Moreover, calling into account and reporting any mode effects found in the analysis of mixed mode survey data should routinely be done by researchers. This would include incorporating “mode” as a control variable in analysis of mixed-mode studies, assessing whether the relationships under study are conditioned or altered by the mode source, and exploring whether some respondents are more susceptible to mode effects than others. Cumulative data from such analyses would provide data to more precisely assess the extent and practical impact of mode differences on research findings.

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Appendix

Table 1. Items, response categories, and numbers of items showing significant ($p < .05$) telephone vs. mail mode differences in responses.

Block Number	Topic and Number of items	Response categories	Significant Mode Differences
1	Participated in activities related to natural gas: <ul style="list-style-type: none"> • leased land for gas drilling • attended a public meeting • contacted government • voted FOR a candidate favorable to gas development • voted AGAINST a candidate favorable to gas development 	Yes No	None significant.
2	Familiarity with: <ul style="list-style-type: none"> • the process of hydraulic fracturing*** • management & disposal of frac flowback water* • frac flowback wastewater treatment technology* 	Scale numbered from 1 to 7 with end points labeled: Extremely unfamiliar Extremely familiar	Three of three items had significant mode differences
3	Self-perceived knowledge of natural gas drilling: <ul style="list-style-type: none"> • economic impacts*** • social impacts*** • effects on natural environment*** • implications for water quality*** • implications for water quantity*** 	None or almost none Very little Some but not much A good bit A great deal	Five of five items had significant mode differences
4	Trust in various groups related to gas development: <ul style="list-style-type: none"> • natural gas industry • state officials/organizations • local officials/organization* • environmental groups/organizations* • scientists/researchers* 	No trust Very little trust Some trust Great deal of trust Don't know	Three of five items had significant mode differences

5	Importance of changes to your community related to natural gas development: <ul style="list-style-type: none"> • job opportunities*** • opportunities for small business development*** • water quality impacts*** • water quantity impacts** 	Very unimportant Unimportant Neither important nor unimportant Important Very important	Four of four items had significant mode differences
6	Attitudes about natural gas development <ul style="list-style-type: none"> • already know enough to move forward** • benefits outweigh the cost** • worry about a catastrophic accident *** • negative impacts can be fixed*** • development will create long lasting environmental problems*** 	Strongly agree Agree Neutral Disagree Strongly disagree	Five of five items had significant mode differences.

Table 1 (cont.)

7	Overall support/opposition to natural gas development (1 Item)	Strongly oppose Somewhat oppose Neither oppose nor support Somewhat support Strongly support	Not significant.
8	How much various sources have contributed to knowledge of hydraulic fracturing: <ul style="list-style-type: none"> • newspapers*** • <i>Gasland</i> (the film) • natural gas industry** • regulatory agencies** • conservation/environmental groups*** • Cooperative Extension** • university professors*** • landowner groups/coalitions* 	None Very little Some A great deal	Seven of eight items had significant mode differences.
9	Trust in various groups to provide unbiased knowledge on hydraulic fracturing: <ul style="list-style-type: none"> • newspapers** • <i>Gasland</i> (the film)*** • natural gas industry • regulatory agencies* • conservation/environmental groups*** • Cooperative Extension*** • university professors*** • landowner groups/coalitions*** 	No trust Very little trust Some trust Great deal of trust	Seven of eight items had significant mode differences.

10	Safe uses of treated waste-water from hydraulic fracturing <ul style="list-style-type: none"> • reuse by gas/oil industry operators*** • watering of livestock*** • industrial uses (e.g. manufacturing)* • people's drinking water • municipal uses (water golf courses, parks, etc.) • irrigation of farmland 	Yes No	Three of six items had significant mode differences
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*significant .05
**significant .01
***significant .001

Table 2. Patterns of mode differences in responses to the familiarity with hydraulic fracturing (Block 2)

How familiar are you with . . . ?	Number of cases	Response							ChiSquare	Prob.
		Extremely Unfamiliar 1	2	3	4	5	6	Extremely Familiar 7		
		-----Percents-----								
The process of hydraulic fracturing									24.04	.001
Telephone	400	24.0	8.8	13.0	13.0	21.5	8.8	11.0		
Mail	396	15.9	12.1	12.9	22.0	19.9	10.9	6.3		
The management & disposal of frac flowback water									16.46	.012
Telephone	400	38.0	13.0	12.5	12.0	10.5	5.5	8.5		
Mail	397	28.5	12.8	15.6	16.6	14.1	7.3	5.0		
Frac flowback wastewater treatment technology									13.40	.037
Telephone	400	43.0	14.2	14.0	9.8	10.8	4.2	4.0		
Mail	398	33.9	18.3	13.8	13.8	11.1	6.8	2.3		

Number of cases varies due to missing data.

Table 3. Patterns of mode differences in responses to self-perceived knowledge (Block 3)

How much do you know about natural gas drilling in the Marcellus Shale?	Response						ChiSquare	Prob.
	Number of cases	None/ almost none	Very little	Some/ not much	A good bit	A great deal		
	-----Percents-----							
Economic impacts							31.11	.000
Telephone	400	12.1	12.2	26.5	25.2	24.0		
Mail	400	6.8	15.8	33.2	32.5	11.8		
Social impacts							56.95	.000
Telephone	400	16.2	63.4	24.2	26.2	22.5		
Mail	395	8.6	62.6	33.4	29.1	7.8		
Effects on the natural environment							30.59	.000
Telephone	400	13.0	11.8	22.8	28.0	24.5		

Mail	397	8.1	15.1	31.7	33.0	12.1		
Implications for water quality							27.10	.000
Telephone	400	12.5	13.2	24.8	25.2	24.2		
Mail	395	9.6	15.2	32.2	31.6	11.4		
Implications for water quantity							19.57	.001
Telephone	400	17.8	17.0	27.5	20.8	17.0		
Mail	392	12.2	20.9	30.9	7.0	8.9		

Number of cases varies due to missing data.

Table 4. Patterns of mode differences in responses to trust in various groups related to gas (Block 4)

How much trust do you have in each of the following groups related to natural gas development?	Number of cases	Response					ChiSquare	Prob.
		No trust	Very little trust	Some trust	A great deal of trust	Don't know		
		-----Percents-----						
Natural gas industry							8.46	.076
Telephone	400	15.2	22.5	35.2	23.8	3.2		
Mail	397	13.1	28.7	38.3	17.4	2.5		
State officials & organizations							7.23	.124
Telephone	400	26.8	34.5	28.7	7.8	2.2		
Mail	400	20.0	38.8	33.2	6.5	1.5		
Local officials & organizations							12.46	.014
Telephone	400	20.8	29.2	34.0	13.5	2.5		
Mail	400	16.0	30.0	43.8	8.5	1.8		
Environmental groups/ organizations							12.03	.017
Telephone	400	14.8	24.5	32.2	24.2	4.2		
Mail	400	13.2	19.8	42.2	23.0	1.8		
Scientists/ researchers							9.54	.049
Telephone	400	5.5	11.0	36.8	39.2	7.5		

Mail	400	2.8	9.0	43.0	40.8	4.5		
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Number of cases varies due to missing data.

Table 5. Patterns of mode differences in responses to the importance of expected changes to your community related to natural gas development (Block 5)

How important do you think each of these changes is to your community?	Response						ChiSquare	Prob.
	Number of cases	Very unimportant	Unimportant	Neither U nor I	Important	Very important		
	-----Percents-----							
Increased job opportunities for local residents							49.94	.000
Telephone	400	4.5	5.8	9.0	26.8	54.0		
Mail	367	10.1	3.8	11.4	43.6	31.1		
Increased opportunities for small business development							43.72	.000
Telephone	400	3.5	6.2	9.0	28.5	52.8		
Mail	368	10.6	4.9	11.1	41.3	32.1		
Water quality impacts from drilling-related activity							22.88	.000
Telephone	400	3.5	2.5	5.2	19.2	69.5		
Mail	366	10.1	3.0	7.9	23.8	55.2		
Water quantity impacts from drilling-related water withdrawals							13.47	.009
Telephone	400	3.8	2.8	8.2	24.8	60.5		
Mail	369	9.5	3.8	10.6	22.8	53.4		

Number of cases varies due to missing data.

Table 6. Patterns of mode differences in expressed attitudes about natural gas development (Block 6)

Indicate whether you Strongly agree (SA), agree (A), are neutral (N), disagree (D), or strongly disagree (SD) with each of the following. . .	Number of cases	Response					ChiSquare	Prob.
		SA	A	N	D	SD		
		-----Percents-----						
		-						
We already know enough about the potential impacts of natural gas to move forward with development in the Marcellus Shale.							17.24	.002
Telephone	400	14.0	31.0	20.0	22.0	13.0		
Mail	399	10.3	20.5	23.5	26.6	18.5		
All in all, the benefits of natural gas extraction from the Marcellus Shale in this region will outweigh the costs.							16.88	.002
Telephone	400	13.5	33.2	22.5	21.5	9.2		
Mail	396	10.9	24.7	30.6	18.9	14.9		
I worry that there will be some sort of catastrophic accident involving natural gas extraction I the Marcellus Shale.							19.52	.001
Telephone	400	17.2	30.8	14.0	27.0	11.0		
Mail	399	12.8	29.8	25.8	23.6	8.0		
Any negative impacts of natural gas extraction in the Marcellus Shale can be fixed.							27.30	.000

Telephone	400	7.8	21.0	17.8	31.2	11.2		
Mail	399	4.5	19.5	27.3	32.3	16.3		
Development of natural gas in the Marcellus Shale will create long lasting environmental problems.							21.45	.000
Telephone	400	12.8	27.3	19.5	22.2	7.2		
Mail	399	12.3	24.6	32.1	22.6	8.5		

Number of cases varies due to missing data.

Table 7. Patterns of mode differences in responses to support/opposition to natural gas development (Block 7)

Considering everything, how do you feel about natural gas extraction from the Marcellus Shale region?	Number of cases	Response					ChiSquare	Prob.
		Strongly oppose	Oppose	Neither oppose nor support	Support	Strongly support		
		-----Percents-----						
Telephone	400	9.8	15.0	15.0	29.2	31.0	3.25	.516
Mail	397	9.1	15.1	18.6	30.7	26.4		

Table 8. Patterns of mode differences in responses to how much various sources of information contributed to knowledge of hydraulic fracturing (Block 8)

How much has each of the following contributed to what you know about the process of hydraulic fracturing?						ChiSquare	Prob.
	Number of cases	None	Very little	Some	A great deal		
	-----Percents-----						
Newspapers						17.98	.000
Telephone	400	20.8	21.0	35.0	23.2		
Mail	395	12.7	16.7	48.1	22.5		
<i>Gasland</i> (the film)						5.34	.149
Telephone	400	74.5	10.2	10.0	5.2		
Mail	386	77.7	11.4	8.5	2.3		
Natural gas industry						13.03	.005
Telephone	400	30.5	21.5	32.2	15.8		
Mail	394	27.7	26.1	37.8	8.4		
Regulatory agencies						11.96	.008
Telephone	400	44.5	23.0	24.2	8.2		
Mail	395	37.1	31.7	26.3	4.9		
Conservation/environmental groups						25.11	.000
Telephone	400	37.2	18.2	30.8	13.8		
Mail	393	28.5	29.3	35.4	6.9		
Cooperative Extension						11.58	.009
Telephone	400	61.0	16.8	17.0	5.2		
Mail	389	55.0	25.7	16.5	2.8		
University professors						18.29	.000
Telephone	400	62.0	16.0	15.0	7.0		
Mail	391	56.5	25.8	15.1	2.6		
Landowner groups/coalitions						10.39	.016
Telephone	400	50.0	15.5	24.8	9.8		
Mail	394	39.6	21.6	29.4	9.4		

Number of cases varies due to missing data.

Table 9. Patterns of mode differences in responses to how much trust is given to various sources of information on hydraulic fracturing (Block 9)

How trust you have in each of the following to deliver						ChiSquare	Prob.
	Number of cases	No Trust	Very little trust	Some trust	Great deal of trust		

unbiased factual knowledge on hydraulic fracturing?		-----Percents-----					
Newspapers						11.72	.008
Telephone	400	15.8	26.2	49.2	8.8		
Mail	397	8.6	28.0	56.7	6.8		
<i>Gasland</i> (the film)						69.69	.000
Telephone	400	64.2	15.0	16.0	16.5		
Mail	353	35.4	31.4	29.7	3.4		
Natural gas industry						7.55	.056
Telephone	400	25.2	25.2	39.0	10.5		
Mail	398	23.9	28.4	42.2	5.5		
Regulatory agencies						9.60	.022
Telephone	400	19.5	25.5	43.5	11.5		
Mail	395	16.2	33.4	43.3	7.1		
Conservation/environmental groups						15.86	.001
Telephone	400	20.0	19.0	43.5	17.5		
Mail	392	14.0	29.3	43.9	12.8		
Cooperative Extension						48.08	.000
Telephone	400	32.2	17.5	37.0	13.2		
Mail	380	13.4	27.1	50.0	9.5		
University professors						22.75	.000
Telephone	400	23.8	19.5	40.2	16.5		
Mail	394	12.2	24.6	50.0	13.2		
Landowner groups/ coalitions						19.95	.000
Telephone	400	21.8	21.5	42.8	14.0		
Mail	396	11.9	31.1	45.7	11.4		

Number of cases varies due to missing data.

Table 10. Gender, age, education, and income differences between the telephone and mail samples

Respondent characteristics	Telephone Sample		Mail Sample		Chi Square	Prob.
	Number of Cases	Percent	Number of Cases	Percent		
Gender					14.56	.000
Male	196	49.0	250	62.7		
Female	204	51.0	149	37.3		
Age					10.58	.060
Less than 35 yrs	30	7.9	20	5.1		
35-44 yrs	57	14.9	39	10.0		
45-54 yrs	94	24.6	93	23.9		
55-64 yrs	100	26.2	107	27.5		
65-74 yrs	63	16.5	71	18.3		
75 yrs and over	38	9.9	59	15.2		
Education					28.67	.000
Less than high school	17	4.2	17	4.3		
High school graduate	174	43.5	114	28.6		
Some post high school	74	18.5	113	28.4		
College graduate	76	19.0	63	15.8		
Post graduate/professional training beyond college	59	14.8	91	22.9		
Income					27.43	.000
Less than \$15,000	29	9.6	10	2.9		
\$15,000 to \$24,999	28	9.3	49	14.0		
\$25,000 to \$34,999	56	18.6	41	11.7		
\$35,000 to \$49,999	39	13.0	59	16.9		
\$50,000 to \$74,999	63	20.9	76	21.8		
\$75,000 to \$99,999	38	12.6	34	9.7		
\$100,000 or more	48	15.9	80	22.9		

Number of cases varies due to missing data.

Table 11. Logistic regressions testing for telephone vs. mail differences in the incidence of choosing of “middle” responses to survey questions, adjusting for the effects of gender, age, education and income

	Bivariate	Multivariate

BLOCKS and Items	B	Odds Ratio	B	Odds Ratio
BLOCK 2: How familiar are you with each of the following?				
Process of hydraulic fracturing	-.63***	.53	-.65**	.52
Management and disposal of frac flowback water	-.38	.68	-.24	.79
Frac flowback wastewater treatment technology	-.40	.67	-.19	.83
BLOCK 3: How much do you know about natural gas drilling in the Marcellus Shale?				
Economic impacts	-.32*	.73	-.54**	.58
Social impacts	-.45	.64	-.38*	.68
Effects on the natural environment	-.46**	.63	-.54**	.53
Implications for water quality	-.37*	.69	-.57**	.56
Implications for water quantity	-.16	.85	-.19	.83
BLOCK 5: How important do you think each of these changes is to your community?				
Increased job opportunities for local residents	-.27	.77	-.13	.82
Increased opportunities for small business development	-.24	.79	-.18	.74
Water quality impacts from drilling-related activity	-.40	.64	-.34	.71
Water quantity impacts from drilling-related water	-.23	.76	-.27	.77
BLOCK 6: Do you Strongly agree (SA), agree (A), are neutral (N), disagree (D), or strongly disagree (SD) with:				
We already know enough about the potential impacts of natural gas to move forward with development in the Marcellus Shale.	-.22	.80	-.38	.69
All in all, the benefits of natural gas extraction from the Marcellus Shale in this region will outweigh the costs.	-.42**	.66	-.56**	1.12
I worry that there will be some sort of catastrophic accident involving natural gas extraction in the Marcellus Shale.	-.70***	.47	-.76***	.47
Any negative impacts of natural gas extraction in the Marcellus Shale can be fixed.	-.56***	.57	-.68***	.51
Development of natural gas in the Marcellus Shale will create long lasting environmental problems.	-.67***	.51	-.77***	.46
BLOCK 4: How much do you trust the following:?				
Natural gas industry	-.26	.77	-.31	.19
State officials and organizations	-.13	.88	-.17	.84
Local officials and organizations	-.41***	.66	-.46**	.63
Environmental groups/organizations	-.56***	.57	-.68***	.51
Scientists/researchers	-.26	.77	-.18	.84

* Sig .05; ** Sig .01; *** Sig .001.

Table 12. Logistic regressions testing for telephone vs. mail differences in the incidence of choosing of “extreme” responses to survey questions, adjusting for the effects of gender, age, education and income

BLOCKS and Items	Bivariate		Multivariate	
	B	Odds Ratio	B	Odds Ratio
BLOCK 2: How familiar are you with each of the following?				
Process of hydraulic fracturing	.63***	1.88	.52**	1.69
Management and disposal of frac flowback water	.55***	1.72	.53**	1.69
Frac flowback wastewater treatment technology	.45**	1.56	.36*	1.43
BLOCK 3: How much do you know about natural gas drilling in the Marcellus Shale? Rate your knowledge in regard to:				
Economic impacts	.91***	2.48	.96***	2.62
Social impacts	1.17***	3.21	1.07***	2.92
Effects on the natural environment	.87***	2.38	.85***	2.33
Implications for water quality	.78***	2.18	.85***	2.33
Implications for water quantity	.68***	1.98	.72***	2.05
BLOCK 8: How much has each of the following contributed to what you know about the process of hydraulic fracturing?				
Newspapers	.37*	1.45	.34*	1.40
<i>Gasland</i> (film)	-.02	.98	.03	1.03
Natural gas industry	.42***	1.53	.39*	1.48
Regulatory services	.44**	1.54	.37*	1.45
Conservation/environmental groups	.64***	1.90	.48**	1.61
Cooperative Extension	.34*	1.43	.34*	1.40
University professors	.43**	1.94	.43*	1.54
Landowner groups/coalitions	.44**	1.55	.35*	1.42
BLOCK 9: How much trust you have in each of the following to deliver unbiased factual knowledge on hydraulic fracturing?				
Newspapers	.58***	1.79	.56**	1.75
<i>Gasland</i> (film)	1.26***	3.51	1.22***	3.37
Natural gas industry	.29	1.34	.34	1.41
Regulatory services	.39*	1.48	.63**	1.88
Conservation/environmental groups	.50***	1.64	.52**	1.69
Cooperative Extension	1.03***	2.81	1.03***	2.81
University professors	.68***	1.98	.77***	2.15
Landowner groups/coalitions	.61***	1.84	.70***	2.02
BLOCK 4: How much do you trust the following?				
Natural gas industry	.38*	1.46	.55**	1.73

State officials & organizations	.38*	1.46	.39*	1.48
Local officials & organizations	.47**	1.60	.66***	1.84
Environmental groups/organizations	.12	1.12	.08	1.09
Scientists/researchers	.05	1.05	.07	1.07

* Sig .05; ** Sig .01; ***Sig .001.