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Chinese Local Residents' Attitudes toward Shale Gas Exploitation

The Role of Energy Poverty, Environmental Awareness, and Benefit and Risk Perceptions

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Chin-Hsien Yu, Huimin Tan, Ping Qin, and Xiaolan Chen

Abstract

This study investigates Chinese local residents’ attitudes toward shale gas exploitation through an interview of 730 local residents in two counties of Sichuan Province (Weiyuan County and Gong County) and explores the determinants of their support or opposition. It is the first study in China to explore local residents’ attitudes, and we comprehensively identify underlying factors accounting for such attitudes, including energy poverty, environmental awareness, and risk and benefit perceptions. The results show that the respondents are generally supportive of toward shale gas development, no matter whether the shale well is built in their hometown or at a distance. About 70% of the respondents express support or strong support for shale gas exploitation, and less than 20% of them oppose or strongly oppose such development. The results also show that the respondents are more likely to oppose shale gas exploitation if they perceive lower benefits or higher risks associated with shale development, if they are more environmentally aware, or if they suffer from a higher degree of energy poverty.

Key Words: attitudes, energy poverty, environmental awareness, risk perceptions, shale gas exploitation, China

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Contents

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1. Introduction

Concerns about climate change and environmental pollution have accelerated the development of clean energy. Shale gas, considered to be a less carbon intensive fuel and exploited by a new technology of hydraulic fracturing, therefore has earned increasing attention in recent years (Ladd 2013). The development of shale gas contributes to emission reductions and the exploitation process offers benefits to the local economy; however, the hydraulic fracturing technology also leads to some environmental risks, including water pollution, air pollution, noise pollution, threats to ecosystems, and risks of disasters such as earthquakes and landslides (Ladd 2013; Israel et al. 2015). This raises a debate on the support for and opposition to shale gas exploitation, resulting in a surge of research interest in understanding the public's attitudes toward shale gas exploitation and the predictors of their attitudes (Boudet et al. 2014; Whitmarsh et al. 2015). This study examines the case in China, which is the world's third country to realize shale gas commercial development, following the U.S. and Canada. In particular, we are aiming to explore the support/opposition attitudes of local residents nearby shale gas exploration areas and the determinants of such attitudes, as local residents are the direct stakeholders affected by both benefits and risks.

This paper is not only the first comprehensive analysis of attitudes toward shale gas exploitation in China, but also the pioneering research exploring the influence of energy poverty on these attitudes. In China, the shale gas enrichment zones that have been developed so far are located mainly in Sichuan Basin and Jianghan Basin in western China. Most shale gas wells are in rural areas, where the residents have lower income on

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average and rely heavily on the traditional use of biomass[1] as energy, especially for cooking. Though modern energy such as electricity and natural gas is becoming more prevalent because of infrastructure construction in recent decades, Chinese rural households still experience energy or fuel poverty[2] and largely consume biomass or coal because of their availability and affordability.

Although China had only four million people without access to electricity in 2010 (IEA 2012), almost 30% of the population still uses biomass for cooking, of whom around 90% are in rural areas. Tang and Liao (2014) employed an analysis on energy poverty in rural China based on China's national population census data, finding that over three-fourths of rural households use coal and biomass as the primary household cooking energy. Besides, the Energy Poverty Research of China Energy Research Report (Wei 2014) reported that one-third of rural households used traditional biomass or coal for cooking in 2011. Similarly, the Chinese Household Energy Consumption Report (Xinye 2015) reported that biomass and coal accounted for 61% and 15%, respectively, of the energy used by Chinese rural households in 2013.

The residents in the shale gas exploitation area are no exception. Shale gas exploitation is expected to encourage use of more clean energy, which can help reduce energy poverty, given that one of the potential benefits from development of new energy might be lower local energy prices (Kreuze et al. 2016; Sovacool 2014). Thus, development of shale gas is likely to win support from local residents who are suffering from energy poverty.

The following section reviews previous literature. Section 3 presents the survey design and Section 4 reports the results; Section 5 discusses the findings; and Section 6 concludes with our findings and inferences for policy.

2. Literature Review

2.1. Attitudes

Attitudes can be defined as individuals' judgments or psychological predispositions toward attitudinal objects such as objects, people and perspectives

[1] Traditional biomass includes fuelwood, charcoal, agricultural residues, wood waste and other solid waste.

[2] In general, fuel poverty is mainly defined from the perspective of energy unavailability, while energy poverty is mainly defined from the perspective of energy unaffordability. Because the main problem in China is unaffordability, hereafter we consider the energy poverty problem in our analysis.

(Whitmarsh 2011). The formation of attitude is highly dependent on the surrounding social environment (Fazio and Zanna 1981), and attitude can greatly influence individual behaviors (Azjen and Fisbbein 1974). The concept of attitude has been decomposed from two dimensions: a hedonic dimension derived from affect and a utilitarian dimension derived from cognition, both of which are found to be direct antecedents to behaviors (Voss et al 2003). This type of categorization of attitudes leads to a question of whether cognition or emotion plays a major role in attitude change.

To understand the fundamental mechanism of attitude change, a large body of literature has developed numerous theories, including the Elaboration Likelihood Model (Eagly and Chaiken 1993). The ELM model presumes emotions can influence attitude through changing the valence of one's thoughts toward the persuasive message (Petty et al. 1993). Contemporary analyses of attitude change focus on the role of mass media persuasion (Petty and Brinol 2010). A variety of social-demographic factors have also been examined in relation to attitude change. For instance, Krosnick and Alwin (1989) studied the relationship between age and susceptibility to attitude change among individuals of different age groups. The authors found that individuals' susceptibility to attitude change peaks during late adolescence and early adulthood, then drops and remains low throughout the rest of life. Likewise, Greenwald et al. (1968) argued that personality traits including sex and age affect individual susceptibility to attitude change.

2.2. Public Attitudes toward Shale Gas Exploitation

As an emerging technology full of uncertainty, shale gas has received broad attention from academia concentrating on public attitudes and perceptions toward shale gas exploitation. Prior literature has suggested obvious regional differences in public attitudes toward shale gas exploitation. Take public attitudes toward shale operations in the U.S. for an example. Studies revealed that respondents in Pennsylvania express a supportive attitude (Lachapelle and Montpetit 2014; Theodori 2012), while those in New York have the opposite attitude (Kromer 2015; Borick et al. 2014). But even in a fixed location, public attitudes toward shale gas can become polarized over time (Mazur 2016). A 2014 national poll shows that 47% of Americans oppose hydraulic fracturing, while 41% of Americans support it (Drake 2015).

On one hand, research along these lines has employed qualitative methodologies such as interviews to understand the reasons that the public claims for the formation of their attitudes toward shale gas. It is found that major reasons for public opposition include safety (Drake 2015), undesirable environmental and ecological impacts (Israel et al. 2015; Boudet et al. 2014; Whitmarsh et al. 2015; Theodori 2012; Jacquet 2012) and conflicts with individual values (Lachapelle and Montpetit 2014; Jacquet 2012). The most prevalent reason for public support is economic benefits that the local community gains from shale gas exploitation, such as leasing and royalty income (Jacquet 2012; Schafft et al. 2013; Brasier et al. 2011; Anderson and Theodori 2009). Nevertheless, some studies have shown that public support for shale gas extraction is conditional, depending on other factors, for instance, whether the economic benefits come at the cost of environmental impacts (Theodori 2009). Willow (2014) finds that the public is supportive of shale gas drilling if they are provided with full and accurate information to guide their decisions.

Other studies have used quantitative structured surveys to explore the factors underlying public attitudes. In the context of emerging energy technologies, higher perceived risk is found to significantly reduce the likelihood of public support for these technologies Willow (2014). Efforts have also been devoted to understanding the role of perceived risk and perceived benefits in public attitudes towards shale gas, finding that people perceiving high risks of shale gas extraction are less likely to support it (Lachapelle and Montpetit 2014). Besides, prior studies have suggested that public attitudes toward shale gas technology depend not only on the risks associated with fracking but also on perceived economic benefits (Lachapelle and Montpetit 2014; Davis and Fisk 2014). For instance, Krause et al. (2014) found that whether individuals believe a shale gas project can generate economic benefits is predictive of their support for these projects. Clarke et al. (2015), through a survey of 1,000 U.S. adults, suggest that people who perceive that the benefits of shale gas development outweigh the risks show more support for it. Jacquet and Stedman (2014) argue that perceived inequity in the distribution of benefits and risks is a predictor of public opposition.

Gender, age and education are the most frequently noted socio-demographic variables to predict public attitudes toward shale gas development. Men are found to be more likely than women to support shale gas drilling (Boudet et al. 2014; Clarke et al. 2012; Kriesky et al. 2013). Consistently, women are found to be more skeptical than men about the safety of wastewater treatment from hydraulic fracturing operations (Willits et al. 2016). In terms of age, both Clarke et al. (2012) and Jacquet (2012) found that younger U.S. respondents were more likely to oppose shale gas drilling, while Boudet et al. (2014) concluded that, in the U.S., a higher age is positively associated with hydraulic fracturing support. However, Whitmarsh et al. (2015), studying the U.K. public, found no evidence that age influences the public’s attitudes. The effect of education varies. Boudet et al. (2014) found that increased education can lead to stronger support for hydraulic fracturing, but Jacquet (2012) found that better-educated respondents are likely to have negative attitudes and Clarke et al. (2012) suggest education might have no correlation with the public's attitude toward unconventional oil and natural gas development such as shale gas exploitation. The type of education makes a difference; Whitmarsh et al. (2015) found that the members of public who have higher science education tend to express favorability towards shale gas. To sum up, age and education have inconsistent influences in predicting attitudes toward shale gas exploitation, but gender has an influence.

Political ideology or political attitude may also shape the public's attitude toward shale gas exploitation, and respondents who are more politically conservative are found to be more supportive of hydraulic fracturing or shale gas development (Boudet et al. 2014; Whitmarsh et al. 2015; Clarke et al. 2015). Clarke et al. (2016) examined the role of political party affiliation on support for unconventional oil and natural gas development and found similar results. Added to this, the public's trust in government, the oil/natural gas industry and other agents has been found to be associated with public acceptance (Willits et al. 2016). The role of trust has also been addressed by previous studies such as Boudet et al. (2014) and Whitmarsh et al. (2015). Meanwhile, respondents with more knowledge or familiarity with shale gas might have stronger support for shale gas (Whitmarsh et al. 2015; Willits et al. 2016; Clarke et al. 2016).

Additionally, personal beliefs and values such as environmental values are related to public attitudes toward shale gas development. On one hand, as the development of shale gas is expected to contribute to carbon emission reductions, residents might be supportive of shale gas exploitation if they are truly concerned about the climate change issue. On the other hand, since evidence suggests that shale gas exploitation has caused a variety of negative environmental impacts (Small 2014), residents have reasons to oppose it if they are aware of ongoing environmental degradation. Jacquet (2012) conducted a survey in Northern Pennsylvania in the U.S. to explore the effect of environmental attitudes on landowners' attitudes toward energy development, including shale gas development. Measuring the respondents' environmental attitudes with eight-item New Ecological Paradigm (NEP) scale (Dunlap and Van Liere 2008), Jacquet (2012) found that a respondent is more likely to oppose natural gas drilling if he ranks higher on the environmental attitude scale. Brasier et al. (2013) also applied the NEP scale to examine how the public's risk perception is associated with environmental attitudes in the core areas of the Marcellus shale region. Though they did not analyze the impact of environmental attitudes on the residents' attitudes toward shale gas extraction, they still found that a higher environmental attitude ranking is associated with higher risk perception. Whitmarsh et al. (2015) introduced the roles of environmental identity (e.g., I think of myself as someone who is concerned about the environment) and climate change skepticism (i.e., beliefs about the reality, causes and impacts of climate change); they found that people with lower environmental identity and higher climate skepticism are more favorable to shale gas.

Mass media also can affect public awareness and discourse of fracking (Boudet et al. 2014; Vasi et al. 2015). For instance, the release of a fracking documentary called Gasland has drawn public attention to the adverse effects of hydraulic fracturing, contributing to anti-fracking movements among the public (Vasi et al. 2015). People who watch TV frequently are more likely to support fracking, while people who read newspapers frequently are less likely to support it (Vasi et al. 2015). It’s also worth noting that public attitudes are highly dependent on the source of the information about shale gas (Theodori et al. 2014). In addition to information source, the content of the information provided also plays a role in public attitudes. The gain or loss framing of information regarding the risks and benefits is found to significantly influence changes in public attitudes toward shale gas (Whitmarsh et al. 2015).

2.3. Energy Poverty

This paper introduces the role of energy poverty as a factor underlying public attitudes toward shale gas, which has been rarely if ever addressed in previous studies. The definition of energy poverty varies depending on international, national or regional level. The International Energy Agency (IEA) definition is that a country or a region faces energy poverty if it lacks access to modern energy services such as electricity or has extensive use of biomass in traditional and inefficient ways (IEA 2002). In 2010, IEA (2010) slightly modified the indicators of energy poverty at the household level: the lack of access to electricity and the reliance on the traditional use of biomass for cooking. Barnes et al. (2011) measured the energy poverty line by energy consumption level; while Pachauri et al. (2004) presented two elements, access to different energy types and energy consumption, to measure energy poverty. Nussbaumer et al. (2012) introduced a new metric, the multidimensional energy poverty index (MEPI), to measure the degree of energy poverty; the MEPI measure can be scaled down to the household level.

Energy poverty is a pressing challenge not only for developing countries but also for developed countries that support economic development projects, and energy-poverty alleviation is one of the policy goals of ending poverty (Sagar 2005). Ürge-Vorsatz and

Herrero (2012) found that household income, energy price and energy efficiency of the dwelling are three main contributing factors to energy poverty. Many previous studies have underlined the issue of international or regional energy poverty, with attention to Sub-Saharan countries, Brazil, India, Japan, Pakistan, rural Bangladesh etc. (Barnes et al. 2011; Pachauri et al. 2004; Bensch 2013; Khandker et al. 2012; Okushima 2016; Pereira and Silva 2011; Sher et al. 2014). Khandker et al. (2012), for example, applied cross-sectional data from the 2005 India Human Development Survey (IHDS) and found that the most effective way to reduce energy poverty is through rural electrification and more use of modern cooking fuels. Pereira and Silva (2011) re-examined the concept of an energy poverty line in Brazil and evaluated the effectiveness of expanded access to electricity, also finding that rural electrification significantly alleviates the energy poverty level. Okushima (2016) employed various poverty and vulnerability measures to examine the dynamics of energy poverty in Japan, concluding that Japan faces a worsened energy poverty problem arising from the increase of energy prices and reduction of income.

2.4. Hypotheses and Research Questions

Because there have been very few studies exploring the support/opposition attitudes toward shale gas in China, we offer the following research question:

RQ1. What is the attitude of local residents nearby a shale gas exploration area?

In addition, because there is so far a lack of empirical evidence on the role of energy poverty in these attitudes, we offer the following research question:

RQ2. Does the degree of energy poverty significantly affect local residents' attitudes toward shale gas exploitation?

Also, this paper aims to explore the influences of various predictors on the public's attitudes toward shale gas exploitation in China. Much of the literature outlined above addressed the role of both risk and benefit perceptions, and we thus propose the following hypothesis:

H1. The public's attitude will be positively associated with their perceptions of the benefits of shale gas exploitation, while it will be negatively associated with their risk perceptions. Specifically, the public's attitude will be negatively associated with the relative scale of perceived risks and benefits.

Further, although the role of socio-demographics in predicting the public's attitudes is inconsistent in previous studies, the following hypothesis can be offered based on previous findings and relationships:

H2. Social-demographic factors also will be predictors of the public's attitudes. Specifically, males, older respondents, and those who have more education will be more likely to have supportive attitudes toward shale gas exploitation.

In addition, the literature review on the roles of political attitudes and the public's trust in government and in the oil/natural gas industry suggests the following two hypotheses:

H3. Conservatives will be more supportive than liberals. Specifically, a Chinese Communist Party member will be more supportive.

H4. The public's attitude will be influenced by their level of trust. Specifically, those who highly trust the local government, the central government, petroleum companies, and the information source will have stronger positive attitudes.

3. Survey Design

3.1. Survey Area

This study selects the Changning-Weiyuan area in Sichuan Basin to conduct the survey because this area was selected as China's first national shale gas demonstration area, started to produce shale gas in July 2012 (Ning201-H1 in Gong County in the Changning area), and has the earliest shale gas well, which was drilled in 2009 (Wei201-H1 in Weiyuan County in the Weiyuan area). The total populations of Weiyuan and Gong counties as of the end of 2016 are, respectively, 728,000 and 437,000; the proportion of males to females is 1.06 in Weiyuan County and 1.09 in Gong County. The survey was conducted in April and May 2016, exploring local residents' views about shale gas exploitation in 13 villages of Weiyuan County and 15 villages of Gong County. All villages in these counties, importantly, had experienced a moderate level of damage in the 2008 Great Sichuan Earthquake.

3.2. Measures

The questionnaire consists of twelve parts—attitudes toward shale gas exploitation, energy usage information, perceived benefits and risks, environmental awareness, earthquake and landslide experiences, familiarity with local shale gas projects, awareness of shale gas accidents, knowledge of shale gas technology, the residents' perspectives on shale gas impacts and risks, the residents' perspectives on responsibility for shale gas risks, information source and demographic characteristics.

To explore the residents' attitudes toward shale gas exploitation, three attitudinal assessment questions were included in our survey. The participants were asked about (1) their overall attitude toward exploitation ('in general, are you for or against shale gas exploitation?'), (2) their attitude toward exploitation within their hometown ('are you for or against shale gas exploitation that takes place in your hometown?') and (3) their attitude toward exploitation far away from their hometown ('are you for or against shale gas exploitation that takes place far away from your hometown?'). The response option is a five-point scale from 'strongly oppose (1)' to 'strongly support (5)' for all three attitudinal questions.

The measure of the degree of energy poverty is composed from the energy usage information and adapted from Nussbaumer et al. (2012), who established MEPI by using six weighted indicators: modern cooking fuel (0.2), indoor pollution (0.2), electricity access (0.2), household appliance ownership (0.13), entertainment /educational appliance ownership (0.13) and telecommunication means (0.13). This study principally adopts the dimensions, indicators, weights, measurement variables and cut-offs introduced by Nussbaumer et al. (2012), with slight adjustments based on China's circumstances, as reported in Table 1. Participants were asked (1) 'what types of fuel do you mainly use?' and (2) 'what types of fuel do you mainly use to cook?' with 'electricity,' 'natural gas,' 'liquefied gas,' 'cylindrical briquette,' 'diesel,' 'firewood,' 'solar energy,' 'biogas' and 'other' as response options, providing measurements of both cooking and lighting dimensions of MEPI. In addition, participants were asked whether they have (1) a refrigerator, (2) a radio or television and (3) an internet in their house, with simple 'yes' or 'no' response options, covering the remaining dimensions of MEPI. Notice that we consider access to internet instead of telecommunication means in the survey area. Because of the comprehensive construction of telecommunication and the popularity of phone lines or mobile phones in Chinese rural areas, telecommunication means is inadequate to measure energy poverty.

An individual is considered as energy poor if he/she is deprived in any of the five dimensions, and the weight of each indicator is used to measure the degree of energy poverty. An individual, for example, is deprived of the cooking dimension because he uses biomass as the main cooking fuel, resulting in 0.4 weighted deprivation; the degree of energy poverty is thus defined as $\text{MEPI} = 0.4$. The value of MEPI ranges from 0 to 1, and a higher MEPI indicates a higher degree of energy poverty. The resident is not energy poor if he has no deprivation ($\text{MEPI}=0$).

We used eight benefit perception questions (local economic boom, increased local job opportunities, facilitation of local infrastructure construction, local service industry development, real estate income increase, local population increase, enhancement of local residents' sense of pride, and energy price decrease) and ten questions about participants' perceptions of risk exposures (groundwater contamination, surface water contamination, air pollution, noise pollution, animals' habitat degradation, vegetation degradation, geologic hazards, health problems of surrounding residents and residents far from wells, and traffic congestion), on a scale from 'very small extent (1)' to 'very great extent (5)'. These questions are adapted from Anderson and Theodori (2009), Boudet et al. (2014), Israel et al. (2015) and Stedman et al. (2012). The sets of benefit perception and risk perception questions were assigned into two new variables—benefit perception ($\alpha(8)=0.83$) and risk perception ($\alpha(10)=0.84$), respectively.

Environmental awareness was adapted from Brasier et al. (2013) and measured by asking participants to report their belief of the certainty (No=0, Yes=1) of six occurrences (natural disasters, increasing temperature, clean water scarcity, clean air scarcity, less food productivity, and worse living environment) and to rate their perceptions of current environmental problems nearby their households and in the whole of China on a scale from 'very slightly severe (1)' to 'very severe (5).' The results were loaded into two new variables—anticipation of future negative environmental impacts ($\alpha(6)=0.73$) and perception of current environmental degradation in China ($\alpha(2)=0.65$, $r=0.48$). Then, participants were asked to report whether they had ever experienced an earthquake or a landslide/debris flow (No=0, Yes=1).

The questionnaire continued by measuring participants' understanding of shale gas exploration. First of all, participants' familiarity with local shale gas project was measured by their level of understandings about the number of shale gas wells and the distance between current shale gas projects and their households (Boudet et al. 2014; Whitmarsh et al. 2015; Willits et al. 2016. The results yielded a 1-5 scale from 'not at all familiar (1)' to 'extremely familiar (5).' Awareness of shale gas accidents was measured by asking participants to self-report whether they were aware of any former shale gas accident (No=0, Yes=1). Participants then were asked to answer 10 True/False questions.[3] Knowledge of shale gas technology was measured by the accuracy rate of those ten questions on a scale from ‘all incorrect (0)’ to ‘all correct (10).’ Then we used another 1-5 scale, adapted from Brasier et al. [46] and Stedman et al. (2012), from ‘strongly disagree or not at all (1)’ to ‘strongly agree or very great extent (5)’, to measure four variables. These were households’ perspectives on shale gas impacts and risks, in which participants were asked to rate two ‘agreement’ questions (whether the negative impacts can be avoided by proper management and whether individuals can take actions to reduce the risk) and two extent questions (the extent to which the negative impacts can be observed; and the extent to which the negative impacts can be controlled).

In addition, the questionnaire asked participants to identify the information sources on which they rely and to rate their reliance using a scale from ‘little (1)’ to ‘much (5)’ and the trustworthiness of the source using a scale from ‘extremely distrusted (1)’ to ‘extremely trusted (5)’. They could choose among ten different information channels (community organizations, authorities, petroleum companies, the Internet, newspaper, television, radio, relatives or friends, other residents, and well guards/project staff), as adapted from previous studies (Boudet et al. 2014; Whitmarsh et al. 2015; Willits et al. 2016; Brasier et al. 2013). Then, participants were asked to rate their trust in stakeholders’ responsible for shale gas risks (the authorities, petroleum companies, environmental protection organizations, scientists/researchers, and community organizations/residents), using a 1-5 confidence scale from ‘totally distrusted (1)’ to ‘totally trusted (5),’ adapted from Brasier et al. (2013) and Willits et al. (2016).

Finally, the questionnaire asked participants to report their age, gender, education level, participation in the Chinese Communist Party, whether he/she is a cadre, and annual income level. A comprehensive introduction of those measurements can also be found in Yu et al. (2017).

3.3. Regression Model Specification

Because the resident’s attitudinal response is a naturally ordered and categorical variable, we apply an ordered probit regression model incorporating socio-demographic

[3] The ten true/false questions consist of the following statements: shale gas is a type of oil; it is a type of natural gas; the principal content is methane; there is a rich ore deposit in Sichuan Province; the ore deposit is shallow in Sichuan Province; there is an inexhaustible supply; it does not require water in its exploration; it does not require chemical reagents in its exploration; it has a by-product of contaminated water; and it requires the technique of hydraulic fracturing.

characteristics and all other predictors, in order to examine the factors' influences on attitude. The model is specified as follows:

$$A_i^* = x_i\beta + \varepsilon_i \qquad (1)$$

where A_i^* is an unobserved measure of the attitude of household i; X_i is a vector of the influence factors; and ε_i is the error term. For very low A_i^*, the respondents' attitude is strongly opposed to shale gas exploitation; for $A_i^* > \gamma_1$, the respondents' attitude alters to simply opposing but not strongly opposing; for $A_i^* > \gamma_2$, the respondent's attitude becomes neutral; and so on for the alternatives of support and strongly support. For the five attitude alternatives, we thus define

$$A_{ik} = k \ \ if \ \ \gamma_{k-1} < A_i^* \le \gamma_k \qquad (2)$$

where $k = 1, \cdots, 5$, $\gamma_0 = -\infty$, $\gamma_5 = \infty$ and $\gamma_0 < \gamma_1 < \cdots < \gamma_4$ are the unknown threshold parameters.

4. Results

Our survey has collected a total of 730 samples (30% in Weiyuan County and the rest in Gong County), among which only 98 (13.4%) respondents answered all the questions. In addition, 44 out of 58 questions (75.9%) have a missing data rate lower than 5% (36 cases). Although Little's (1998) MCAR (missing completely at random) test yields a significant result ($\chi^2_{17111} = 18613.4$, $p < 0.001$), an additional MAR test for those 14 items having a missing data rate higher than 5% indicates 13 of them have the missing values completely at random. A post hoc test indicates that the significance of the remaining item is a result of another relevant item. The MAR test yields a nonsignificant result ($t = 1.30$, *n.s.*) as the accompanying effect has been removed. Hence, missing values are replaced using the Expectation-Maximization (EM) algorithm in SPSS 17.0, providing a comprehensive data set of all measures considered in this study.

4.1. Participants

Demographically, the sample is 42.6% female, averaging 52 years of age and 7.22 years of education, with around 87% of respondents having not graduated from high school. The sample earns on average USD $1,170 annual individual income, and only 16.16% of the respondents earn USD $4,400 or more per year. 13.97% of participants are Chinese Communist Party members. In addition, 89.72% of respondents had previous earthquake damage experience and a quarter of the interviewees (25.48%) have experienced landslides. In our sample, 50.82% of respondents answered benefit questions prior to risk questions.

4.2. Local Resident's Overall Attitudes toward Shale Gas Exploitation

The respondents were asked three attitudinal questions, including overall attitude toward exploitation, attitude toward exploitation within their hometown and attitude toward exploitation far away from their hometown. As shown in Table 2, each question has over 70% of the respondents expressing support or strong support for shale gas exploitation, while less than 20% of the respondents oppose or strongly oppose the exploitation; the rates of neutrality for these three questions are 10.90%, 10.37% and 16.26%, respectively. Similarly, in the study by Stedman et al. (2012) of local residents in the Marcellus Shale Gas region, the supportive attitude dominated opposition in both New York (40.5% vs. 30.7%) and Pennsylvania (47.3% vs. 18.5%). In the survey by Stedman et al. (2012) on the general public in both Pennsylvania and Texas (N=1,716), 59% of the respondents are supporters, while only 20% of them are opponents. Hence, whether in China or the U.S., a majority of the respondents express a supportive attitude toward shale gas exploitation. The supportive proportion in the U.K. is found to be relatively low in Whitmarsh et al. (2015), who found that only 31% of the U.K. respondents affirmatively agreed with allowing widespread shale gas extraction in the U.K.

As the three attitudinal assessment questions have similar response rates and high correlations, this study adopts the first question, which assesses the resident's overall attitude toward shale gas exploitation, to be the attitudinal measure in the following analysis.[4] The average level of the overall attitudinal measure is relatively high ($M = 4.07,\ SD = 1.16$), as shown in Table 3, and it is greater than that in the U.S. and U.K. (Boudet et al. 2014; Whitmarsh et al. 2015; Clarke et al. 2015).

We are further interested in the differences in attitudes in terms of risk and benefit perceptions. Figure 1 shows the attitudinal and risk/benefit perception variables together. The five-point scale of the perceived extent of risk/benefit is compressed to three levels: small, fair and great; there is also a possible response of 'benefit/risk is not perceived'. We also categorize the respondents into three groups: opponents, who oppose or strongly

[4] Hence, we only included the first question in Little's (1998) MCAR test and the following examination procedures.

oppose the exploitation; supporters, who are supportive or strongly supportive; and neutrals. As Figure 1 indicates, the proportion of supporters is ascending when the extent of benefit perception ranges from 'not perceived' to 'great extent.' In addition, Figure 1 shows that high levels of risk perception move in the direction opposite the proportion of supporters.

Generally, the respondents are likely to support shale gas exploitation if they believe that the exploitation is relatively beneficial to them but are likely to be opponents if they are more concerned about the potential adverse impacts caused by the exploitation. In view of this, in our survey, we asked the participants to compare the overall benefit and risk after an array of questions about benefits and risks.[5] The respondents were asked 'which is greater, the benefits or the risks from shale gas exploitation?' with 'benefits outweigh risks,' 'benefits equal risks,' 'risks outweigh benefits' and 'uncertain' as response options. Over 60% of the respondents stated that the risks outweigh the benefits, while only around 20% of the respondents stated that the benefits outweigh the risks. Whitmarsh et al. (2015) also found that, in the U.S., slightly more participants feel that the risks outweigh the benefits (35%) than vice versa (27%), with 24.8% of the participants answering 'don't know'. Stedman et al. (2012) found a consistent response in New York but the opposite result in Pennsylvania, with almost half of the respondents being neutral on the question 'how do you feel/believe that benefits outweigh costs?' Hence the Chinese local residents seem to perceive more risks than the U.S. residents.

Besides separately considering the perceived risks and benefits, we additionally investigate the impact of relative risk and benefit perception compiled from the perceived risk scale divided by the perceived benefit scale. Figure 2 illustrates the respondents' attitudes toward shale gas exploitation while considering their rating of relative risks and benefits. The proportion of supporters in the group that feels that the risks outweigh the benefits is twice as large as those who feel that the benefits outweigh the risks, indicating that a resident with a higher relative scale of risk and benefit perception is likely to be an opponent.

Most of the respondents who believe that benefits outweigh or equal risks are supporters or neutral. However, almost half of those who claimed that risks outweigh benefits are also supporters of shale gas exploitation, while less than 40% of them are

[5] Notice that this question is not used as our predictor because it is highly correlated with the benefit and risk measures.

against shale gas exploitation. This conflict between the attitude and relative risk/benefit perception might be possible if the respondents perceive higher risks than benefits but believe that the adverse impacts caused by shale gas exploitation can be controlled. Therefore, we further explore the attitudes of the specific residents who think that the adverse impacts can't be controlled. As reported in Table 4, however, only 17% of the respondents oppose the exploitation; a majority of the residents (65%) still expressed their support even though they don't believe the adverse impacts can be controlled. The influence of the resident's opinion about whether the adverse impacts can be controlled is thus uncertain and will be examined later.

Moreover, during the survey, many interviewees claimed to support shale gas exploitation just because it is a national project. In our survey, the residents were asked to indicate whether both the central and local governments should be responsible for shale gas risks, and over 85% of the respondents gave the response of 'yes.' They were further asked to rate the extent of their trust in the central/local government; three-fourths of the respondents trust the central government and almost half of the respondents trust the local government. As Table 4 indicates, 47.83% of the respondents who do not trust the central government still support shale gas projects, and the supporters are also in the majority of those who do not trust the local government. We may, therefore, infer that the public in China is likely to support projects that are based on government policies, with the result that the supporters are predominant in our survey. We have thus controlled for the impacts of the role of central and local governments in our analysis; however, we won't further discuss this China-specific phenomenon, which can be further explored in future work.

The next influence factor is environmental awareness. Though the issues of climate change have received much attention in the last two decades, many of the public are actually ignorant of climate change and the contribution of shale gas to carbon reduction. At the same time, they observe the noticeable environmental degradation and worry that environmental problems are getting worse, highlighting this considerable group as a higher environmental attitude cluster. Our present study, unfortunately, is unable to identify whether the residents' environmental awareness affects their attitudes because they are aware of the link between shale gas and carbon reduction or because of their experiences of environmental change. However, we believe that it is still valuable to explore the residents' attitudes toward shale gas exploitation given their subjective opinions on the environment. Figure 3 presents the attitudes in different scales of environmental awareness, and shows that the proportion of supporters is likely to be lower if the scale of anticipation or perception trends to 'yes' or 'severe,' respectively.

4.3. The Degree of Energy Poverty

In our survey sample, 27% of the participants do not use modern fuel such as electricity, natural gas, LPG or solar energy as cooking fuel; meanwhile, less than 1% of the participants have no access to electricity. Less than 6% of the participants have no refrigerator and only 2% of them have no TV or radios; however, over half of the participants have no access to internet in their house. The MEPI is then developed, and it is significantly negatively correlated not only with the individual's income ($R = -0.16$) but also with the household's total income ($R = -0.22$), showing that the energy poor household is usually income poor. For further analysis, we divided our sample into three groups: the first group facing no energy poverty (MEPI=0), the second one facing a relatively low degree of energy poverty ($\text{MEPI} < 0.5$) and the third one facing a relatively high degree of energy poverty ($\text{MEPI} > 0.5$). The results show that 37% of the respondents do not suffer from energy poverty; 41% face a relatively low degree of energy poverty; and the rest face a relatively high degree of energy poverty. All residents facing a relatively high degree of energy poverty use non-modern cooking fuels, which contribute 0.4 of the weight to the degree of energy poverty. The above results imply that the issue of energy poverty in our study area is mainly caused by the unaffordability of energy and the use of highly polluting traditional fuels, which is quite similar to what Stedman et al. (2012) reported.

Next, we examine the correlations between the degree of energy poverty and attitudes ($R = -0.12$), benefit perception ($R = -0.15$) and risk perception ($R = -0.01$), finding that the attitude and benefit perception are significantly negatively correlated with the degree of energy poverty, while risk perception has an insignificant and weak correlation with the degree of energy poverty. Table 5 only reports the Pearson's correlations and the proportions of attitude and benefit perception under different degrees of energy poverty.

As shown in Table 5, 18.63% of the respondents who experience a relatively high degree of energy poverty oppose shale gas exploitation, while only 8.46% of the respondents who are not suffering from energy poverty express opposition. Moreover, around 81% of the respondents who are not suffering from energy poverty are supporters, while 70% of the respondents facing a relatively high degree of energy poverty express their support. In other words, the higher the degree of energy poverty, the lower the support for shale gas exploitation. This phenomenon is a little bit puzzling since we expected that the residents who face a relatively high degree of energy poverty would tend to support local shale gas exploitation. We further explore the relationship between the degree of energy poverty and each benefit item, as reported in Table 5.

We examine the relationship between the degree of energy poverty and the perception of energy price, finding that 50% of the residents who suffer from energy poverty do not perceive that energy price might decrease with more energy provision (46% for $\text{MEPI} < 0.5$ and 52% for $\text{MEPI} > 0.5$). Even for those respondents who face no energy poverty, around 46% of them perceive no such benefit, indicating that many of the residents nearby a shale gas exploitation area have not benefited from the development of shale gas through a decrease in energy prices. We also observe that the residents facing energy poverty are more likely not to perceive other benefits than are those not suffering from energy poverty, and the correlation analysis shows that the degree of energy poverty is significantly negatively associated with each benefit item.

4.4. Predictor Selection

The bivariate correlations between the attitude measure and all the potential predictors plus the results of complete regression estimation can be found in Table A1. A measure will not be included as an explanatory variable if its correlation with attitude is $R < 0.05$ and the coefficient in the regression is nonsignificant. Experiences with earthquakes and landslides, familiarity with local shale gas projects and three responsibility dummies are thus excluded. Note that the measure of belief that shale gas is the responsibility of the petroleum company is excluded, even though its correlation coefficient with attitude is greater than 0.05. This is because this measure and the measure of trust in the petroleum company are structured questions with a Spearman's correlation of $R = 0.18$. Besides, the measure of 'whether impacts can be avoided by an individual's measures' is also excluded, because the Spearman's correlation between it and the measure of 'whether impacts can be avoided by proper management' is $R = 0.24$. Cadre status is also excluded because of high correlation with Chinese Communist Party membership ($R = 0.43$). To sum up, 16 predicators of interest plus 5 socio-demographic characters are finally included for the following empirical analysis.

4.5. Findings

The empirical results are given in Table 6. In terms of RQ1, we showed in Section 4.2 that a majority of the local residents nearby shale gas exploration area are supportive. As part of RQ2, the degree of energy poverty was significantly negatively associated with the public's attitudes ($\beta = -.424,\ p < .1$), suggesting that the degree of energy poverty is a noticeable predictor of the Chinese public's attitudes toward shale gas exploitation.

Overall, the following hypotheses are fully supported:

H1. The public's attitude was positively associated with the benefit perceptions ($\beta = -.131,\ p < .01$) and negatively associated with both the risk perceptions ($\beta = .261,\ p < .01$) and the relative scale of risk and benefit perception ($\beta = -.048,\ p < .01$);

H3. A Chinese Communist Party member was more supportive ($\beta = .389,\ p < .05$).

Besides, the following hypotheses are partially supported:

H2. Only age was predictive of the local respondent's supportive attitudes ($\beta = .013,\ p < .01$); neither gender nor education level was predictive of the attitudes;

H4. The local respondent's attitude was positively associated with their trust in the central government ($\beta = .166,\ p < .01$), in the petroleum company ($\beta = .184,\ p < .01$) and in the information source ($\beta = .110,\ p < .05$). Trust in the local government was not predictive of the attitude.

5. Discussion

In general, our study shows that the majority of Chinese respondents support shale gas exploitation, which is different from the finding of a US national poll that the majority of Americans oppose hydraulic fracturing (Drake 2015), and also diverges from results of some regional studies (i.e., New York) (Kromer 2015; Borick et al. 2014). Given that exploitation of shale gas potentially poses greater environmental and health risks in China than in western countries due to weak environmental surveillance and regulation, the evidence that Chinese residents tend to favor shale gas seems difficult to understand at the first glance. But a closer examination of their environmental awareness, status of energy poverty, and other perceptual factors may unravel the puzzle.

In terms of the degree of energy poverty, MEPI has a negative and significant effect on the residents' attitude in all four specifications, as well as what we found in the correlation analysis. The residents who have energy poverty problems are more likely to oppose shale gas exploitation. The most likely explanation is that they have no incentives to support it. First, as we found earlier, a relatively high proportion of these residents perceive no benefits of shale gas exploitation, in particular energy price decrease. Though the distribution of shale gas as household energy has been realized in Gong County, one of our survey areas, the residents who use shale gas still have to pay the same energy price. Besides, the main contributor of energy poverty is that these residents still use traditional biomass for cooking, meaning no improvement in modern cooking energy. Hence, these residents have not benefited from shale gas exploitation, giving them no incentives to support the project. Second, government agencies or the petroleum companies give subsidies to the residents in shale gas exploitation areas, mainly as compensation for house demolition and cultivated land occupation. During our interview, however, we found that most of these residents claimed that they had not received any subsidies since the construction of shale gas wells, resulting in their conflict psychology, which also can be observed from their levels of trust in the central/local government.

We also found that environmental awareness plays a crucial role in predicting the local resident's' attitude toward shale gas exploitation. The regression result shows that local resident's' attitude is significantly negatively associated with their perception of environmental degradation, indicating that the public will be more opposed if they perceive higher environmental degradation. Though the variable of anticipation of future negative environmental impacts is insignificant as a predictor, the negative signs on the public's attitude in both specifications suggest that the public will be more opposed if they are worried about the environmental impacts of climate change in the future.

Perceptual factors are related to Chinese residents' attitude toward shale gas development. The residents who have higher risk concerns are more likely to oppose shale gas exploitation, while those who perceive more benefits tend to be more supportive, which is also consistent with previous studies (Israel et al. 2015; Boudet et al. 2014; Whitmarsh 2015; Theodori 2012; Jacquet 2012; Schafft et al. 2013; Brasier et al. 2011; Anderson and Theodori 2009). The influence of relative risk and benefit perception on attitude is significantly negative, showing that residents are more likely to oppose shale gas exploitation if their risk perceptions are larger than their benefit perceptions. This result is also found by Clarke et al. (2015; 2016). During our survey, when asking the interviewees whether they perceive each of the risk items,[6] we noticed that many of the respondents took the initiative to mention the risks they perceived, but few of them mentioned benefit items they perceived on their own initiative. This suggests that risks of shale gas exploitation are more perceivable than the benefits, giving the respondents reasons to oppose the activity.

The trust of the respondents in the central government and in the petroleum companies are significant positive predictors of their support/opposition, while trust in the local government is not predictive of support. Shale gas development is a policy-driven project that is carried out in response to instructions by the central government, and both local government and local residents are stakeholders. The China-specific political ideology leads to the more supportive attitudes underlying the higher trust in the central government. Besides, all the petroleum companies are state-owned enterprises, also earning the residents' trust and in turn positively associated with the residents' attitudes. However, there might be conflicts between the local government and the residents regarding how compensation and benefits are received, which could explain the finding that trust in local government is not predictive of support. Mass media also affect the respondents' attitudes; in particular, the residents who highly trust the information source are more likely to support shale gas exploitation.

6. Concluding Comments

The Chinese government is taking an active role in developing shale gas, partly driven by growing energy demand and partly by increasingly pressing environmental conditions. However, the environmental risks from shale development are generally perceived as higher than the risks from the development of conventional natural gas, because production of shale gas relies on a new technology of hydraulic fracturing that requires the use of chemicals and a large amount of water. Based on the first comprehensive Chinese field survey of 730 participants, the study examines the local residents' attitudes toward shale gas exploitation. We find that the Chinese are generally supportive of shale gas development, no matter whether the shale wells are built locally in their hometown or at a distance. Roughly 70% of the sampled respondents express their support or strong support for shale gas exploitation, and less than 20% of the

[6] The ten risk items are groundwater contamination, surface water contamination, air pollution, noise pollution, animals' habitat degradation, vegetation degradation, geologic hazards, health problems of surrounding residents and residents far from wells, and traffic congestion.

respondents oppose or strongly oppose such activity. We also find that the respondents tend to be more negative toward shale gas development if they perceive lower benefits or higher risks associated with such activity, if they have higher environmental awareness, or if they face a higher degree of energy poverty.

It is surprising to find that the local residents are quite optimistic about shale development, given that over 60% of them perceive the risks associated with such activity as higher than the benefits, and 32.6% of them believe that the adverse impacts caused by shale exploitation can't be controlled. This attitudinal conflict, on one side, reflects the fact that the local residents feel pressed to support this policy because this is a national project that brings them and their hometown a sense of pride. We do find that more than half of the respondents express a strong sense of pride in having the wells drilled in their hometown. On the other side, the conflict may also reflect the fact that local respondents are not aware of the potential environmental impacts on their local community from shale development, given that the current development is at the small-scale stage. Once shale gas development becomes a large-scale activity, community disruption, habitat fragmentation and other local effects are likely to be significant. In Sichuan Basin, where population is high, or watersheds are present, or the ecosystems are sensitive, the environmental risks could be noticeable, in particular in the absence of effective environmental regulation (Krupnick et al. 2014).

Whereas the majority of respondents stated that the risks of shale gas exploitation outweigh benefits, public risk perceptions of shale gas exploitation are generally low. This evidence is opposite to the existing literature, as prior findings suggest that US residents affected by drilling were mostly concerned about environmental and health risks posed by shale gas development (Israel et al. 2015). Perhaps very few Chinese residents have knowledge about hydraulic fracturing and its potential risks; this could be because most of the respondents have less than nine years of education. As a result, these residents could be vulnerable to negative impacts of shale gas development without being aware of their vulnerability. In this regard, efforts from environmental NGOs are required; they should help local residents gain the knowledge necessary to protect themselves from potential risks.

The absence of public perceptions about the benefits of shale gas exploitation indicates that it is important to enhance public participation in shale gas projects and to inform local residents about both the positive and negative impacts of shale gas exploitation, with particular attention those suffering from energy poverty. Better communication about the benefits of shale gas projects can reduce the conflicts between the local government and the residents.

Close surveillance and regulation by both the central and local government can play a crucial role in controlling the risks of shale gas exploitation. However, residents remain suspicious about the impartialness of the local government in regulating such exploitation projects, because local government is heavily involved in the development of shale gas as a major stakeholder. In order to foster a more positive attitude among the public toward shale gas development, local governments should make attempts to eliminate the distrust of residents and to initiate collaborative surveillance of the environmental risks, together with policy-makers involved in energy development and environmental protection at the central government level.

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Table 1. Multidimensional Energy Poverty Index Computation

Dimension	Indicator (weight)	Measure Variable	Measures (household is energy poor if…)
Cooking	Modern cooking fuel (0.2)	Type of cooking fuel	Using any fuel beside electricity, natural gas, LPG, or solar energy
	Indoor pollution (0.2)	Food cooked by using any fuel beside electricity, natural gas, LPG, or solar energy	True
Lighting	Electricity access (0.2)	Has access to electricity	False
Services provided by means of household appliances	Household appliance ownership (0.13)	Has a fridge	False
Entertainment/Education	Entertainment/Education appliance ownership (0.13)	Has a radio or television	False
Communication	Telecommunication means (0.13)	Has internet	False

Note: The dimensions, respective variables, relative weights and cut-offs are principally adopted from Nussbaumer et al. (2012).

Table 2. Household's Attitudes toward Shale Gas Exploitation

	Pearson's Correlations among			Household's Attitude (%)				
	Overall Attitude	Attitude_ Locally	Attitude_ Distantly	Strongly Oppose	Oppose	Neither	Support	Strongly Support
Overall Attitude toward Shale Gas Exploitation (Overall Attitude)	-	0.723*** (0.000)	0.579*** (0.000)	5.99	5.31	10.90	30.11	47.68
Attitude toward Shale Gas Local Exploitation (Attitude_Locally)	0.732*** (0.000)	-	0.629*** (0.000)	7.50	10.10	10.37	28.24	43.79
Attitude toward Shale Gas Distant Exploitation (Attitude_Distantly)	0.553*** (0.000)	0.610*** (0.000)	-	2.05	4.10	16.26	30.19	47.40

Note: The values in parentheses are p-values in the first three columns.

Table 3. Descriptive Statistics of All Considered Measures (N=730)

Variables	Descriptive Statistics
Dependent Variable: Attitude toward Shale Gas	M=4.07 SD=1.16
Perceived Risks	M=2.04 SD=1.18 α=0.84
Perceived Benefits	M=2.06 SD=2.06 α=0.83
Anticipation of Future Negative Environmental Impacts (1=Yes)	M=0.74 SD=0.28 α=0.73
Perception of Current Environmental Degradation in China	M=3.08 SD=1.00 α=0.65
The Degree of Energy Poverty	M=0.19 SD=0.22
Benefit Questions Answered Prior to Risk Questions (1=Yes)	50.82% answered benefit questions first
Experience with Earthquake (1=Yes)	89.73% have experienced
Experience with Landslide (1=Yes)	25.48% have experienced
Familiarity with Local Shale Gas Projects	M=3.35 SD=1.55
Awareness of Shale Gas Accidents (1=Yes)	15.75% know accident(s) happened before
Number of Information Sources	M=2.39 SD=1.57
Extent of Information Received	M=2.80 SD=1.05
Trust in Information Source	M=3.78 SD=0.90
Knowledge of Shale Gas Technology	M=6.97 SD=1.41
Perceived Ability of Proper Management to Avoid Impacts	M=3.47 SD=1.31
Perceived Individual Ability to Avoid or Mitigate Impacts	M=2.01 SD=1.27
Perceived Observability of Negative Impacts	M=3.44 SD=1.35
Perceived Controllability of Negative Impacts	M=3.29 SD=1.39
Responsibility of the Central Government (1=Yes)	84.93% believe that
Responsibility of the Local Government (1=Yes)	87.40% believe that
Responsibility of the Petroleum Company (1=Yes)	86.58% believe that
Trust in the Central Government	M=4.46 SD=0.78; 89.62% trust that
Trust in the Local Government	M=3.44 SD=1.29; 53.58% trust that
Trust in the Petroleum Company	M=3.33 SD=1.19; 49.45% trust that
Age	M=52.00 SD=13.69
Gender (1=Male)	42.6% Female
Education Years	86.85% - less than high school Averaged 7.22 years
Chinese Communist Party (1=Yes)	13.97% joined
Cadre (1=Yes)	12.47% served
Average Annual Individual Income	16.16% earned USD$4,400 or more Average USD$1,700

Table 4. Household's Attitudes by Considering Other Measures

Measure	The Respondents' Answers		Household's Attitude under the scale (%)		
	Measure Scales	Proportions of Full Sample (%)	Opponent	Neutral	Supporter
Whether the adverse impacts of shale gas exploitation can be controlled?	Can't be Controlled	32.60	17.37	16.95	65.68
	Neither	8.49	11.29	11.29	77.42
	Can be Controlled	53.97	11.58	10.85	77.57
To what extent do you trust the central government?	Distrusted or lower	3.15	39.13	13.04	47.83
	Neutral	5.75	11.90	42.86	45.24
	Trusted or higher	75.89	9.42	9.24	81.34
To what extent do you trust the local government?	Distrusted or lower	22.88	21.08	14.46	64.46
	Neutral	15.21	10.81	21.62	67.57
	Trusted or higher	49.32	5.57	6.70	87.71
To what extent do you trust the petroleum companies?	Distrusted or lower	20.68	26.00	16.00	58.00
	Neutral	20.82	9.27	16.56	74.17
	Trusted or higher	44.25	3.73	5.59	90.68

Note: The 'not sure' and 'don't know' answers are not reported in this table.

Table 5. Relationships among the Degree of Energy Poverty, Attitude and Benefit/Risk Perception

	Pearson's R		The Degree of Energy Poverty		
			MEPI=0 (No Energy Poverty)	MEPI>0	
				MEPI<0.5	MEPI>=0.5
Observations			N=272	N=297	N=161
Attitude toward Shale Gas Exploitation	-0.118***		(%)	(%)	(%)
Opponents			8.46	10.10	18.63
Neutrals			10.66	12.12	10.56
Supporters			80.88	77.78	70.81
Perceived Benefits		**The Extent**	(%)	(%)	(%)
Local Economic Boom	-0.116***	Not Perceived	18.75	25.25	31.68
		Small or Below	13.60	16.16	13.66
		Fair	15.44	16.50	15.53
		Great or Above	52.21	42.09	39.13
Increased Local Job Opportunities	-0.077***	Not Perceived	31.25	37.37	40.99
		Small or Below	19.12	20.88	22.98
		Fair	19.49	15.15	6.21
		Great or Above	30.15	26.60	29.81
Facilitation of Local Infrastructure Construction	-0.093***	Not Perceived	27.94	41.75	40.99
		Small or Below	12.87	14.14	11.80
		Fair	13.97	10.44	11.18
		Great or Above	45.22	33.67	36.02
Energy Price Decrease	-0.071***	Not Perceived	45.59	46.46	52.17
		Small or Below	10.66	14.48	16.77
		Fair	11.76	9.76	7.45
		Great or Above	31.99	29.29	23.60
Real Estate Income Increase	-0.093***	Not Perceived	36.40	46.13	44.10
		Small or Below	14.71	22.22	23.60
		Fair	17.28	13.80	15.53
		Great or Above	31.62	17.85	16.77
Local Population Increase	-0.120***	Not Perceived	33.46	47.14	45.34
		Small or Below	13.60	18.52	22.98
		Fair	18.75	15.82	12.42
		Great or Above	34.19	18.52	19.25
Local Service Industry Development	-0.195***	Not Perceived	27.94	37.37	48.45
		Small or Below	10.29	16.50	18.01
		Fair	15.81	14.14	10.56
		Great or Above	45.96	31.99	22.98
Enhancement of Local Residents' Sense of Pride	-0.098***	Not Perceived	36.40	47.47	45.96
		Small or Below	9.93	9.09	14.29
		Fair	17.28	14.14	14.91
		Great or Above	36.40	29.29	24.84
Composite Benefit Perception	-0.154***	Not Perceived	1.84	4.71	9.32
		Small or Below	46.69	60.27	57.76
		Fair	27.94	21.89	16.77
		Great or Above	23.53	13.13	16.15

Table 6. Estimation Results on the Household's Attitude toward Shale Gas Exploitation

Variables	Ordered Probit Model	
	Specification (1)	Specification (2)
Perceived Risks	-0.131***	
	(0.048)	
Perceived Benefits	0.261***	
	(0.044)	
Relative Risk and Benefit Perceptions		-0.048***
		(0.014)
Anticipation of Future Negative Environmental Impacts	-0.282	-0.317
	(0.195)	(0.197)
Perception of Current Environmental Degradation in China	-0.146***	-0.165***
	(0.054)	(0.055)
The Degree of Energy Poverty (MEPI)	-0.424*	-0.394*
	(0.226)	(0.225)
Awareness of Shale Gas Accidents (1=Yes)	0.021	-0.042
	(0.132)	(0.133)
Number of Information Sources	0.011	0.056
	(0.034)	(0.033)
Extent of Information Received	-0.012	0.023
	(0.047)	(0.048)
Trust in Information Source	0.110**	0.155***
	(0.052)	(0.053)
Knowledge of Shale Gas Technology	0.084**	0.066*
	(0.037)	(0.039)
Perceived Ability of Proper Management to Avoid Impacts	0.031	0.024
	(0.039)	(0.040)
Perceived Observability of Negative Impacts	-0.028	-0.016
	(0.036)	(0.036)
Perceived Controllability of Negative Impacts	0.071*	0.094**
	(0.040)	(0.040)
Trust in the Central Government	0.166***	0.160**
	(0.063)	(0.066)
Trust in the Local Government	0.047	0.047
	(0.046)	(0.048)
Trust in the Petroleum Company	0.184***	0.220***
	(0.051)	(0.052)
Age	0.013***	0.016***
	(0.004)	(0.004)
Gender (1=Male)	0.168	0.078
	(0.105)	(0.110)
Education Years	-0.017	-0.010
	(0.015)	(0.016)
Chinese Communist Party (1=Yes)	0.389**	0.401***
	(0.151)	(0.152)
Average Annual Individual Income	0.000	0.000
	(0.000)	(0.000)
Gender (1=Male)	0.168	0.078
	(0.105)	(0.110)
Cut1	0.868	0.940
	(0.547)	(0.553)
Cut2	1.345	1.480
	(0.545)	(0.553)
Cut3	1.978	2.134
	(0.549)	(0.558)
Cut4	3.097	3.252
	(0.555)	(0.565)
Town Effect	YES	YES
Number of Observations	730	696
Log Pseudo-likelihood	-763.65	-722.63
Chi-squared Statistic	322.03***	288.42***
Pseudo R-squared	0.183	0.166

Figure 1. Residents' Benefit/Risk Perceptions and their Attitudes toward Shale Gas Exploitation (%)

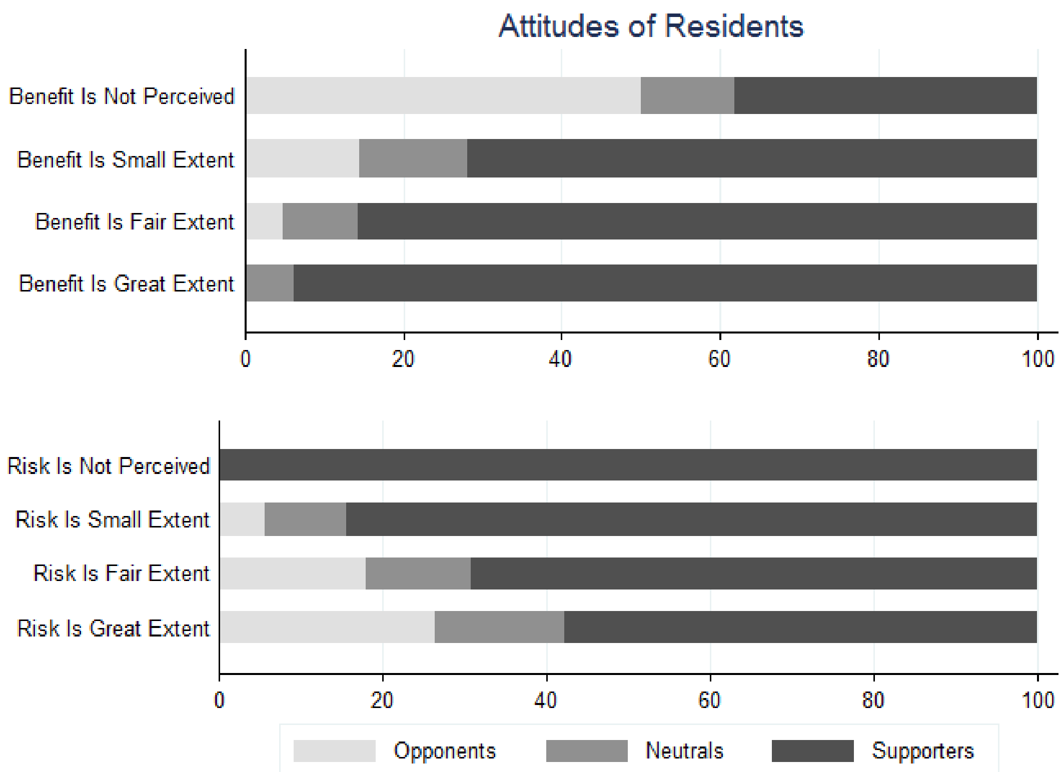


Figure 2. Relative Risk/Benefit Comparison and Attitudes toward Shale Gas Exploitation (%)

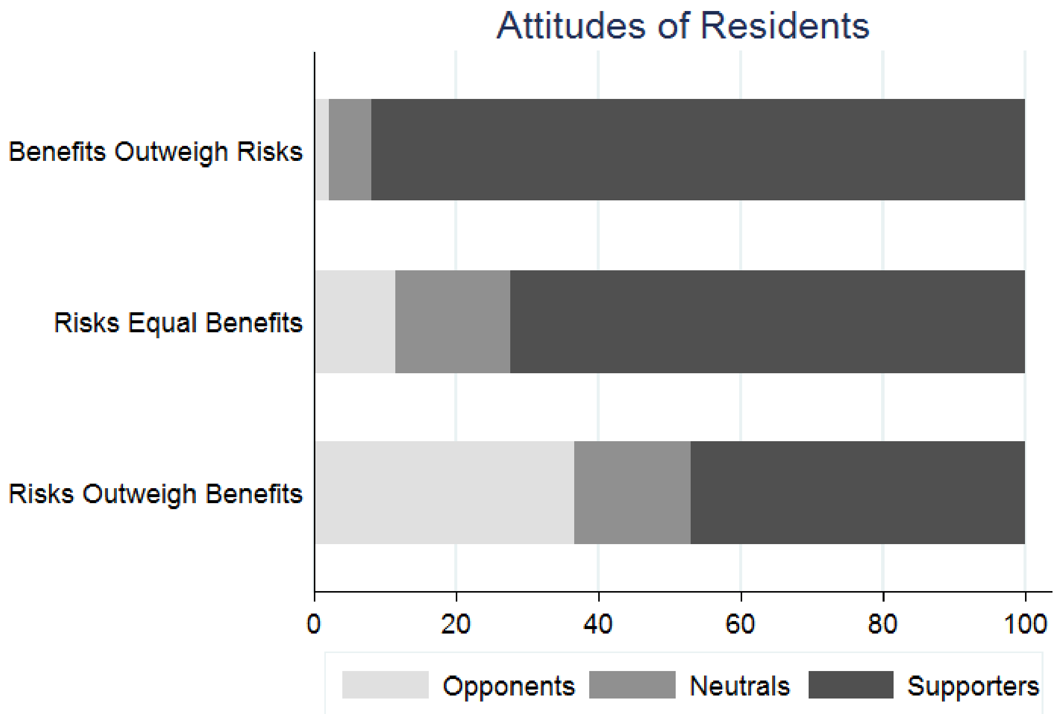
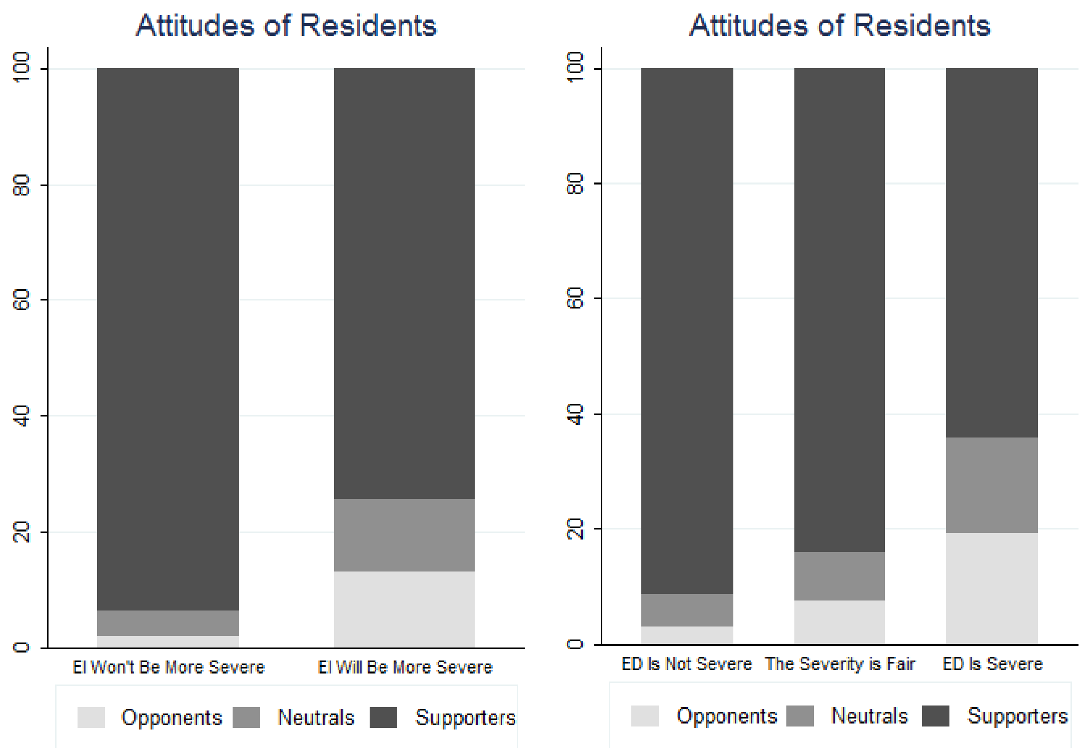


Figure 3. Anticipation of Future Negative Environmental Impacts (EI), Perception of Current Environmental Degradation in China (ED) and Attitudes toward Shale Gas Exploitation (%)



Appendix

Table A1. Bivariate Correlation and Full Regression: Predictor Selections (N=730)

Dependent Variable: Attitude toward Shale Gas Exploitation	Bivariate Correlation		Regression
	Pearson's R	Spearman's R	
Perceived Risks	-0.327***	-0.321***	-0.964**
	(0.000)	(0.000)	(0.040)
Perceived Benefits	0.422***	0.410***	0.196***
	(0.000)	(0.000)	(0.032)
Anticipation of Future Negative Environmental Impacts (1=Yes)	-0.298***	-0.300***	-0.240*
	(0.000)	(0.000)	(0.135)
Perception of Current Environmental Degradation in China	-0.316***	-0.300***	-0.123***
	(0.000)	(0.000)	(0.042)
The Degree of Energy Poverty (MEPI)	-0.102***	-0.063*	-0.395**
	(0.006)	(0.088)	(0.191)
Benefit Questions Answered Prior to Risk Questions (1=Yes)	-0.006	0.023	-0.079
	(0.875)	(0.541)	(0.072)
Experience with Earthquake (1=Yes)	0.010	0.021	-0.049
	(0.786)	(0.573)	(0.111)
Experience with Landslide (1=Yes)	0.015	-0.009	0.051
	(0.682)	(0.813)	(0.082)
Familiarity with Local Shale Gas Projects	-0.034	-0.013	0.005
	(0.358)	(0.720)	(0.025)
Awareness of Shale Gas Accidents (1=Yes)	-0.120***	-0.122***	-0.023
	(0.001)	(0.001)	(0.124)
Number of Information Sources	0.195***	0.166***	-0.012
	(0.000)	(0.000)	(0.022)
Extent of Information Received	0.150***	0.161***	-0.020
	(0.000)	(0.000)	(0.038)
Trust in Information Source	0.221***	0.258***	0.061
	(0.000)	(0.000)	(0.046)
Knowledge of Shale Gas Technology	-0.005	-0.021	0.058*
	(0.883)	(0.570)	(0.032)
Perceived Ability of Proper Management to Avoid Impacts	0.206***	0.219***	0.038
	(0.000)	(0.000)	(0.032)
Perceived Individual Ability to Avoid or Mitigate Impacts	0.156***	0.143***	0.002
	(0.000)	(0.000)	(0.029)
Perceived Observability of Negative Impacts	-0.105***	-0.099***	-0.015
	(0.004)	(0.008)	(0.027)
Perceived Controllability of Negative Impacts	0.266***	0.302***	0.038
	(0.000)	(0.000)	(0.033)
Responsibility of the Central Government (1=Yes)	0.048	0.044	0.053
	(0.197)	(0.235)	(0.108)
Responsibility of the Local Government (1=Yes)	0.040	0.043	0.037
	(0.283)	(0.250)	(0.119)
Responsibility of the Petroleum Company (1=Yes)	0.066*	0.050	0.002
	(0.077)	(0.178)	(0.121)
Trust in the Central Government	0.313***	0.333***	0.138**
	(0.000)	(0.000)	(0.058)
Trust in the Local Government	0.356***	0.379***	0.034
	(0.000)	(0.000)	(0.039)
Trust in the Petroleum Company	0.424***	0.440***	0.148***
	(0.000)	(0.000)	(0.045)
Age	0.174***	0.185***	0.010***
	(0.000)	(0.000)	(0.003)
Gender (1=Male)	0.177***	0.166***	0.143
	(0.000)	(0.000)	(0.090)
Education Years	0.073**	0.052	-0.011

	(0.049)	(0.159)	(0.012)
Chinese Communist Party (1=Yes)	0.154***	0.168***	0.172*
	(0.000)	(0.000)	(0.100)
Cadre (1=Yes)	0.179***	0.203***	0.212**
	(0.000)	(0.000)	(0.107)
Average Annual Individual Income	0.095**	0.130***	0.000
	(0.011)	(0.000)	(0.000)

Note: The values in parentheses in the first two columns are p-values. The values in parentheses in the last column are robust standard errors. * $p<0.1$, ** $p<0.05$ and *** $p<0.01$.