Rural residents' understanding and willingness to pay higher prices for mitigation against global warming in China

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Abstract

Purpose – Studies addressing rural residents' understanding of global warming and their willingness to pay higher prices to mitigate it are very limited. The purpose of this study is to examine the general understanding and attitudes of rural residents in China regarding global warming and their willingness to pay higher prices to mitigate it.

Design/methodology/approach – This study surveyed 1,185 rural residents in three counties of coastal, middle and western China. Multivariate regression analysis was conducted to reveal the relationships between the willingness to pay higher prices to mitigate global warming and influencing factors.

Findings – The majority of respondents had heard of global warming; however, their knowledge of the phenomenon and its causes was very limited. Most respondents admitted the likelihood of risks from global warming. Although most respondents thought they had an obligation to mitigate global warming, only a small percentage of them were willing to pay higher prices to address the problem; the unwillingness of respondents to pay higher prices to mitigate global warming may have been associated with their low income and perceived inability to handle the cost, externalisation of responsibility and causes and lack of knowledge of how to affect it.

Originality/value – This study examines the general understanding and attitudes of rural residents in China regarding global warming and their willingness to pay higher prices to mitigate it. The research is conducive to climate change communications and the implementation of climate policies in China's rural areas.

Keywords China, Perception, Mitigation, Global warming, Rural residents, Willingness to pay higher prices

Paper type Research paper

1. Introduction

The Intergovernmental Panel on Climate Change (2014) reported that since the 1950s, we have witnessed an unprecedented warming of the atmosphere and ocean, diminishing of snow and ice and a rise in sea level. It is extremely likely that global warming from 1951 to

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2010 was the result of anthropogenic causes, especially the increase in greenhouse gas concentrations induced by human activity. Global warming may have severe, pervasive and irreversible effects on people, species and ecosystems with greater potential risks for disadvantaged people and communities. Mitigation measures can reduce the risks of global warming, and the way in which the public understands global warming is very important for its mitigation. The public's understanding of global warming may affect their attitudes towards climate policies and the effectiveness of those policies, and the public's low-carbon-consumption behaviour and lifestyle could result in less emission of greenhouse gases (Bostrom *et al.*, 1994; Weber, 2010; Tobler *et al.*, 2012).

Studies on the public's understanding of global warming have mainly been conducted in developed countries, especially in the USA (Brechin, 2003; Capstick *et al.*, 2015), and more attention should be paid to rural residents' understanding of global warming in developing countries. Rural residents in developing countries are more exposed to the risks of global warming than urban residents because their livelihoods, such as farming and the availability of drinking water, are closely linked to the climate (IPCC, 2014). As far as China is concerned, although more studies are needed before allowing a clear assessment of the impact of anthropogenic climate change on China's water resources and agriculture (Piao *et al.*, 2010), global warming is likely to be harmful to rainfed farms in China, and the damage of global warming to those farms will grow over time (Wang *et al.*, 2009). The damage of global warming to rainfed farms, their greater dependence on weather and their relatively disadvantaged socio-economic situations can make rural residents more vulnerable to global warming than urban residents. In addition, personal experience of a natural hazard has a substantial impact on risk perception (Wachinger *et al.*, 2013), and it is likely that personal experience with local temperature changes may influence global warming beliefs and even behavioural responses (Weber, 2010; Spence *et al.*, 2011; Shao, 2015). Specific experiences with local temperature changes, vulnerability to global warming and backward socio-economic situations may be responsible for rural residents' particular understanding of and mitigation responses to global warming.

China is the most populous country in the world; its economy is the second largest. Because of its rapid economic development, China's emission of greenhouse gases has been on the rise in the past decades. Its efforts to control and even reduce the emission of greenhouse gases can be very important for the mitigation of climate change. However, knowledge of the public's understanding of global warming in China is relatively limited. Several international surveys have shown that the Chinese are more concerned about global warming and are more willing to pay to address it in comparison with Americans (Brechin and Bhandari, 2011; Jamelske *et al.*, 2015). Those studies, as well as some domestic studies (Li, 2013; Yu *et al.*, 2013; Duan *et al.*, 2014; Yang *et al.*, 2014), have included both urban and rural Chinese; however, they have generally included a higher percentage of urban respondents than urban Chinese in the total population. Nearly half of the Chinese population lives in rural areas; however, there are few studies that specifically address how rural Chinese understand global warming. This paper analyses rural residents' understanding of global warming and willingness to pay higher prices to mitigate it. The respondents were from three counties in coastal Shandong Province, middle Shanxi Province and western Gansu Province. There may be regional differences in farmers' perceptions of global warming. The physical, socio-economic contexts in eastern, middle and western China vary greatly. There are many geographical factors that might lead to regional differences, and it is beyond the scope of this study to reveal such factors. Thus, the possible differences in the understanding of global warming among the counties are ignored.

2. The factors that influence willingness to pay to mitigate climate change

To promote the public's involvement in the mitigation of global warming, it is necessary to understand the factors that influence the public's mitigation behaviours and their willingness to pay to support climate policies. Among the socio-demographic variables, it is consistently found in US studies that political affiliation has significant influence on the public's support for climate polices (Dietz *et al.*, 2007; McCright, 2009). The findings on the relationships between other socio-demographic variables, including income, race, age and education and support for climate policies, have been inconsistent (Dietz *et al.*, 2007; McCright, 2009; Tobler *et al.*, 2012).

In the literature on pro-environmental behaviour, it is widely argued that pro-environmental behaviours are value-based (Schultz and Zelezny, 1998), and a mega-analysis showed that certain clusters of values, in particular, self-transcendent and/or altruistic values, are strongly predictive of positive engagement with climate change (Corner *et al.*, 2014). Perceived scientific agreement on anthropogenic global warming has been linked to support for climate policy and societal action (Ding *et al.*, 2011; Marquart-Pyatt *et al.*, 2011; McCright *et al.*, 2013), whereas scepticism has been found to negatively influence people's willingness to engage in climate change mitigation (Tobler *et al.*, 2012). A correct understanding of the causes of global warming (O'Connor *et al.*, 1999; McCright, 2009; Bord *et al.*, 2000), concern (McCright, 2009; Spence *et al.*, 2011) and perceived risks (Zahran *et al.*, 2006; Dietz *et al.*, 2007; O'Connor *et al.*, 1999; Bord *et al.*, 2000; Spence *et al.*, 2011) was found to have a significant correlation with the public's support for climate policies and their mitigation behaviours. Other factors that influence respondents' willingness to pay for climate change include trust in information providers (Vainio and Paloniemi, 2013), confidence in policy (Yang *et al.*, 2014), their level of mass media exposure (Akter and Bennett, 2011), perceived costs and perceived climate benefit (Tobler *et al.*, 2012), perceived personal efficacy in climate change mitigation (Spence *et al.*, 2011) and affect and imagery (Leiserowitz, 2006).

In this study, the factors that influence farmers' willingness to pay higher prices to mitigate climate change were surveyed from two complementary perspectives. One perspective was that some respondents who were not willing to pay higher prices to mitigate global warming were asked to explain the reasons for their unwillingness. The other was that a quantitative analysis was made to test whether farmers' willingness to pay higher prices was associated with the demographic variables of sex, age and education, perceived impact of local temperature rise on wheat and maize, perceived risks, knowledge of global warming, perceived ability to mitigate global warming and perceived obligation to mitigate global warming. According to the value-belief-norm theory, perceived ability to reduce threat and the sense of obligation to take pro-environmental actions are causally associated with pro-environmental actions (Stern *et al.*, 1999). Two factors could explain private-sphere behaviour, environmental citizenship and policy support (Stern, 2000). It is hypothesised that perceived ability and obligation to mitigate global warming are associated with willingness to pay higher prices to mitigate global warming.

3. Methods

3.1 Three case counties

The three case counties are Shanxian in coastal Shandong Province, Wenxi County in middle Shanxi Province and Anding District in western Gansu Province. These three counties lie near the dividing line between North and South China, within similar latitudes (Figure 1). As the altitude increases, the average annual temperatures decrease, and the average annual precipitation decreases from eastern Shanxian to middle Wenxi and further

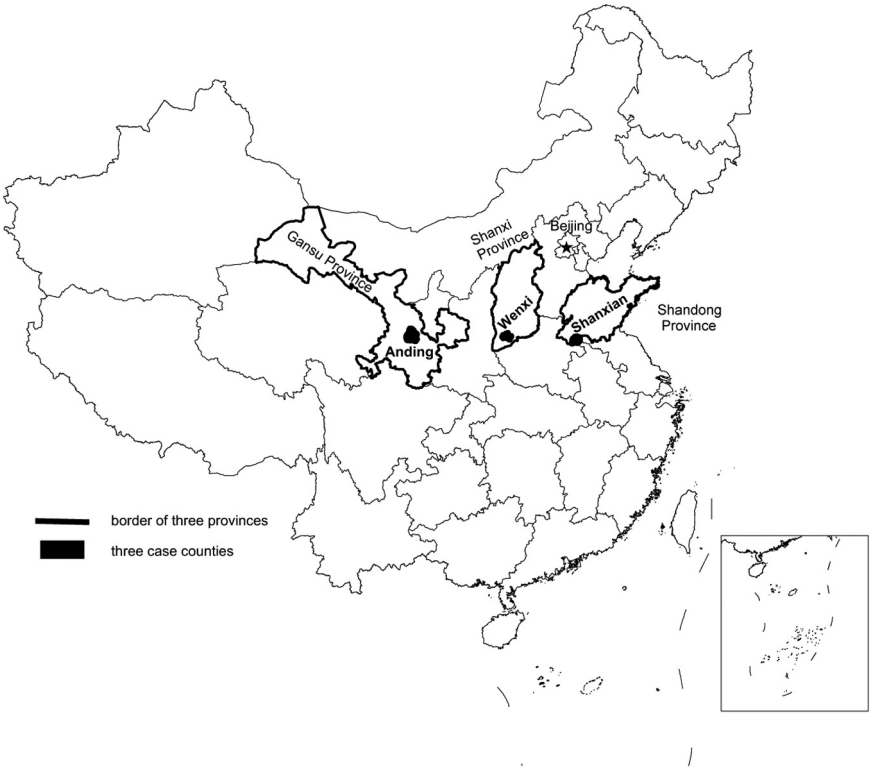

Figure 1.
Locations of the three case counties in China

to western Anding. The altitude in Shanxian varies between 40 and 59 m, and that in Wenxi varies between 450 and 1,500 m, whereas the altitude in Anding increases from 1,671 to 2,577 m. The average annual temperature in Shanxian between 2006 and 2015 was 15.0°C, 1.8°C higher than that in Wenxi and 6.8°C higher than that in Anding. The average annual precipitation in Shanxian, Wenxi and Anding between 2006 and 2015 was 670, 510 and 454 mm, respectively. The average temperature has increased over the past 50 years in all three counties. The annual increase in temperature varies between 0.02°C and 0.05°C (Figure 2). Rainfed agriculture is dominant in the three counties, which are subject to drought and other extreme weather. Wheat and maize are planted in all three counties. The population of rural residents in Shanxian, Wenxi and Anding in 2015 was 611,000, 219,000 and 234,000, respectively.

3.2 Respondents and procedure

A total of 1,185 questionnaires were received in the three case counties: 531 in Shanxian, 340 in Wenxi and 314 in Anding. The samples in each county were not fully proportional to the rural population, and more samples in Shanxian should have been received. In each county, several towns and townships were randomly selected as case areas. The potential respondents in each town or township were selected randomly, and their number was proportional to their residents. The potential respondents were no less than 20 years old. The enumerators were graduate and undergraduate students, and they conducted face-to-

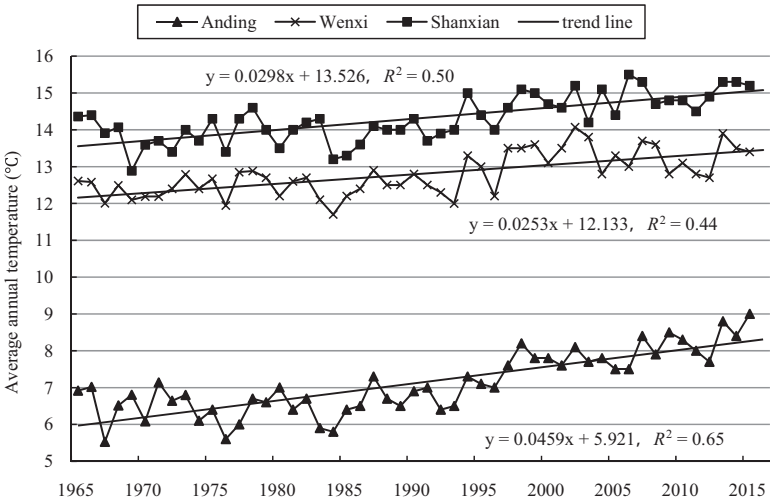

Figure 2.
Average annual temperature of the three case counties

face surveys. They explained the survey's purpose to potential respondents and then asked them to accept the survey. The enumerators read the items on the questionnaire to respondents and recorded their responses. After completing the structured questions, some respondents were further interviewed on issues such as the concrete benefits and costs of local temperature increases and the reasons for their unwillingness to accept higher prices to mitigate global warming. It took approximately 30-40 min to complete each survey. The respondents received a towel as incentive for their participation, and the response rate was approximately 60 per cent. Because of the face-to-face nature of the survey, missing data were very limited.

Some of the female respondents said they knew nothing and refused to take the survey. Thus, male respondents were somewhat overrepresented (Table I). Other demographic features of the respondents in the three counties were similar to those of the whole population that resides in those counties most of the year.

3.3 Questions and items

The three-page questionnaire included the following questions and items: demographic variables sex, age and education level (Table I); perceived impacts of local temperature change on wheat and maize; whether respondents had heard of global warming and from where; understanding of the phenomenon of global warming and its causes; perceived risks of global warming; perceived individual and family ability to mitigate global warming; perceived obligation to mitigate global warming; and willingness to pay higher prices to mitigate global warming. Understanding of the phenomenon of global warming and its causes are open-ended questions, while the others are structured questions (Table II).

Fossil fuels and their related products are the main source of greenhouse gas emissions in China (Chmutina *et al.*, 2012). China has used economic instruments of taxation and flexible pricing systems to restrict the use of fossil fuels (Xu *et al.*, 2010). For example, consumption taxes on petrol increased from 0.2 to 1.0 CNY per litre in 2009, to 1.4 CNY per litre in 2014 and further to 1.52 CNY per litre in 2015; and consumption taxes on diesel increased from 0.1 to 0.8 CNY per litre in 2009, to 1.1 CNY per litre in 2014 and further to 1.2 CNY per litre in 2015. In 2012, electricity tariffs were introduced for household electricity consumption, and

Demographic variables	(%)
Sex	
Male (0)	53.8
Female (1)	46.2
Age (years)	
20-29 (1)	16.3
30-39 (2)	18.4
40-49 (3)	28.0
50-59 (4)	17.9
60 and over (5)	19.4
Education level	
Illiteracy (1)	12.5
Primary school (2)	23.2
Senior middle school (3)	49.4
Junior middle school (4)	11.2
College and university (5)	3.7

Note: (1): Coding

Table I. Demographic features of the respondents (%)

an extra tariff must be paid for excessive electricity consumption. Increases in taxes and the introduction of electricity tariff systems could lead to increase in the prices of fossil energy and its related products. Thus, it was surveyed in this study whether farmers are willing to pay higher prices for fossil fuel energy and related products to mitigate global warming. In the previous studies, willingness to pay to reduce emissions of greenhouse gases has been an important aspect of understanding the public's mitigation behaviours (Dietz *et al.*, 2007; Brechin and Bhandari, 2011; Duan *et al.*, 2014; Yang *et al.*, 2014).

3.4 Analysis method

The features of how respondents understood global warming and their willingness to pay higher prices to mitigate it were reported by percentages. Cronbach's alpha coefficients were calculated to evaluate the internal consistency of the latent variables (Table II). A linear ordinary least squares regression analysis was conducted to reveal the relationships between the willingness to pay higher prices to mitigate global warming and the underlying variables. When a variable has several measuring items, the mean value of all the items was calculated:

$$Y = a + b_1X_1 + b_2X_2 + \cdots + b_nX_n$$

where Y is the dependent variable, a is the intercept and b_1, b_2, …, b_n are the coefficients of the dependent variables X_1, X_2, …, X_n. In this study, the dependent variable is the willingness to pay higher prices to mitigate global warming. The independent variables include the demographic variables of sex, age and education, county, perceived impact of local temperature rise on wheat and maize, perceived risks, knowledge of global warming, perceived ability to mitigate global warming and perceived obligation to mitigate global warming.

The software PASW Statistics 18.0 was used to calculate percentages and Cronbach's alphas and to perform regression analysis. Figure 1 was made by the software ArcGIS 10.2, and Figure 2 was made by Microsoft Office Excel 2007.

Table II.
Variables and items

Variables	Wordings and items	Categories and coding	Cronbach's α
County		Shanxian (1), Wenxi (2), Anding (3)	
Perceived impact of local temperature change on wheat and maize	Do you think how local temperature change impacted wheat and corn, respectively? (two items)	Significant positive impact (1), minor positive impact (2), unsure or no impact (3), minor negative impact (4) and Significant negative impact (5)	0.673
Awareness of global warming	Have you ever heard of global warming?	Yes, no	
Channels of knowing global warming	Through which channels did you know global warming? [a]	Television programmes, the internet, other people, newspapers, radio	
Understanding of the phenomenon of global warming	How do you understand the phenomenon of global warming? [a]	Open-ended	
Knowledge of global warming	Please explain causes of global warming [a]	Open-ended; when a respondent said he/she did not know causes of global warming, it was coded 0, otherwise it was coded 1	
Perceived risks of global warming	Do you think how likely would global warming cause the following risks: risks for you, risks for your family, risks for the whole of society, unpredicted risks, risks for future generations? (five items)	Very likely (5), mildly likely (4), do not know or unsure (3), mildly unlikely (2), absolutely unlikely (1)	0.823
Perceived ability to mitigate global warming	Do you think you or your family is able to mitigate global warming? (two items)	Strong ability (4), a little ability (3), basically unable (2), fully unable (1)	0.856
Perceived obligation to mitigate global warming	Do you think you or your family has obligation to mitigate global warming? (two items)	Full obligation (4), a little obligation (3), basically no obligation (2), absolutely no obligation (1)	0.890
Willingness to pay higher prices to mitigate global warming	To mitigate global warming, do you agree to increase the prices of the following goods? gasoline and diesel oil; coal; electricity; chemical fertilizer; agricultural plastic film. (five items)	Strongly agree (5), mildly agree (4), unsure (3), mildly disagree (2), strongly disagree (1)	0.890

Note: [a]Several responses are possible

4. Perceived impact of local temperature rise on agriculture

The three counties selected for this case study exhibit a monsoon climate with much more precipitation in July, August and September than in other months. Drought is common during the wheat-growing season between March and July. Of all respondents, 41.1 per cent said that the rise in local temperature had a minor negative impact on wheat, and 13.5 per cent recognised a significant negative impact (Table III). Only 20.0 per cent of respondents thought that the rise in local temperature had a positive impact on wheat. The respondents explained that the higher temperature led to a greater degree of drought and more severe cases of wheat diseases. During the growing season for maize, there is relatively more precipitation, and drought caused by higher temperature occurs less frequently. Of respondents, 43.2 per cent said that the rise in local temperature had a negative impact on maize, 11.4 per cent points less than for wheat. Of respondents, 28.9 per cent recognised a positive impact on maize, approximately 9 per cent points more than for wheat. The respondents who observed a rise in local temperature as a positive for wheat and maize said that the temperature increase is associated with a longer growth season and a higher yield of wheat and maize.

5. Understanding of global warming

5.1 Awareness and understanding of the phenomenon of global warming

Of all respondents, 73.2 per cent had heard of global warming. The respondents had learned about global warming mainly through television programmes (72.3 per cent), followed by the internet (20.5 per cent), other people (15.8 per cent), newspapers (9.9 per cent) and radio (4.1 per cent).

Although the majority of respondents declared they had heard of global warming, most of them did not have a clear understanding of what global warming is. Approximately 73 per cent of all respondents said that they did not know what global warming was (Table IV).

Of all respondents, 58 per cent who revealed their understanding of the phenomenon of global warming viewed global warming as a rise in temperature, which was followed by air pollution (12.6 per cent), environmental pollution (7.0 per cent), emission of carbon dioxide (6.3 per cent), ice melting (4.4 per cent) and deforestation (4.1 per cent).

5.2 Perceived causes of global warming

Most respondents (78.3 per cent) said that they did not know the causes of global warming (Table V). Among respondents who offered answers to the causes of global warming, only 5.8 per cent regarded it as a natural process, whereas the remaining majority of survey respondents attributed global warming to anthropogenic causes. Four types of anthropogenic causes were cited by respondents: pollution, including air pollution (21.8 per cent), industrial pollution (8.2 per cent) and environmental pollution (16.0 per cent); emissions of gases, including emission of carbon dioxide (16.3 per cent), hot gases (3.9 per cent) and waste gases (6.6 per cent); deforestation (9.7 per cent) and ecological degeneration (7.0 per cent); other causes that may be linked to the emission of gases and heat included too

Table III.
Impact of local temperature changes on agriculture (%)

Crops	Significant positive impact	Minor positive impact	Uncertain or no impact	Minor negative impact	Significant negative impact
Wheat	6.0	14.0	25.4	41.1	13.5
Maize	4.8	24.1	27.8	32.7	10.5
Cronbach's α	0.673				

Understandings of global warming	No.	(%)
The respondents who answered the question of the phenomenon of global warming	270	22.8
Various understandings (the total number is 270)		
Pollution		
Air pollution	34	12.6
Industrial pollution	6	2.2
Environmental pollution	19	7.0
Temperature rise	157	58.1
Emission of carbon dioxide	17	6.3
Other understandings		
Ice melting	12	4.4
Sea level rise	4	1.5
Abnormal local temperature	7	2.6
Environmental degeneration	6	2.2
Deforestation	11	4.1
Ozone depletion	10	3.7

Table IV. Understanding of the phenomenon of global warming

Causes of global warming	No.	(%)
The respondents who explained causes of global warming	257	21.7
Various causes (the total number is 257)		
Anthropogenic causes		
General anthropogenic causes (no details)	25	9.7
Pollution		
Air pollution	56	21.8
Industrial pollution	21	8.2
Environmental pollution	41	16.0
Gas emission-related causes		
Emission of carbon dioxide	42	16.3
Emission of hot gases	10	3.9
Emission of waste gases	17	6.6
Ecological causes		
Ecological degeneration	18	7.0
Deforestation	25	9.7
Others		
Too many cars	22	8.6
Too many plants	21	8.2
Too many people	18	7.0
Consumption of fossil fuel	9	3.5
Ozone depletion	13	5.1
Natural phenomena	*15*	*5.8*

Table V. Causes of global warming

many cars (8.6 per cent), too many industrial plants (8.2 per cent), too many people (7.0 per cent) and consumption of fossil fuel (3.5 per cent).

5.3 Perceived risks of global warming

The Cronbach's α for the five items of risk perception is 0.823, indicating that the risk perceptions of respondents are internally consistent. More than half of respondents thought

it was likely that global warming would cause unpredictable risks and risks for individuals, their families, the whole of society and future generations (Table VI). Approximately two-thirds of those who perceived the likelihood of risks from global warming thought it was mildly likely that global warming would cause various risks, whereas the remaining one-third said it was very likely. Approximately 10 per cent of all respondents could not judge the likelihood of the risks from global warming for individuals and their families, whereas approximately 20 per cent could not judge the likelihood of the unpredicted risks and risks from global warming for society and future generations. Less than 5 per cent of respondents thought it was absolutely unlikely that global warming would cause various risks.

6. Mitigating global warming

6.1 Responsibility attribution

Of respondents, 31.2 per cent thought that the central government should be mainly responsible for the mitigation of global warming, and 14.7 per cent thought it was the responsibility of the local government to mitigate global warming. In total, 45.9 per cent of respondents thought that the government should take on the main responsibility of addressing global warming, which was followed by industrial firms (21.6 per cent), nongovernmental organisations (11.3 per cent) and international organisations (5.5 per cent). Only 8.7 per cent of respondents thought that individuals and their families should take the lead in addressing global warming, whereas 7.0 per cent did not have any idea of who should be responsible for mitigating global warming.

6.2 Perceived ability to mitigate global warming

Most respondents thought they or their families would be unable to mitigate global warming. Less than 3 per cent of all respondents thought that they or their families had a strong ability to mitigate global warming, and approximately one-quarter of them showed a little ability (Table VII). The respondents with declared ability thought that they and their families could help to mitigate global warming by reducing car and electricity use, not directly using straw as fuel, planting trees and not polluting the environment. The reasons listed by respondents who showed inability included lack of money, powerlessness, elderliness, lack of knowledge of how to do it and inability of human beings to control the natural process of global warming.

Table VI.
Perceived risks of global warming (%)

Risks	Very likely	Mildly likely	Do not know or unsure	Mildly unlikely	Absolutely unlikely
Individual	17.7	43.5	10.5	23.8	4.6
Family	13.9	43.9	10.8	27.2	4.2
Society	19.2	36.6	19.5	20.8	3.9
Unpredicted risks	17.4	39.7	23.7	14.5	4.7
Future generations	20.8	38.5	19.6	16.2	4.9

Table VII.
Perceived ability to mitigate global warming (%)

Members	Strong ability	Some ability	Basically unable	Fully unable
I personally	2.3	25.9	44.5	27.3
My family	2.7	27.2	44.0	26.1

6.3 Perceived obligation to mitigate global warming

Most respondents thought they and their families had an obligation to mitigate global warming. Approximately 20 per cent of all respondents thought that they and their families had a full obligation to mitigate global warming, whereas approximately half of respondents recognised a slight obligation (Table VIII). The respondents who admitted obligation to mitigate global warming thought that everyone had an obligation to do the same. Approximately 30 per cent of all respondents did not think they and their families had an obligation to mitigate global warming due to powerlessness, uncontrollability of global warming and lack of knowledge of how to act to mitigate global warming.

6.4 Willingness to pay higher prices to mitigate global warming

The majority of respondents did not agree to increases in the prices of gasoline and diesel oil, coal, electricity, chemical fertiliser and agricultural plastic film to mitigate global warming (Table IX). Of respondents, 65.0, 66.8, 78.5, 79.4 and 74.2 per cent refused to increase the prices of gasoline and diesel oil, coal, electricity, chemical fertiliser and agricultural plastic film, respectively.

6.5 The factors that influence willingness to pay higher prices to mitigate global warming

Of all respondents, 147 were interviewed concerning the reasons for their unwillingness to pay higher prices to mitigate global warming. A total of 62.6 per cent of them said that their incomes were too low and higher prices would become a heavy burden for them, and 38.1 per cent said that farming benefits are low and higher prices would make farming no longer profitable (some respondents said both), whereas only 12.9 per cent of the interviewed respondents reported other reasons. In comparison to electricity (13.6 per cent), chemical fertiliser (12.5 per cent) and agricultural plastic film (14.1 per cent), relatively more respondents supported the increase in prices of gasoline and diesel oil (22.8 per cent) and coal (20.8 per cent). Some respondents who were willing to accept higher prices on gasoline and diesel oil said that their consumption of gasoline and diesel oil was very limited, and thus, higher prices would not have an obvious impact on them.

The regression analysis involved 1,159 samples. The F-value was 17.00, significant at the 1 per cent level, which means that the whole linear equation was significant (Table X). The adjusted R^2 was 11.0 per cent, showing that all of the independent variables could explain 11.0 per cent of the variance in the willingness to pay higher prices to mitigate global warming.

Table VIII. Perceived obligation to mitigate global warming (%)

Members	Full obligation	Little obligation	Basically, no obligation	Absolutely no obligation
I personally	21.7	48.9	18.8	10.7
My family	20.6	49.7	18.2	11.4

Table IX. Willingness to pay higher prices to mitigate global warming (%)

Products	Strongly agree	Mildly agree	Unsure	Mildly disagree	Strongly disagree
Gasoline and diesel oil	7.3	15.5	12.2	40.3	24.7
Coal	5.7	15.1	12.4	39.9	26.9
Electricity	3.0	10.6	7.9	41.6	36.9
Chemical fertiliser	3.0	9.5	8.1	40.5	38.9
Agricultural plastic film	4.1	10.1	11.6	42.1	32.1

Both non-standardised and standardised coefficients of independent variables were reported. According to the non-standardised coefficients, perceived ability and obligation to mitigate global warming were significantly and positively correlated with willingness. The standardised coefficient of perceived ability to mitigate global warming was 0.16, 0.05 larger than that of perceived obligation to mitigate global warming, meaning that the former played a somewhat more important role in influencing the willingness to pay higher prices to mitigate global warming than the latter. The non-standardised coefficient of the variable county was also positive and significant, showing that respondents in Anding were more willing to pay higher prices to mitigate global warming than those in Wenxi, and that respondents in Wenxi were more willing to pay than those in Shanxian. Perceived impact of local temperature change on wheat and maize was negatively and significantly correlated with willingness, and it seems that the farmers who encountered a relatively significant negative impact of global warming were not inclined to be more willing to pay higher prices to mitigate global warming than those who encountered a minor negative impact and who had experienced a significant impact. Sex, age, education level, perceived risks of global warming and knowledge of global warming had no significant correlation with willingness.

7. Discussion

The rise in local temperature may have brought both benefits and costs to rainfed agricultural production in the three northern Chinese counties of this case study. The main cost is related to prolonged drought, whereas the main benefit is associated with a longer growing season and a higher yield. Benefits and costs varied by region, and it seems that they also varied by households. The impacts of the rise in local temperature in the past decades on agriculture, as well as on health and household fuel consumption in winter, may have led to concern on the part of Chinese rural residents about global warming. More than 70 per cent of the rural respondents in this study paid attention to television programmes related to climate change and had heard of global warming.

Although most of the rural respondents had heard of global warming, their knowledge about it is very limited. Only approximately one in five respondents had a clear mental picture of global warming. Among those who shared their understanding of global warming, more than 60 per cent observed global warming as a temperature rise and emissions of carbon dioxide, whereas approximately 20 per cent regarded global warming as pollution. Many residents in Western countries tend to misunderstand global warming as ozone depletion

Table X.
Regression analysis of explaining factors of willingness to pay higher prices to mitigate global warming

Independent variables	Non-standardised coefficient	Standardised coefficient
Constant	1.30***	
Sex	0.07	0.04
Age	0.01	0.02
Education level	−0.03	−0.04
Perceived impact of local temperature change on wheat and maize	−0.11***	−0.11
Perceived risks of global warming	0.02	0.02
Knowledge of global warming	−0.09	−0.04
Perceived ability to mitigate global warming	0.20***	0.16
Perceived obligation to mitigate global warming	0.12**	0.11
County	0.24***	0.21

Notes: $N = 1{,}159$, Adjusted $R^2 = 11.0\%$; $F_{(9,1150)} = 17.00$***; ***$p < 0.01$, **$p < 0.05$

(Kempton, 1991; Read *et al.*, 1994; Kempton, 1997; Dunlap, 1998; Nisbet and Myers, 2007; Reynolds *et al.*, 2010). In comparison, very few respondents in this study linked global warming to ozone depletion, which may be because rural residents in China are not familiar with ozone depletion. The overwhelming majority of respondents attributed global warming to anthropogenic causes, linking it mainly to emissions of gases from industrial plants and vehicles, pollution and reduction in vegetation. Some respondents associated global warming directly with emissions of carbon dioxide. Industry in the rural areas of the three case counties is underdeveloped, and the number of various vehicles is also limited. This means that, to a great degree, respondents were disassociated from the causes of global warming.

Most respondents recognised the negative impact of the rise in local temperature on wheat and maize, and they further admitted that global warming is likely to cause unpredicted risks and risks for individuals, their families, the whole society and future generations. This may support the argument that experience with local weather may influence global warming beliefs (Howe *et al.*, 2013). In addition, these results are in line with the findings in Western countries, where many respondents think that the risks of global warming outweigh its benefits (Leiserowitz, 2005; Lorenzoni and Pidgeon, 2006).

The majority of respondents in this study were unwilling to accept higher prices to mitigate global warming. This seems contrary to some of the previous studies, according to which most of the Chinese are willing to pay to address climate change (Brechin and Bhandari, 2011; Li, 2013). One possible reason for this inconsistency is that respondents in the previous studies have been disproportionately urban (Brechin and Bhandari, 2011; Li, 2013; Yu *et al.*, 2013; Duan *et al.*, 2014; Yang *et al.*, 2014). Another reason may be that respondents of this study cannot represent the whole of rural China, and it is possible that the percentage of all of rural China that are willing to pay to address global warming is higher than that in this study. However, the most important reason for this inconsistency may result from the different questions and the choice of wording with regard to willingness to pay. Two surveys are cited here for comparison. In the nationwide survey conducted by the China Climate Change Communication Centre in 2012, the question was whether the respondent would be willing to pay more for environmentally friendly products. Environmentally friendly products include a wide range of products that may not be necessities, and the price increase of these products may not have a direct impact on respondents and their families. In contrast, the products that are used in this study are necessities for most (if not all) respondents, and price increases would have a direct impact on respondents and their families. Household agricultural production costs would be increased, as well as transportation costs and the costs of energy consumption. Just as most Americans do not support policies of carbon taxes or a gas tax (Dietz *et al.*, 2007), most of the rural residents in China are unwilling to accept higher prices on the goods that are necessary for agricultural production and daily life. The other survey is an international one conducted in 2009 by the Pew Global Attitudes Project, and the wording was "please tell me whether you agree or disagree with the following statement: people should be willing to pay higher prices to address global climate change" (Brechin and Bhandari, 2011, p. 874). In this wording, it is not clear which products are involved, and respondents may not link higher prices with their own lives. Similarly, many respondents may disconnect "people" from themselves. When respondents are not aware of the direct impact of higher prices on their own lives, they may support higher prices. It seems that more careful surveys are needed to reveal the willingness of both urban and rural Chinese to pay to address global warming.

The respondents attributed their unwillingness to pay higher prices to mitigate global warming mainly to low income; that is, higher prices may make agricultural production with low benefits unprofitable and function as a burden on their lives. Overwhelmingly,

respondents attributed the main responsibility of addressing global warming to government, industry, international organisations and non-governmental organisations, as has the public in developed countries (Leiserowitz, 2006; Whitmarsh, 2009). The externalisation of responsibility and causes can also be a reason for their unwillingness to pay. The regression analysis further revealed that the perceived ability was positively correlated with willingness to pay higher prices to mitigate global warming. Most respondents believed that they were unable to mitigate global warming, and their perceived inability may lead to unwillingness to pay higher prices to mitigate it.

Most respondents declared an obligation to mitigate global warming, and the perceived obligation was positively correlated with willingness to pay to mitigate global warming. However, it seems that perceived obligation did not lead to general acceptance of higher prices to mitigate global warming. Furthermore, previous studies have shown that perceived risks could result in the public's support for climate policies or low-carbon behaviour (Dietz *et al.*, 2007; Bord *et al.*, 2000; Spence *et al.*, 2011; Zahran *et al.*, 2006). However, the regression analysis in this study showed that perceived risks did not have an obvious influence on willingness to pay higher prices. Moreover, most respondents in this study admitted that it is likely that global warming will cause various risks. This does not match low acceptance of higher prices. The question is why their perceived obligation and perceived risks do not translate into a willingness to pay higher prices. Previous studies in natural hazards and climate change can help explain this paradox (Lorenzoni *et al.*, 2007; Whitmarsh, 2008; Whitmarsh *et al.*, 2011; Wachinger *et al.*, 2013). There may be barriers that hamper personal accountability for the purported risks of global warming, which typically translate into a willingness to pay higher prices. Low income and perceived inability may act as main obstacles for rural Chinese in mitigating global warming. Other factors may include the externalisation of responsibility and blame, as well as a lack of knowledge of the causes of global warming and how to act to mitigate it.

It is difficult to explain why the perceived impact of the rise in local temperature was negatively correlated with a willingness to pay higher prices. One potential reason may be that the farmers who encountered a relatively large negative impact from global warming are poor and thus are unable to pay higher prices. In contrast, farmers who encountered a minor negative impact from global warming are more capable of paying higher prices to mitigate climate change. More studies are needed to explain this negative relationship. The respondents' knowledge of global warming in this study was very limited. This correlates with low acceptance of higher prices, and this may be the reason for the insignificant relationship between knowledge of global warming and willingness to pay higher prices. The demographic variables of sex, age and education had no obvious correlation with willingness to pay, and any meaningful connection may be sample-specific.

China's rural residents are less to blame for the causes of global warming, and they are inclined to externalise the responsibility for the mitigation of global warming. However, it is still important to obtain their perceptions of global warming and willingness to participate in mitigation actions. First, most of the public in Western countries is inclined to favour mitigation behaviours that could be easily undertaken and that do not levy unusual hardships (Bord *et al.*, 1998; Tobler *et al.*, 2012). This may also be the case for rural Chinese. A better understanding of global warming may promote mitigating behaviour in rural Chinese in daily life, including recycling, reuse and energy saving methods. Second, although inconvenient, some types of mitigation behaviour will not bring any obvious economic burden to farmers. A typical example is the use of methane gas. The Government of China has made great efforts to expand the development of the methane gas industry over the past decades, and a better understanding of global warming may be conducive to

helping to expand it further. This would involve its more efficient use and the reduction in the burning of crop straw, which until now has been quite common in rural China. Third, a better understanding of global warming may promote the adoption of mitigation behaviours among richer farmers, who would be able to bear the higher economic weight of more energy-efficient household appliances and vehicles. Finally, the income of rural Chinese will increase continuously with further economic development, and more and more rural Chinese will live in towns and cities as a result of urbanisation. Their contribution to global warming may increase, and therefore, it is becoming more and more pertinent to learn how they understand global warning and their potential mitigation behaviour.

The samples from the three case counties may not represent all the residents in rural China, and efforts should be made in the future to obtain nationally representative samples. Further, there are differences in the willingness of farmers to pay higher prices to mitigate global warming, and additional studies are needed to reveal the reasons behind such differences. Possible regional differences in the public's understanding of global warming should also be addressed in the future. In addition, the perception of local temperature changes should be surveyed, and its possible relationship with global warming beliefs should be analysed (Shao, 2015). Still, research methods are important, and the results from qualitative and quantitative research (open-ended questions and checklist questions) may differ (Henry, 2000; Whitmarsh, 2009; Akerlof *et al.*, 2010). More accurate and abundant information may be obtained if open-ended questions are used by surveying risk perception, the impacts of increases in local temperature and the ability to mitigate global warming. Moreover, family income information and other possible explanatory variables should be included within surveys, and integrated models should be developed to explain willingness to pay. Finally, various avenues of greenhouse gas emission and mitigation behaviour and projects in rural China, such as the use of renewable energy and reforestation, should be surveyed in the future.

One policy suggestion is that climate change communications in China should be improved and strengthened. The rural residents in China have learned about global warming mainly through television programmes, especially China Central Television. Television programmes have introduced general knowledge about the phenomena, causes and impacts of global warming by using academic terms that may challenge a broader audience, usually without clear geographical linkages and personal relevance to the audience. Most rural Chinese are unfamiliar with and uninterested in some frequently reported concepts such as rising sea levels, melting ice and species extinction. Such information may lead them to feel to some degree that global warming is something irrelevant to them. The concept of emissions of greenhouse gases is too abstract for them to understand, and they hardly link straw burning and their consumption of fossil fuels to global warming. It may be possible that rural Chinese need more locally and personally relevant information on global warming. They need concrete information on local climate change and its possible impact on them, on the relationships between their agricultural production, behaviour and lifestyles and global warming and on how to act to mitigate global warming (Leal-Filho, 2009). Armed with locally and personally relevant information and knowledge, they are more likely to respond to global warming. The other policy suggestion is that climate policies should take their possible influence on residents into account. Measures that will not bring obvious economic costs to individuals and families should be preferentially adopted. Additionally, governments at various levels should provide financial support for rural Chinese to mitigate global warming, such as subsidies for the recycling of agricultural plastic film, more energy-efficient vehicles and the use of renewable energy.

8. Conclusion

The main purpose of this study is to examine the general understanding and attitudes of rural residents in China regarding global warming and their willingness to pay higher prices to mitigate it. The respondents were 1,185 rural residents in three counties of coastal, middle and western China. The majority of the rural respondents in this study had heard of global warming, but at the same time, they had very limited knowledge about it. Most respondents recognised both the negative impact of the rise in local temperature on agriculture and the various risks that are caused by global warming. The majority of them were unwilling to accept higher prices to mitigate global warming, although they felt an obligation to do so. Their unwillingness could be attributed to low income, the externalisation of responsibility and causes, a perceived inability to mitigate global warming and a lack of knowledge of how to affect it. Rural Chinese need more locally and personally relevant information on global warming, and climate policies should consider their possible influence on local residents.

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