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Why are environmentally aware citizens unwilling to support drinking water quality improvements? Evidence from Kemerovo, Russia

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Abstract

The quality of drinking water is one of the most serious environmental problems for industrial cities in countries with economies in transition. A referendum format contingent valuation (CV) survey was used to elicit household willingness-to-pay responses for drinking water that meets national quality standards. Citizens revealed that, to reduce health risks associated with deteriorating drinking water quality, they currently have to implement various preventive measures and incur some related costs. This behavior indicates a high latent demand for safer drinking water services, which the CV survey evidence corroborates. However, the survey also revealed a high rate of protest bids (53 percent), for which this study attempts to provide possible explanations. Further, the results indicate that households are willing to pay 315.4 Rubles per month from their reported monthly income in addition to their current water bill for safe drinking water.

Introduction

1.1. Background of the study

Despite the gradual increase in the provision of tap water around the world, questions about system reliability and water quality remain. This is an urgent issue especially for developing countries and countries with economies in transition (UNDP, 2006). Water infrastructure and water treatment for drinking purposes are not adequately maintained in these countries because of financial constraints and insufficiency of available program subsidies. As a result, tap water is often unsafe to drink and the water supply system is in some cases unreliable (Gadgil, 1998; UNDP, 2006). Thus, in many transitional economies, safe drinking water remains a serious concern even when water delivery systems with a satisfactory level of functioning are in place.

Many city dwellers in such circumstances have to implement various avoidance measures in their households to adjust the quality of tap water. Whittington et al. (1991) argues that prices for collectively provided tap water of a good quality are significantly lower and more efficient than those for water from alternative sources. A heated discussion emerged in the literature when some researchers reported that the price per unit of bottled water is 500–1,000 times higher than that of tap water in general (Ferrier, 2001) or 2,400–10,000 times higher in the case of US cities (Blumenfeld and Leal, 2007). It was also mentioned that bottled water is not necessarily safer than tap water, despite strong consumer perceptions, which indicate successful marketing (Ferrier, 2001; Blumenfeld and Leal, 2007). In addition to buying bottled water, preventive measures such as filtering, settling, and boiling are available. However, these personal water treatment measures are rarely cost effective (Goodrich et al., 1992).

Drastic political changes during the late 1980s and early 1990s, along with the collapse of the Soviet Union in 1991, led to a great transformation of the former socialist countries in central and eastern Europe. The transformation from the command-and-control type of economy to the free market has been associated with major changes in the economic (privatization, price and foreign trade liberalization) and political (increasing level of democracy) spheres of life. The previous economic system bequeathed to newly established states a number of environmental problems (including the deteriorating quality of drinking water) that became worse during the transition period, although some evident achievements in this field have been identified (Kalugin et al., 2009).

The Russian Federation has experienced economic transition and now must address the issue of poor drinking water quality, especially in cities far from Moscow. According to the Annual State Report on “State of Environment and Environmental Protection of the Russian Federation” (2008), 19 percent of the country’s water does not meet sanitary and hygienic standards, and some 8 percent does not meet bacteriological standards. Recent statistics show that about 50 percent of the Russian population has to use contaminated reticulated drinking water. This has resulted in significant increases in water-related diseases such as chronic nephritis, hepatitis, typhoid, dysentery, cholera, and poliomyelitis (The A.N. Sysin Research Institute, 2009).

Given the scarce financial resources available for environmental management in modern Russia, there is an urgent need to use these resources effectively, so that environmental quality is improved and health risks are reduced (Golub and Strukova, 1995). Environmental evaluation analysis provides practitioners and environmental policy makers with valuable information that may become a solid basis for economic analysis of environmental policies and projects. Better understanding of household preferences (e.g., willingness to pay (WTP) for safe drinking water) can help to make a project sustainable by identifying the preferred level of services and designing appropriate policies for recovering operating and maintenance costs (Gadgil, 1998).

Attention to environmental valuation techniques in Russia began soon after the onset of the transition period. However, 20 years have already passed since then, and the number of those studies can hardly be characterized as high.

Larson et al. (1999), Bashmakov (2005), Larson and Gnedenko (1998), Gnedenko and Gorbunova (1998), Gnedenko et al. (1999), and Kanennova and Martynov (1994) have touched upon issues of environmental valuation in terms of air pollution, communal services, and drinking water quality, but mainly with regard to the European part of the Russian Federation.

1.2. Kemerovo: Background and drinking water quality

Kemerovo city is the administrative center of the Kemerovo region. The city is in the northern part of the region, at the confluence of the Iskitim and Tom Rivers, 3,482 kilometers from Moscow. Kemerovo is the second largest city in the region in terms of population (520,600 inhabitants in 2008) and it occupies 280.2 square kilometers of land. Kemerovo is one of the largest industrial cities in the Russian Federation, having developed during the Soviet era, with important chemical, fertilizer, and manufacturing industries; it is linked to western Russia by a branch of the Trans-Siberian Railway. After the disintegration of the Soviet Union, the city's industries experienced severe decline, creating high levels of unemployment. The main industries in Kemerovo are coal mining, chemicals, and machine building. Administratively, Kemerovo consists of five districts that are located on both banks of the Tom River.

As Kemerovo is situated in immediate proximity to the Tom River, the river serves as the city's main source of drinking water. Additional and reserve sources of drinking water are 10 artesian wells located outside the city. However, their low productivity means they cannot be used as the main source of drinking water. Only one water producing and supply organization operates in Kemerovo. It is a big organization that was established during the Soviet era and changed its type of ownership during the privatization process in the early 1990s. This organization is responsible both for drinking water production and supply and for communal wastewater collection and treatment. The total length of Kemerovo's plumbing is 1,174.4 kilometers, but 56.5 percent of the total plumbing needs to be replaced due to dilapidation. Chronic budget constraints meant the water supply organization was able to replace only 23.6 kilometers (less than 2 percent) of pipes in 2008, although the defined and approved renewal rate was 5 percent.

Determining the quality of the water in the Tom River is crucial for understanding Kemerovo's current situation regarding drinking water quality. As the Kemerovo region is a large industrial area, the Tom River is used as a receiver of wastewater from both the industrial and the residential sectors. Because Novokuzneck city (the largest city in the region in terms of population and industrial production) is located in the upper stream of the river, the water that reaches Kemerovo has a seriously deleterious quality. Data on water quality in the Tom River in the vicinity of Kemerovo for the period 2004–2008, presented in Table 1, show that in 2008, the maximum allowable concentrations (MAC) were exceeded for three types of contaminants, namely, nitrite nitrogen, phenol, and oil products.

Table 1. Annual average concentrations of major pollutants in Tom River (in Kemerovo)

Pollutant	MAC, mg/l	2004	2005	2006	2007	2008
Ammonium nitrogen	0.4	0.4	0.23	0.15	0.12	0.18
Nitrite nitrogen	0.02	0.35	0.3	0.25	0.35	0.2
Phenol	0.001	4	3	2	2.2	1
Oil products	0.05	2.6	2.6	2.4	2.2	1.8

Source: Annual State Environmental Report of Kemerovo Region (2009)

Although the water supply organization claims that its water is appropriately and adequately treated and that it meets Russian quality standards at the point of entering the city's plumbing, the quality of drinking water that residents use in their households does not always meet these standards. Indeed, the number of irregular samples in Kemerovo and its districts is relatively high: in 2008, for microbiological characteristics, it was 20.4, and for sanitary and chemical characteristics, the number was 27.7 of total number of samples.

The repetition factor of excess of annual maximum allowable concentrations by organoleptic nuisance value is high for such characteristics as iron, hardness, and manganese. Table 2 provides these data as well as the number of people who are affected.

Table 2. Repetition Factor of Excess of Annual Maximum Allowable Concentrations by Organoleptic Nuisance Value and Number of People Under Effect in Kemerovo Region in 2007 (share of MAC/No of people)

Pollutant	MAC (Russian standard)	Repetition factor of MAC access	No of people under effect
Iron	0.3 mg/l	3.2	347,682
Manganese	0.1 mg/l	2.9	66,652
Hardness	7 mg-eqv.l	1.4	78,563

Source: Kemerovo Region Department of Russian Consumer Supervision (2009)

In the case of iron, for example, the real concentration at the tap was 3.2 times higher than the quality standard and nearly 348,000 people were consuming such drinking water. Clearly, dilapidated plumbing combined with low quality of water in the primary source adversely affected household drinking water quality.

The study has two main objectives. First, it aims to investigate households' perceptions of tap water supply and the quality of drinking water, and to calculate their WTP for safe water provision in the city of Kemerovo. Second, it aims to estimate citizens' readiness to support environmental quality improvement programs and reasons for that support by analyzing protest bids for the CV scenario.

The remainder of the paper is organized as follows. Section 2 outlines contingent valuation methods and introduces our survey design. Section 3 contains estimation procedures. The results of empirical analysis are presented in Section 4 followed by a discussion. The final section concludes with the policy implications of the study findings and provides some practical recommendations.

2. Methodology

Contingent valuation (CV) surveys are a valuable method for collecting information on preferences for the provision of public goods and services in transition economies (Bluffstone and Larson, 1997), despite a variety of validity and measurement issues raised in a recent study by Carson and Hanemann (2006). Recent CV studies in the context of developing countries and transitional economies were conducted by Al-Ghuraiz and Enshassi (2005), Dogaru et al. (2009), Kip Viscusi et al. (2008), Del Saz-Salazar et al. (2009), Kathuria (2006), and Kalugin et al. (2009). The results of most of these studies have shown that respondents are willing to pay significant amounts for safe drinking water; these findings have been used in a variety of policy settings around the provision of improved water services.

2.1. Survey design

The assessment in this paper is based on an in-person, referendum format CV survey carried out in winter 2009 among heads of households in Kemerovo. A collaborative team from Hiroshima University and Kemerovo State University designed and implemented an in-person CV survey instrument. Successfully eliciting respondents' preferences through the CV method requires careful survey design, choice of survey mode, and selection of the random sample (Bateman et al., 2002; Whittington, 2002). A number of focus groups were included in the survey design, and the survey also went through a number of iterations in order to receive feedback. For this purpose, for example, in-depth interviews were conducted with 15 randomly selected respondents with different socioeconomic characteristics and living in different districts of Kemerovo city. The information collected at that stage allowed the design of WTP questions for the pilot (40 respondents participated) and main surveys. Trained interviewers conducted the main survey in the field with a random sample of 300 respondents.

2.1.1. Questionnaire

The final version of the questionnaire consisted of 6 sections. In the first section, respondents were asked to provide general information about their type of dwelling and water supply, and to evaluate the functioning of their current water delivery system and the quality of drinking water. In the second section, respondents reported on various preventive measures they take in their households to adjust water quality. The contingent scenario was introduced in the following section; the survey participants were then provided with general information on drinking water quality in Kemerovo and were asked to respond to a single-bounded referendum valuation question (additional fees of 100, 300, and 500 Rubles per month in the form of offered bids were randomly varied across the sample). The fourth section contained practical information about possible measures to improve tap water quality; the respondents were invited to rank five available measures according to their personal preferences. The fifth section collected data on the current state of respondents' health, and the final section elicited respondents' general sociodemographic characteristics.

In the valuation section, the quality characteristics of existing drinking water were described and the scenario improvements of water quality were presented. The valuation question asked households whether they would pay an incremental monthly fee for improved water quality in addition to their current water bills. This payment method was chosen as the most appropriate with regard to the credibility of the hypothetical market because it is plausible and familiar to the surveyed population. It also helps minimize protest responses and avoid the free rider behavior typical of voluntary payments (Jones et al., 2008). Respondents were reminded that the money they would agree to spend on this additional fee would not be available for other household expenses. The referendum voting question presented in the questionnaire was as follows:

> *Consider that the current drinking water in your household does not meet Russian quality standards and cannot be safely drunk. Suppose that the local authorities and the water supply organization plan to implement a project designed to improve the quality of drinking water. If the project is approved, and the plumbing system is renewed and modern treatment facilities are installed, a fixed fee will be added to your water bill in addition to what you currently pay. Please note that money you spend for safe drinking water will not be available for any other purpose.*
>
> ***Would your household be willing to pay X Rubles for the water quality improvement project and thus the reduction of health risk?***
>
> ***YES NO***

This question was followed by two additional questions related to the respondents' reasons for their willingness or unwillingness to pay. Two further questions required by the National Oceanic and Atmospheric Administration (NOAA) panel to be used in a CV study—debriefing questions about respondents' confidence while answering the WTP question and their understanding of this question (Arrow et al., 1993)—were included in the questionnaire.

2.1.2. Protest zero bids

Protest zero bids—when respondents place a zero value on a good that they actually value by answering "No" to the valuation question—are quite common in CV studies. This problem is of particular concern in dichotomous-choice CV, because a "No" response may be misinterpreted as willingness to pay less than the stated amount, rather than as a protest (Halstead et al., 1992). It is therefore necessary to examine all zero bids carefully and classify them in order to determine whether they are protest bids or legitimate zero bids (Freeman, 1986).

Protest zero bids are commonly identified by follow-up questions that examine respondents' motivation for their zero bids. Disagreement with or distaste for the vehicle of payment used in the survey instrument, ethical reasons, or the belief that the good should be provided by means other than personal payments are often cited for zero bids (Mitchell and Carson, 1989; Freeman, 1986).

After answering the valuation question, those respondents who answered negatively were given the follow-up question designed to elicit their reasons for saying "No". The question was presented as follows:

Please specify the reason(s) for your unwillingness to support the suggested program:
a) I don't believe that there is a risk from drinking water.
b) The government should be responsible for solving this problem.
c) I am not sure that the risk from consuming contaminated drinking water can be reduced.
d) I am not sure that drinking water quality will be improved even though the payment is increased.
e). I can implement avoidance measures in my household.
f) I am satisfied with the current drinking water quality.
g) I understand the importance of the problem but cannot afford the suggested charge.
h) I oppose the payment method.
i) Other (specify).

3. Estimation procedure

We apply the indirect utility function approach proposed by Hanemann (1984). We use the econometric software Stata 10.0 (Stata Corp LP) for estimation. Following are the procedures for estimating the parameters to be affected for utility function, median WTP, and mean WTP. We referred to Hanemann (1984) and Kuriyama (2007) for these procedures.

Concerning the respondents who answered "Yes" to paying the offered bid T when the utility level will be increased after paying T, compared with the condition when there is no project, the probability that the respondent will pay the offered bid T can be denoted as:

$$Prob\{Yes\} = Prob\{U_Y > U_N\} = Prob\{(V_Y + \varepsilon_Y) > (V_N + \varepsilon_N)\} = \\ = Prob\{(\varepsilon_Y - \varepsilon_N) > \Delta V\} \quad (1.1)$$

where U_Y is the utility level when the project for improving water quality is implemented and U_N is the utility when the project does not exist. The utility is decomposed into deterministic and error terms, represented by V_Y,V_N and ε_Y,ε_Y (the subscript indicates the respondent's answer). The differences of the utility function ΔV could be defined as

$$\Delta V = V_Y - V_N = \beta_0 + \beta_T lnT + \sum \beta_k x_k \quad (1.2)$$

where x indicates the kth sociodemographic variable and β are the parameters to be estimated. Assuming ε_Y,ε_N as type 1 Extreme Value distribution (EV1), then $\varepsilon = \varepsilon_Y - \varepsilon_N$ follows the logistic distribution. The log-likelihood function follows:

$$lnL = \sum_{i=1}^{n} [d_Y lnProb\{Yes\} + d_N ln(1 - Prob\{Yes\})] \quad (1.3)$$

where i indicates the respondent and d_Y is the binary value when the respondent answers "Yes": $d_Y = 1$ otherwise: d_Y

= 0. d_N is the binary value when the answer is "No": $d_N = 1$, otherwise: $d_N = 0$. The parameters are estimated using the maximum likelihood estimation.

From the estimated parameters above, the mean and median WTP were estimated using the following equations:

$$\text{MedianWTP} = exp\left(-\frac{-\beta_0+\Sigma\beta_k x_k}{\beta_T}\right) \quad (1.4)$$

$$\text{MeanWTP} = exp\left(-\frac{-\beta_0+\Sigma\beta_k x_k}{\beta_T}\right)\frac{\pi/\beta_T}{sin(-\pi/\beta_T)},\ -1 < \frac{1}{\beta_T} < 0 \quad (1.5)$$

As most of the respondents refused to accept the highest offered bid, the estimation was not truncated at the highest offered bid.

4. Results

The general impression from the survey is that Kemerovo residents were keen to participate in the study. However, 2.3 percent of initially defined respondents declined to participate. Respondents were predominantly female, married and had children. The majority of the survey participants described their present health condition as "good", although personal health-care expenditures (purchasing medicine, visiting doctors, staying in hospitals, etc.) in 2009 appeared to be relatively high: 5 percent of mean monthly household income. The analysis of the debriefing questions revealed that most respondents felt confident in answering the survey questions: nearly 88 percent said that questions were "absolutely" and "rather" understandable, and 85 percent were "absolutely" and "rather" confident. These results are summarized in Table 3.

Table 3. General characteristics of Kemerovo household survey respondents

Variable	Description	Value
Age	Respondent's age in years	46.68
Gender	1 if male; 2 if female	1.77
Family size	Number of people in household	2.73
Number of children	Number of children under 10 years old	0.28
Income	Mean monthly household income (Rub)	17,981 [1]
Present health condition	From 1 to 5: if 1 'very good'; if 5 'very bad'	1.90
Health care expenditure	Mean personal health care expenditures in 2009 (Rub)	10,354
Answering confidence	From 1 to 4: 1 if 'absolutely confident', 4 if "not confident at all"	1.90

Note: 1 USD = 29.04 Rub (The Central Bank of the Russian Federation, 2010)

[1] 619.2 USD

4.1. Drinking water quality and water supply system functioning

The analysis of responses revealed that slightly more than half of the survey participants are dissatisfied with the quality of tap water they have in their households: 56.0 percent chose either "rather" or "absolutely" dissatisfied. The three water quality problems most often cited as causing dissatisfaction are rust, bad odor, and bad taste with 59.0, 33.0, and 32.7 percent, respectively. Kemerovo residents believe that the tap water they use is not suitable for some common purposes. Indeed, the majority said that it is not suitable for drinking (88.3 percent). It was also deemed unsuitable for cooking (36.0 percent), watering plants (20.0 percent), hygienic procedures (16.7 percent), and washing clothes (3.7 percent)

One of the study's objectives was to find out what, in respondents' opinion, is (are) the most probable reason(s) for the deteriorated drinking water quality. "Insufficient treatment", chosen by 62.0 percent of respondents, was the most often cited. A slightly lower number of respondents (52.7 percent) believe that the state of the plumbing is to blame, while 31.7 and 25.7 percent mentioned "various types of pollution" and "low quality of water in primary source", respectively.

By contrast, the majority of respondents (75.5 percent) expressed satisfaction with the water supply system functioning. This large proportion can be explained by the fact that almost every household in Kemerovo now uses the centralized drinking water supply system and outages are infrequent; 96.3 percent of the survey participants cited the centralized water supply as the main source of drinking water in their household.

4.2. Avoidance behavior

Given the low quality of drinking water in Kemerovo, one can suppose that residents adopt avoidance measures in their households in order to adjust water quality before use. Several questions in the survey were dedicated to eliciting this information. The results show that the overwhelming majority of the sample (92.3 percent) believes that it is necessary to adjust water quality to make it safer and, thus, reduce health risks.

Boiling is the most popular avoidance measure among Kemerovo households, practiced by 69.7 percent of respondents. The second most popular measure, implemented by 51.0 percent, is settling water in a reservoir for some time (e.g., in a pan overnight) so that rust and sediment are precipitated. A similar proportion of households (49.0 percent) filter drinking water before use. Another 23.3 percent regularly buy bottled water, 15.0 percent let water flow out of the tap for some time and 4.0 percent take water from natural sources (e.g., springs).

The popularity of "boiling" and "settling" can be explained by their being absolutely or relatively costless. Boiling water does not require people to spend much, apart from the additional expenses for gas or electricity. Settling is absolutely costless and does not require any financial injection. The relatively high percentage of those who chose filtering as their preventive measure suggests respondents are aware of the possible negative health consequences of using low-quality tap water. Clearly, many citizens are concerned about their health and, thus, are willing to implement even costly measures in order to reduce health risks.

The mean preventive measures expenditure is equal to 207.02 Rubles per month per household, which is 1.15 percent of the mean household monthly income. Respondents were also asked to consider their avoidance behavior in a situation where improved tap water quality does meet Russian quality standards. In this case, the majority of respondents stated they would reduce their spending for preventive measures by up to 50 percent. Only 2 percent, however, stated that they would stop spending money to improve drinking water quality.

4.3. Factors affecting bid acceptance

A number of independent variables in the model affected the size of respondents' WTP. These determinants must be analyzed in order to give credibility to the results obtained. Carson (2000) suggests that the construction of an equation that predicts WTP for the good with a reasonable explanatory power and coefficients with the expected signs provides evidence of the proposition that the survey has measured the intended construct. In Table 4, we set out the variables chosen for the model along with the estimation results.

Table 4. Description of variables and model estimation results

Variable name	Description	Coeff.	Std.Err.	z	P > |z|
logBID	Suggested bid	-2.333	0.412	-5.670	0.000***
WATSAT	Satisfaction with drinking water quality from 1 (completely satisfied) to 4 (completely dissatisfied)	0.777	0.322	2.410	0.016**
INCOME	Monthly household income	$7.94*10^{-5}$	$2.88*10^{-5}$	2.760	0.006***
AGE	Respondents age in years	-0.043	0.018	-2.370	0.018**
Log-likelihood	-55.26				
Number of observations	141				

Note: *** and ** indicates significance at the 1% and 5% levels, respectively

All the variables in the model are significant at the 0.05 level or better. The dependent variable records whether or not a respondent was willing to pay the amount asked in the interview. The logBID was precisely the presented amount, which has three possible values, as explained previously. The interpretation of the regression results suggests that the increase in bid values leads to a decrease in the likelihood of "Yes" responses to the dichotomous WTP question. This gives the negative sign of the variable logBID, so the higher the payment offered to the respondent, the lower the probability of it being accepted. Another variable that shows a negative sign is AGE. This variable was included in the model in order to test the hypothesis that older people have a lower probability of giving a positive answer to the proposed payment. The results support this idea. This can be explained by the fact that older respondents have a different scale of values because their education and their perception of the quality of the environment differ from those of younger generations. In the same way, older people have lower expectations of use (since they are not sure that the improvements can be made in the nearest future), and hence their WTP is lower. Another possible explanation for this might be the fact that older people have been affected by the Soviet regime to the greater extent than younger generations and that their distrust of the government is higher.

The remaining significant variables have positive signs. This means that there is a direct positive relationship between them and the probability of the proposed payment being accepted. INCOME is one of the most important variables when validating contingent valuation results from a theoretical point of view. The positive sign, as expected, corresponds to the higher WTP or probability of accepting the proposed payment in the case of a higher household income. The WATSAT variable, which is also positive, can be interpreted as indicating that the more dissatisfied people are, the more they are willing to support water quality improvement programs.

Characteristics for education, avoidance behavior, and current water expenditure were also tested, but none proved to be statistically significant. There might be several reasons for this. One concern is the size of the sample. Most probably it was not large enough to draw such a conclusion; hence, there is not enough information for the statistics to be accurate.

4.4. WTP

30 percent of respondents gave a positive answer to the WTP question and agreed to pay an additional sum of money for drinking water quality by accepting one of the three offered bids. Respondents were also asked to specify reasons for their willingness to support the suggested scenario. The three most common reasons given were "understanding the seriousness of the problem", "affordability of offered bid", and "concern about income that could be lost due to sickness" with 75.5, 11.3 and 1.7 percent of respondents, respectively. Mean WTP equaled 451.5 Rubles

per month per household (15.56 USD)[1], which is about 2.5 percent of mean monthly household income. Median WTP equaled 315.4 Rubles (10.86 USD)[1], which is about 1.75 percent of mean monthly household income. Descriptive statistics of respondents' WTP and bid acceptance are presented in Table 5.

Table 5. Descriptive statistics of respondents' WTP and bid acceptance

bid, Rubles	100	300	500
Number of respondents accepted the bid	61	17	12
Mean WTP, Rubles/household/month		415.5*	
Median WTP, Rubles/household/month		315.4*	

Note: Respondents from every city's district were randomly assinged to the bid
** 2.5 and 1.75 percent of mean monthly household income, respectively*

The analysis of the data on acceptance ratios derived from Table 4 revealed that the proportion of "Yes" responses decreases with an increase in the price of the environmental good in focus. These results comply with Freeman's (2003) ideas on the downward nature of an acceptance ratio curve and corroborate the robustness of the analytical model applied in the study.

4.5. Protest bids

A large majority of respondents (70 percent) answered the WTP question negatively. The most common reasons for rejecting project implementation were nonaffordability of suggested bids (35.5 percent), belief that government should be responsible for solving this problem (30.7 percent), and uncertainty about the possibility of water quality improvement (28.7 percent). As these are quite large portions of the sample, reasons and consequences should be scrutinized.

Several types of protest to the CV method are possible. Individuals who object to the survey may simply not respond. Some individuals may give positive but invalid bids (outliers), and others may state a zero value for a good that they do actually value (protest zero bid) (Halstead et al., 1992). The protest behavior of respondents may cause a deviation of stated willingness to pay from "true" values. Mitchell and Carson (1989) discuss biases caused by or in response to the survey instrument itself, such as strategic bias, starting-point bias, or scenario misspecification. Shultz and Luloff (1990) mention "non-response" bias caused by individuals not responding (either in whole or in part).

The existing literature provides three principal ways to deal with protest zero bids: (1) drop them from the data set; (2) treat the protest bids as legitimate zero bids and include them in the data set; or (3) assign protest bidders mean WTP values based upon their sociodemographic characteristics relative to the rest of the sample group (Halstead et al., 1992). When the benefit aggregation issue is the focus, the treatment of protest bids becomes especially important because aggregate value estimates can be significantly affected by the decision to include protest zero bids.

Protest zero bids in the current study were treated by excluding them from the sample, with some exceptions. Those respondents who chose only variants e), f), or g) (or any of their combinations) in the follow-up question were treated as legitimate zero bids and remained in the data set, and their responses were used in further econometric analysis.

5. Discussion

Applying the results of the study requires careful interpretation and caution, especially concerning the high rate of protest bids. To explain the higher number of protest bids in Kemerovo than in previous studies for two cities in the European part of Russia[2] (where the rate of protest zero bids was less than 30 percent), we carried out an in-depth analysis of two groups of respondents. The first group comprised 47 percent of those demonstrating a positive WTP; the other group consisted of protest bidders.

That the overwhelming majority of respondents (up to 93 percent) in both groups agreed with the need to adjust drinking water quality before use can be considered to show high demand for environmental improvements. This factor had common patterns among respondents, as did present health condition, satisfaction with water system functioning, household income, and family size. However, further comparative analysis revealed a number of other factors that may influence on how decisions differ between the two groups. In short, those respondents who supported the program are more dissatisfied with current water quality, implement more costly preventive measures, and, consequently, have higher avoidance expenditures. They also believe that their current health problems may be an aftereffect of the long-term consumption of contaminated drinking water, have a higher educational level, and, mainly, work as company employees or public servants. These respondents are also younger and have more children under 10 in their families. The data on cross tabulation analysis of two groups of respondents is presented in Table 6.

These differences, however, are not extraordinary but rather to be expected. Indeed, they support the idea that individuals with the abovementioned characteristics are more willing to pay for improved water quality and expected reduction in health risks. However, a question remains: Why in this study are so many citizens who expressed a high level of environmental awareness and demand for environmental improvements apparently unwilling to support these improvements, even though their socioeconomic characteristics do not differ much from program supporters? To answer this question we need to look at the background of Kemerovo.

Kemerovo is a very traditional industrial city located far from the Russian capital and other large centers of the European part of the country. The historical peculiarities of governmental management when decisions were directed from the center to the periphery, combined with an almost absolute exclusion of the ordinary public from the decision-making process, have inevitably influenced citizens' perception of any actions undertaken by local authorities. The current study supports this idea. Even though respondents are highly aware of the issue in focus, they demonstrate a lack of trust regarding governmental initiatives.

Supporting this last statement is the fact that the majority of respondents said they would not stop spending money on personal avoidance measures. Only 2 percent of respondents said they would decrease their spending by 100 percent if the drinking water quality in Kemerovo met Russian standards.

Table 6. Comparative analysis of protest and non-protest zero bidders

	Non-protest zero bidders (N=141)	Protest zero bidders (N=159)
1. Satisfaction with drinking water quality (%)		
"yes" and "rather yes"	36.9	50.3
"no" and "rather no"	63.1	49.7
2.Educational level (%)		
"junior high school"	2.1	5.0
"high school"	10.6	15.7
"vocational school"	11.3	7.5
"technical school"	31.2	37.1
"university"	44.8	32.7
"graduate school"	0	2.0
3. Preventive measures (%)		
"filtering"	54	44.7
"bottled water"	26	21.4
"natural sources"	6	2.5
Mean household preventive measure expenditures (Rub/month)	270	151.0
4. Correlation between health problems and deteriorating water quality (%)		
"yes"	50.4	35.8
"maybe"	28.4	14.5
"no"	9.9	40.3
"don't know"	11.3	9.4
5. Respondent's age in years (%)		
"under 18"	0	0.6
"18-25"	12.8	3.8
"26-30"	12.1	7.5
"31-40"	18.4	20.8
"41-50"	24.8	15.7
"51-60"	21.3	27.7
"61-70"	7.1	17
"over 70"	3.5	6.9
6. Occupation (%)		
"company employee"	9.9	7.5
"public servant"	53.9	28.3
"student"	1.4	2.5
"housewife"	2.8	1.9
"worker"	11.3	17.6
"retired"	12.1	30.8
"self-employed"	0	1.9
"unemployed"	3.5	1.9
"other"	5.1	7.6
7. Family composition (%)		
Presence of children (under 10)	28.4	20.7
Presence of aged members (under 60)	13.5	18.2

6. Conclusion and policy implications

This study was undertaken with the primary aim of analyzing citizens' perceptions of drinking water quality in the city of Kemerovo, Russia, where the dilapidated plumbing system and the low quality of the water in the primary source have caused the deterioration of the tap water that city residents consume in their households. The water currently does not meet Russian national standards and its consumption has a negative long-term impact on residents' health.

To improve the quality of drinking water and, thus, eliminate the present health risk associated with its consumption, households implement various avoidance measures. The overwhelming majority of survey respondents practiced these, with boiling, settling in a pan, and filtering being the three most popular avoidance measures. The mean monthly expenditure on adjusting water quality before use is equal to 1.15 percent of the mean monthly household income.

Given the public awareness about the importance of drinking water quality in promoting public well-being and reducing health risk, there is an increasing need to provide public authorities with valuable information that can be used in the decision-making process. Therefore, citizens' willingness to pay for the implementation of a program aimed at improving drinking water quality was estimated. Although both mean and median WTP were calculated, it is preferable to use the median WTP in cost–benefit analyses because it reflects what the majority of people would be willing to pay. Passing on no more than this amount to individuals should therefore have a correspondingly greater degree of public acceptability than seeking to pass on an amount that is closer to a mean WTP, which will have been overly influenced by a relatively few very large bids (Pearce et al., 2006).

The median WTP in the Kemerovo drinking water quality study was estimated at the level of 315.4 Rubles per household per month, as an addition to current water bills. A number of independent variables, namely age, satisfaction with current drinking water quality, income, and presented bids, affected the probability of respondents' accepting the proposed payment. The high rate of protest bid in the study can be explained by the nature of the reasons that led to the current situation with drinking water quality. Indeed, the beginning of infrastructural depreciation can be traced back to Soviet times, when the government alone was responsible for plumbing maintenance. This was probably a determining fact for respondents when they were considering the proposed scenarios.

The household WTP results obtained can be applied to Kemerovo as a whole, providing practitioners and decision makers with more concrete information about the probable benefits of the project. The total city WTP per year equals:

$$\begin{aligned} \mathrm{WTP_{city}} &= \mathrm{WTP_{houshold}} * \mathrm{H} * \mathrm{L} * 12 = 315.4 * 206{,}040 * 0.47 * 12 \\ &= 336{,}536{,}407 \text{ Rubles per year} \end{aligned}$$

where H is the total number of households, and L is the program support ratio (the number of respondents that support the proposed program divided by the total number of respondents: 141/300 = 0.47)[3].

The derived results can be compared with numbers for the actual city plumbing renewal budget constraints. As mentioned in Section 1.2 of this paper, in 2008, only 23.6 kilometers of pipes and communication hubs were renewed, less than half the planned renewal of 59.0 kilometers. Using data on the cost of replacing 1 meter of plumbing (26,744 Rubles)[4], we can estimate the sum of money that was needed to replace the remaining 35.4 kilometers in 2008:

$$\mathrm{R_{total}} = 35{,}400 * 26{,}744 = 946{,}737{,}600 \text{ Rubles}$$

These results show that the yearly budget constraint is nearly three times the size of the amount of money calculated based on citizens' WTP.

Kemerovo city budget expenditure in 2010 equals to 11.8 billion Rubles (406 million USD) with budget revenue equaled to 11.3 billion Rubles (389 million USD) and 4.24 percent deficit (Kemerovo City Council, 2010). Budget spending on communal service infrastructure renovation (including drinking water pipes, pumps and communication hubs) accounts for 8 percent or 944 million Rubles of yearly budget revenue (Kemerovo City Council, 2010).

Obviously, this amount of money is not sufficient even to cover the cost of replacement of 2008 “non-replaced” pipes. It is also clear that the city is facing chronic budget constraint in communal service since drinking water infrastructure renovation is not only expense item for the government. Since the implementation of the project (which will require collection of additional payments made by citizens) needs the local legislation to be changed, it is rather questionable that the local authorities can develop and realize it in the nearest future.

As there are limitations to both the methodology applied and the research conducted, a full answer to such an important issue as drinking water quality management cannot be provided at the moment. However, we believe that this study and its results have both academic and practical value as this appears to be the first attempt to estimate the nonmarket benefits derived from drinking water quality policies in the Russian Federation. Further studies should carefully consider the peculiarities of citizens’ perceptions of environmental quality and government actions in transitional economies revealed in this work. We also expect that our study will become a starting point for other research in this field, as local authorities and water supply organizations in other Russian cities facing similar problems could gain from studies such as this when trying to design and implement relevant policies.

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Endnotes

1 1 USD = 29.04 Rubles (The Central Bank of the Russian Federation, 2010)
2 Gnedenko and Gorbunova (1998), Gnedenko et al. (1999)
3 Since only 47 percent of the sample supported proposed plan, it is more realistic to base WTP estimations for Kemerovo city on this ratio.
4 Kemerovo water supply organization “KEMVOD” (2010)

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