THE VALUE OF A STATISTICAL LIFE IN THE CZECH REPUBLIC: EVIDENCE FROM A CONTINGENT VALUATION STUDY[*]

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Abstract

We present the results of a contingent valuation survey of residents of three cities in the Czech Republic. The purpose of the survey was to obtain estimates of the value of a statistical life in the context of the risk of dying for cardiovascular and respiratory illnesses. We estimate the VSL to be 18.52 million CZK or 40.16 million CZK, depending on whether we use median or mean WTP figures from our study. Our estimates can be used to compute the mortality benefits of environmental policies and of weather advisories and other policies for reducing exposure to heat waves.

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I. Introduction.

The Value of a Statistical Life (VSL) is a key input when one wishes to compute the mortality benefits of environmental policies or other safety regulations that save lives. The VSL is defined as the rate at which individuals are prepared to trade off income for risk reductions, and is the figure that must be multiplied by the expected number of lives saved by the policy to estimate its mortality benefits.

The VSL is usually estimated using one of three main approaches. The first is by observing the compensating wage differentials that workers must be paid to take riskier jobs (see Viscusi and Aldy, 2003, for a recent literature review). The second approach examines other behaviors where people weigh costs against risks (Blomquist, 2004), and the third is through contingent valuation surveys where respondents report their willingness to pay (WTP) to obtain a specified reduction in mortality risks.[1]

The European Commission has recently adopted an interim VSL of about €1 million for policy analysis purposes, with adjustments for the age of the beneficiaries of environmental policy and for whether the cause of death is cancer (in which case a premium of 40% is applied).[2] These figures do not vary with the income of the beneficiaries. In principle, they could be adopted to estimate the mortality benefits of policies that promote adaptation to climate change.[3]

[1] See Alberini (2004) for an examination of recent contingent valuation studies used for US environmental policy purposes.
[2] See http://europa.eu.int/comm/environment/enveco/others/recommended_interim_values.pdf.
[3] Because extreme weather events, heat waves, and the spreading of certain vector-borne diseases are considered potential, and worrisome, consequences of climate change, these policies may include heat, storm and other weather advisories, emergency procedures, development of health care facilities, training of health professionals, preparation of evacuation plans, etc.

Without further documentation, however, there is no reason to believe that these figures, which were developed by experts on the basis of previous studies, most of which were conducted in Western Europe, reflect the preferences of people living in the countries that recently joined the European Union. Differences in incomes and in the taste for income and risk may imply different VSLs.[4]

Another problem with the DG Environment figures is that they are based on transferring the VSL from other contexts (e.g., transportation or workplace safety) and/or that they are based on individuals' WTP for all causes of death, rather than for causes specifically associated with environmental or climate exposures.

This paper reports the results of an original contingent valuation survey in the Czech Republic where residents of three cities (Prague, Brno, and Ostrava) were asked to report information about their WTP for reductions in their own risk of dying for cardiovascular and respiratory causes. By focusing on these causes of death, we obtain WTP figures that are immediately applicable to the climate change and environmental policy contexts. The VSL is then obtained by dividing WTP by the risk reduction being valued.

To circumvent the problem of possible double-counting of benefits, we ask respondents to consider a private reduction in their own risk of dying. Our WTP questions adopt the dichotomous-choice format, in that respondents are asked whether or

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[4] Costa and Kahn (2002) suggest that the compensating wage differentials observed in the labor market—and hence, they conclude, the VSL—has increased over time in the US, as has the quantity of workplace safety. Using Census micro-data and fatality risk figures from the Bureau of Labor Statistics for 1940, 1950, 1960, and 1980, they estimate the implied elasticity of VSL with respect to per capita GNP to be 1.5 to 1.7. A meta-analysis of compensating wage studies by Viscusi and Aldy (2003) pegs the income elasticity of VSL to be 0.5-0.6, and certainly less than one. DeBlaeij et al. (2000) conduct a meta-analysis of the WTP to reduce transport risks, finding a considerable higher income elasticity of 1.33. Liu et al. (1997) compare estimates of the VSL from compensating wage studies in Taiwan based on 1982-1986 data with predictions based on VSL-income relationship from developing countries.

not they would pay a specified Czech Koruna (CZK) amount. To refine information about WTP, this is followed by a higher (lower) CZK amount if the respondent agreed (declined) to pay the initial amount.

Our experimental design allows us to answer four questions that are important for climate change and environmental policy. First, we survey individuals of ages 30-75, so that we can answer the question whether the VSL varies with the age of the beneficiary of the policy—an issue previously explored by Shepherd and Zeckhauser (1982), Jones-Lee (1976), Johannesson et al. (1997) and Alberini et al. (2004a)—and with their heath status. This question is particularly important in the climate change context, because the mortality effects of heat waves and thermal stresses fall disproportionately on the elderly and persons with chronic conditions.

Second, we vary the size of the risk reduction to the respondent to see if WTP increases with the size of the risk reduction, as prescribed by the economic theory, and if so, by how much. Third, we ask people to value both an immediate and a future risk reduction, as is consistent with the type of exposure changes implied by many environmental and climate change adaptation policies. Fourth, we experiment with two alternative mechanisms for delivering the risk reduction: a completely abstract risk reduction, and one that would be delivered by a new medical test.

Using the survey data, we estimate mean VSL to be 40.16 million CZK (€1.27 million at the current exchange rate, €2.86 million at the Purchasing Power Parity [PPP]), while median VSL is 18.52 million CZK (€0.58 million at the current exchange rate, €1.32 million at the PPP). These estimates increase by roughly 5 to 15% if we increase household income to levels that are closer to the population's household incomes of the three cities than the incomes in our sample. The VSL is lower for older people, but not for individuals with cardiovascular or respiratory illnesses.

The remainder of this paper is organized as follows. Section II defines the VSL, and presents advantage and disadvantages of using contingent valuation. Section III describes the structure of the questionnaire. Section IV presents the experimental treatments used in our study, and Section V the sampling plan and the administration of the survey. Section VI describes the data, and section VII the VSL estimates. In section VIII, we discuss the results of our VSL regressions. Section IX concludes.

II. Use of Contingent Valuation with Mortality Risks

Contingent valuation is a method of estimating the value that a person places on a good. The approach asks people to directly report their willingness to pay (WTP) to obtain a specified good, rather than inferring them from observed behaviors in regular marketplaces.

Contingent valuation can be used to value a reduction in a person's chance of dying, and the VSL implied by this person's WTP. We begin by defining the VSL, which is the rate at which a person is prepared to trade off income for risk reduction. Formally, assume that the individual's utility is U(y), where y is aggregate consumption, and that he has a probability p of dying at the end of this period. Assuming that the state-dependent utility of consumption when the individual is dead is zero, expected utility is equal to

(1) $$E(U) = (1 - p)U(y) .$$

The VSL is defined as the rate at which an individual is prepared to trade off income for risk changes, while keeping expected utility the same:

(2) $$VSL = \frac{dy}{dp} = \frac{1}{1-p}\frac{U(y)}{U'(y)}.$$

Although the VSL is a derivative, in a contingent valuation survey individuals are asked to report their WTP for a specified finite risk chance Δp, and the VSL is approximated as WTP/Δp.

If the researcher's goal is to estimate the VSL, contingent valuation has several advantages over revealed-preference approaches. For example, it is flexible, in that it can be adapted to any desired context, and it is not limited to workplace risks. Moreover, respondents can be informed about their baseline risk and are told what risk reduction they are to value, so that the researcher does not have to rely on the (untested) assumption that perceived risks are identical to objective risks, as is usually the case in compensating wage and consumer behavior studies. Finally, by assigning the risk changes to be valued exogenously to the respondent, the researcher avoids by construction problems like endogeneity of risk and wages, and poorly observed measures of risk.

One potential disadvantage of contingent valuation is that it imposes a heavy cognitive burden on the respondents (see Carson, 2000). Visual aids are usually deployed to communicate risks to the respondents (Corso et al., 2001), and respondents are sometimes given practice questions about probabilities.

The most widely used approach to eliciting information about the respondent's WTP is the so-called dichotomous-choice format. A dichotomous choice payment question asks the respondent if he would pay $X to obtain the good. There are only two possible responses to a dichotomous choice payment question: "yes," and "no." The dollar amount $X is varied across respondents, and is usually termed the bid value.

When dichotomous choice questions are used, the researcher does not observe WTP directly: at best, he can infer that the respondent's WTP amount was greater than the bid value (if the respondent is in favor of the program) or less than the bid amount (if the respondent votes against the plan), and form broad intervals around the respondent's WTP amount. To estimate the usual welfare statistics, it is necessary to fit binary data models (Cameron and James, 1987).

III. Structure of the questionnaire.

Heat waves are typically associated with excess deaths for cardiovascular and respiratory causes. For this reason, the questions at the heart of our questionnaire elicit WTP for reductions in the risk of dying for these causes. Our questionnaire is self-administered by the respondents using the computer, and was developed by translating into the Czech a questionnaire that was previously administered to a sample of Italian residents (see Alberini et al., 2004b).

The questionnaire is divided into seven sections. In section 1, we query the respondent about gender and age, and if he or she has ever been diagnosed to have certain cardiovascular and respiratory illnesses (including heart disease, chronic obstructive pulmonary disease, and emphysema), and cancer. We also ask people to tell us a little about the health and longevity of other family members, to assess their current and future health, and to report a subjectively assessed life expectancy.

In section 2, we ask questions about the respondent's health over the last four weeks, physical mobility limitations (if any) and psychological well-being. Our questions are adapted from the Short Form 36 (SF36) questionnaire, which is widely used in medical research to assess physical and emotional health. Section 3 provides a simple probability tutorial, leading to the explanation of one's chance of dying, which is expressed as X in 1000 over 10 years, and is graphically depicted using a grid of 1000 squares, a commonly used risk communication device. White squares represent survival, while blue squares represent death. Respondents are then tested for probability comprehension.

In section 4, we acquaint respondents with the concept that it is possible to reduce one's risk of dying, and that many people do so on a routine basis. For example, we tell respondents that a pap smear can reduce the risk of dying of cervical cancer (in women) and that blood pressure medication reduces the risk of dying of a heart attack. We then introduce cardiovascular and respiratory illnesses, and allow the respondent to learn more about them by reading a glossary which is launched by double-clicking a link on the screen. The respondents are then asked questions about treatments or actions they take against cardiovascular and respiratory illnesses, and their cost.

In section 5, we present the chance of dying for a person of the respondent's age, gender, and health status. This is shown using blue squares in the grid of 1000 squares. We highlight the chance of dying for cardiovascular and respiratory illnesses using orange squares, emphasizing that these risks increase with age. For example, cardiovascular and respiratory causes account for a small fraction of the total risk of dying among persons of age up to 40 years, but for 50% among 70-year-olds. These mortality risks were taken from the official population statistics of the Czech Republic.

Section 6 presents the hypothetical risk reduction scenario. People are asked to value a reduction of X in 1000 in their chance of dying for cardiovascular and respiratory causes over the next 10 years, where X ranges from 1 to 12, depending on the respondent's age and gender. The experimental design for the baseline risk and risk reduction is displayed in table 1, where the baseline risk of dying for all causes is denoted as FILL, the baseline risk of dying for cardiovascular and respiratory causes if denoted as FILL2, and the risk reduction in the latter is denoted as FILL3.

During the focus groups we conducted as part of the initial questionnaire development work in Italy, we noticed that people of ages 30 to 40 would regard their risk reductions—which were usually of about 1 in 1000—as negligible, although these risk reductions in many cases account for half of the baseline risk. Accordingly, we decided that the questionnaire should explicitly remind respondents of the percentage risk reductions implied by the absolute risk reductions. The percentage risk reduction is denoted as FILL4 in table 1.

Respondents are told that to obtain the risk reduction described in the questionnaire, they would have to pay a given amount of money every year for 10 years. The payment question is in a dichotomous choice format with one follow-up.

Table 1. Baseline risks and risk reductions assigned to respondents in the survey (immediate risk reduction).

	MALE				**FEMALE**			
AGE	**FILL1**	**FILL2**	**FILL 3**	**FILL 4**	**FILL 1**	**FILL 2**	**FILL 3**	**FILL 4**
30-34	17	2	1	50%	8	2	1	50%
35-39	30	4	2	50%	13	2	1	50%
40-44	51	8	4	50%	22	4	2	50%
45-49	81	16	5	31%	35	6	2	33%
50-54	126	30	3	10%	55	9	3	32%
55-59	189	59	6	10%	86	13	4	30%
60-64	274	94	5	5%	141	35	4	11%
65-69	387	160	8	5%	240	72	7	10%
70-74	539	274	12	4%	397	155	7	5%
75-79	714	487	12	2%	611	342	7	2%

In section 7 we describe and elicit WTP for a risk reduction that would take place X years from now (where X varies with the respondent's age), when the respondent is older. To make this question meaningful to the respondents, we show them that the chance of dying for any cause and for cardiovascular causes increases as one gets older. Baseline risks and risk reductions used in this valuation task are reported in table 2, where they are denoted as FILL5 and FILL7, respectively.

Table 2. Baseline risks and risk reductions assigned to respondents in the survey (future risk reduction).

	FILL 5	**FILL 7**	
AGE	**FUTURE AGE**	**MALE**	**FEMALE**
30-34	50 and 70	3 12	3 7
35-39	50 and 70	3 12	3 7
40-44	60 and 75	5 12	4 7
45-49	60 and 75	5 12	4 7
50-54	65 and 75	8 12	7 7
55-59	75	12	7

In section 8, we ask questions intended to investigate the intertemporal rate of preference of the respondent, and his or her financial risk aversion. Section 9 concludes the survey with the usual socio-demographic questions, and with debriefing questions about the respondent's interpretation of the questions.

We wish to emphasize that climate change is never mentioned to the respondent is this survey. We chose to do so for two reasons. First, we wished to keep the risk reduction a private good, because it is difficult to identify the altruistic components of WTP, and to account for them appropriately to avoid double-counting. Second, linking risk changes to public policies for emissions reductions or adaptation to climate change would require that we provide information about them. In our opinion, doing so would have resulted in an excessively heavy cognitive burden, which prompted us to choose a context-free risk reduction.

IV. Experimental Treatments

Our study involves a total of four experimental treatments. The first is that our respondents are randomly assigned to one of two mechanisms for delivering the risk reduction: a completely abstract risk reduction, and a medical test. In the abstract risk reduction version of the questionnaire, respondents are simply told to suppose that it were possible to reduce their risks. Our focus groups indicated that people accept such an abstract risk reduction, and that this approach is likely to get them to focus more sharply on the size of the risk reduction, without being distracted by other details. The purpose of the experimental treatment is, therefore, to see if people truly focus on probabilities better in this fashion.

Regarding the medical test, we had previously found that people were comfortable with this vehicle for the risk reduction, as long as the medical test was approved by the national health care system. In this case, the payment mechanism is a co-pay, modeled after the routine charge for medical tests within the Czech national health care system. Respondents are told that the medical test would have to be done, and paid for, every year for ten years, for it to be effective. They are also told that the test would be safe and have no side effects.

The second experimental design is that respondents are randomly assigned to one of four possible bid sets, which we report in table 3.

Table 3. Bid amounts.

BID 1	**BID 2 if BID 1 = yes**	**BID 3 if BID 1 = no**
1 500 Kč	3 500 Kč	950 Kč
3 500 Kč	7 000 Kč	1 500 Kč
7 000 Kč	13 000 Kč	3 500 Kč
13 000 Kč	17 000 Kč	7 000 Kč
In EURO using the exchange rate (31.5 CZK / €)		
48 €	111 €	30 €
111 €	222 €	48 €
222 €	413 €	111 €
413 €	540 €	222 €
In EURO by PPP (14.0 CZK / €)		
107 €	250 €	68 €
250 €	500 €	107 €
500 €	929 €	250 €
929 €	1 214 €	500 €

Our third experimental treatment is that respondents younger than age 55 are randomly assigned to one of two possible ages at which the future risk reduction is supposed to start, and the risk reduction itself takes one of two possible sizes.

Our fourth experimental treatment refers to section 8 of the questionnaire, and varies the annual payment to be paid annually to the respondent for ten years as an alternative to an immediate payment of 140,000 CZK. The annual payments are reported in table 4, along with the implied discount rate. All of these amounts were obtained as the purchase power parity equivalents of the corresponding euro figures used in the Italian survey.

Table 4. Annual payment (for ten years) offered as an alternative to an immediate payment.

Immediate payoff	Annual payment	Implicit discount rate
140,000 CZK (4,444 € by exchange rate 10,000 € by PPP)	16,000 CZK (1,150 € by PPP)	2.5%
	21,000 CZK (1,500 e by PPP)	8.1%
	23,000 CZK (1,650 € by PPP)	10.2%

V. Sampling Plan and Administration of the Questionnaire

The survey was self-administered by the respondents using the computer in three cities of the Czech Republic—Prague, Brno and Ostrava.[5] These were selected on the grounds of population and income, and to ensure variability in the population risk factors. For example, Prague, the capital of the Czech Republic and its largest city, has relatively high age- and gender-specific mortality rates, and both cardiovascular and respiratory mortality rates are relatively high. By contrast, Brno has relatively low overall mortality rates, low mortality rates for respiratory causes, but somewhat high mortality rates for cardiovascular causes. Finally, Ostrava, an industrial city in the Northeast of the Czech Republic, has high overall and respiratory mortality rates, but low mortality rates for cardiovascular causes. These characteristics are summarized in table 5.

[5] Charles University Environment Center (CUEC) was commissioned to translate the questionnaire, pretest, and implement the survey in the Czech Republic. The Czech Republic team is comprised of Milan Scasny (team leader), Marketa Braun Kohlova, Jan Melichar and Jan Urban, plus three researchers involved in the recruitment and administration of the survey. The project started in March 2004 and was completed by September 2004.

Table 5. Characteristics of the three cities.

Prague (capital; central Bohemia)	- capital city - has relatively high mortality overall, high both for respiratory and cardiovascular causes - there is a wide variation in income, and the wealthiest people in the CR live in Prague - lowest unemployment rate
Brno (second largest city in the CR; Moravia; Southeast CR)	- former capital of Moravia province; economy based mostly on agriculture - low mortality overall, low respiratory causes, relatively high cardiovascular cause in the region - relatively high unemployment rate in the region
Ostrava (Northeast CR)	- industrial city; the income of the region is among the lowest among the regions of the CR. However, the city does not have low income - highest overall mortality rates, high respiratory deaths, low cardiovascular mortality rates - high unemployment rate (16% in the region, one of the highest in the CR)

We began with translating the questionnaire developed by Alberini et al. (2004b) for Italy into the Czech, and by testing it in three focus groups in Prague and Karlovy Vary, a city in western Bohemia. Evidence from the focus group was used to revise slightly the questionnaire to improve clarity, where needed.[6, 7]

[6] The focus groups were attended by 5-7 participants. We used paper handouts at this phase of the research.
[7] For example, in section 4, people found our question about checkups and medical tests to reduce one's chance of dying confusing. Clarity and comprehension was greatly improved when we added a response category that allowed people to tell us that they did undertake such actions, and that they did so because their doctor had specifically prescribed them. Likewise, we felt it was necessary to add a question to ascertain whether respondents were familiar with certain preventive actions (e.g., aspirin therapy) to reduce the chance of dying for cardiovascular causes. All questionnaire amendments were discussed mainly by e-mail and telephone, and during three work meetings held in Brussels on March 13, 2004, in Washington, on May 24-25, 2004, and in Budapest, on June 26-27, 2004.

The self-administered computer questionnaire was conceived as an internet-based application and developed using PHP language. It was then installed on three servers,[8] to be accessed by individual computers at the three facilities in the cities where the survey was conducted. Each of the individual computers had high-speed internet access.

The computer questionnaire was pre-tested in Prague, on August, 4, 2004. The respondents were recruited by the professional survey company, Factum Invenio (www.factum.cz), following the sampling quotas specified for the final sample.[9] The pre-test included 55 respondents, and was conducted at the same location as for the final survey (the university computer lab in downtown Prague). The room included 17 computers, all of them dedicated to the pre-test.

The sampling plan for the final survey called for quota sampling of the 30-45, 46-60, and 61-75 age groups in roughly equal proportions. We also wished to have an equal number of men and women, and a sample that was similar to the population in terms of educational attainment and financial circumstances of the household.

The data were collected in Prague, Brno, and Ostrava at facilities with 10 personal computers within University buildings. Table 6 summarizes locations, sample sizes, and dates when the data collection took place.

Throughout the administration of the final version of the questionnaire, we made sure that assistance was available for those respondents who needed help. This proved necessary only in a few cases. Most people, even those who were not familiar with

[8] The URLs of these servers were http://www.czp.cuni.cz/mortalita (the official web site of CUEC belonging to Charles University server), http://vydra.ff.cuni.cz/jd/mortalita (the server of the computer center of Faculty of the Arts, Charles University in Prague), and http://mortalita.zabukem.cz (a private server).

[9] As explained below, there were three equally represented age groups, an even number of men and women, and that variation in income was ensured by sampling by quotas on education.

computers, quickly learned how to use the mouse and how to type in open-ended answers when needed.

Table 6. Administration of the survey.

City	Address	Days	Date
PRAGUE N=351	Charles University in Prague, Faculty of Arts and Philosophy, Celetna 20, Prague 1	8 days	30 August – 5 Sept. plus 9 Sept 2004 10 a.m. – 8 p.m.
BRNO N=296	Masarykova Univerzita in Brno, Fakulty of Mediciny, Komenského aq. 2, Brno	9 days	31 August – 8 Sept. 10 a.m. – 7:15 p.m.
OSTRAVA N=307	Ostravská univerzita, Centre of information technologies, Bráfova 5, Ostrava	12 days	30 August – 10 Sept. 10 a.m. – 7:15 p.m.

Our survey respondents were recruited by Centrum Výzkumu Veřejné Mínky (CVVM) Public Opinion for Research Centre, a survey firm within the Sociological Institute, Academy of Sciences of the Czech Republic (http://www.cvvm.cz). They were offered a token of 100 CZK (3.2 €) in Prague, and 80 CZK at the other locations, for participating in the study. The payment was made upon completion of the questionnaire. Our final sample is comprised of 954 observations.

VI. The Data

A. Individual Characteristics of the Respondents

In this section, we present descriptive statistics for the purpose of examining whether the final sample is consistent with the sampling plan. Our final sample size was 954, with 36.79% of our respondents in Prague, 31.03% in Brno, and 32.18% in Ostrava.

Table 7 reports descriptive statistics for one experimental treatment variable, the abstract risk reduction scenario v. medical test, and for individual characteristics of the respondent. As shown in table 7, half of the respondents were given the abstract risk reduction scenario. The sample is balanced in terms of gender, with only a slight prevalence of women. The average age is almost 51 years, as required by the sampling plan.[10]

Regarding the health status of the respondents, 20% of the sample suffers from heart disease or has had a heart attack, 18% has high blood pressure, 31% has high cholesterol, and 13% suffers from a chronic respiratory illness, like asthma, COPD, or emphysema. About one-third of the sample reports being a diabetic. Only about 4% of the sample has or has had cancer.

About 54% of the respondents are married, almost a quarter of the sample is divorced or separated, nine percent is comprised of widows or widowers, and 13% never married (Table 8). Returning to table 7, the average household size is 2.74 people, while annual household income is on average 247,510 CZK. This is slightly less than the average household income in the population (which as of 2003 is 290,000 CZK in Prague, 264,000 CZK in Brno, and 278,000 CZK in Ostrava), and is confirmed by comparing the cumulative distribution of household income in the sample and population, as we do in Figure 1.[11]

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[10] The older age group is relatively less represented in Prague and Ostrava, where it accounts for about 24% of the sample.

[11] Czech Statistical Office, 2003. Median household income ranges from 252,000 CZK (in Prague) to 267,000 CZK (in Ostrava).

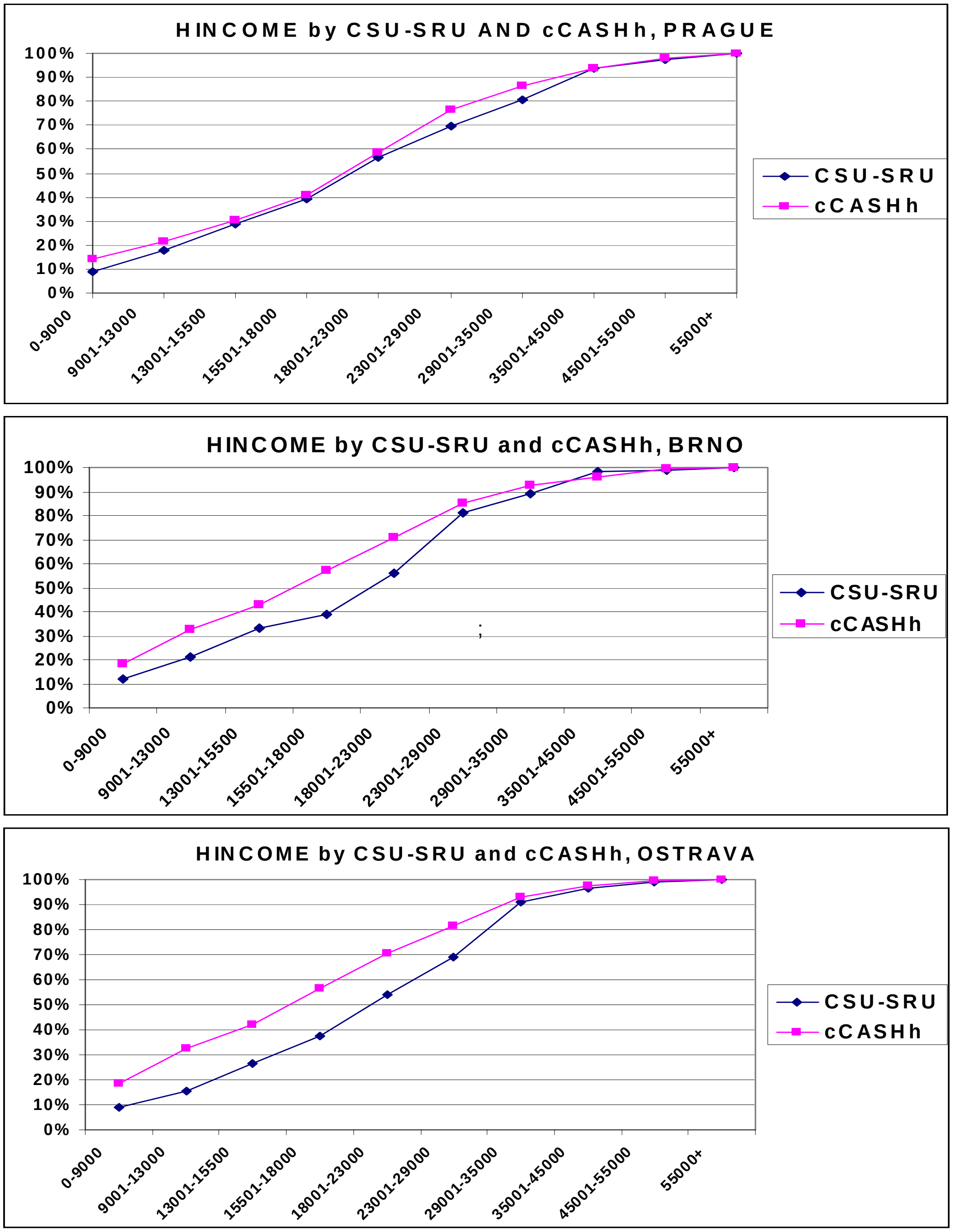
Table 7. Descriptive statistics of the sample.

Variable	Label	N	Mean	Std Dev	Minimum	Maximum
abstract risk reduction		954	0.50	0.50	0	1
male		954	0.47	0.50	0	1
AGE		954	50.75	12.84	30	75
cardio		954	0.20	0.40	0	1
pressure		954	0.18	0.38	0	1
cholesterol		954	0.31	0.46	0	1
diabetes		954	0.33	0.47	0	1
lungs		954	0.13	0.33	0	1
canc		954	0.04	0.19	0	1
married		954	0.54	0.50	0	1
HHSIZE	household size	953	2.74	1.51	1	25
dependents		953	0.49	0.90	0	9
inc	hh income in thou. CZK	876	247.51	129.22	108	660
works full-time		954	0.51	0.50	0	1

Table 8. Marital status of the respondents.

Category	Frequency	Percent of the sample
Married	511	53.56
Divorced or separated	238	24.96
Widow/widower	82	8.60
Never married	121	12.68
Missing	2	0.21

Figure 1. Comparison of the household income for three cities under examination with CSU-CRU, Household Budget Survey by Czech Statistic Office, for year 2003.



B. Probability Comprehension.

When asking people to value mortality risk reductions, it is important to make sure that the concept of chance has been communicated effectively to them. We included two questions meant to test for probability comprehension in section 3 of the questionnaire. First we ask respondents to indicate which of two people has the higher chance of dying—person A, with risk of 5 in 1000, or person B, with risk equal to 10 in 1000. Then we ask people to tell us which of these two people they would prefer to be. These questions are similar to those used in a previous mortality risk survey by Alberini et al. (2004a). We dub the former question our "probability quiz" and the latter our "probability choice" question.

As shown in table 9, the majority of the respondents (83%) answered the probability quiz correctly. However, the percentage of respondents who failed this question (about 17%) is slightly higher than we have seen in previous studies conducted in the US and Canada (Alberini et al., 2004a), and in the UK, France and Italy (Alberini et al., 2004c). Likewise, the majority of the respondents chose the person with the lower risk of dying.

Table 9. Comprehension of risks. Absolute and relative frequencies of the respondents who…

	Person A	Person B	Indifferent between A and B	Missing
In the probability quiz, choose…	157 [16.46%]	794 [83.23%]	N/A	3 [0.31%]
In the probability choice question, choose….	681 [71.38%]	136 [14.26%]	135 [14.15%]	2 [0.21%]

C. Response to the Payment Questions

Table 10 reports descriptive statistics for the responses to the payment questions. About 56.19% of the responses to the initial payment questions were a "yes." Similar proportions of the sample reported a sequence of two "yes" (32%) and two "no" responses (29%), respectively, to the payment questions. The relative frequency of "yes"-"no" responses is also relatively high (24%), while "no"-"yes" pairs account for 15% of the sample.

We report the percentage of respondents that answered "yes" to the payment questions within the subsample that received a given bid set in table 11. The table shows clearly that the percentage of "yes" responses declines with the initial bid, which means that responses are consistent with the economic paradigm. It also shows that the bids were selected judiciously, in the sense that they cover a broad range of the distribution of WTP. Finally, table 11 suggests that the median WTP lies between 3500 and 7000 CZK.

In table 12, we check for patterns in the percentage of "yes" responses by FILL3. We were expecting this percentage to increase with FILL3—the larger the risk reduction, the more one should be willing to pay for it—but the relationship is not monotonic. In retrospect, we suspect that there could be two reasons for this result. First, WTP may be less than proportional to the risk reduction. Second, people may be influenced by the relative risk reduction, and not just by the absolute risk reduction. In future research we will explore these effects.

Table 10. WTP response patterns.

Pattern	Percent of the sample
yes (yes to the initial payment question)	
YY	31.87
YN	24.32
NY	14.99
NN	28.72

Table 11. Number of respondents assigned to initial bid amounts and percentage of yes responses.

	Bid amount (CZK)			
	1500	3500	7000	13000
Number of respondents	235	245	241	233
Percentage of yes	72.34	67.35	47.72	36.91

Table 12. Percentage of yes responses by FILL3 level.

yes FILL3(FILL3)

	1	2	3	4	5	6	7	8	12	Total
yes	47.51	53.01	58.77	61.54	52.63	50.00	61.04	75.00	70.45	
Total	181	166	114	182	114	48	77	28	44	954

Table 13. Goodness of fit for various distributions, double-bounded interval-data model of the responses to the dichotomous-choice payment question and follow-up. N=953 valid observations.

Distribution assumed for VSL	**Log likelihood**	**Parameter 1**	**Parameter 2**
Normal	-1506.78	Mean 27.16 [s.e. 1.57]	Scale 42.98 [s.e. 1.68]
Lognormal	-1325.36	Mu 2.81 [s.e. 0.06]	Sigma 1.63 [s.e. 0.06]
Weibull	-1329.81	Scale 31.42 [s.e. 1.80]	Shape 0.69 [s.e. 0.03]
Exponential	-1382.09	Scale 32.60 [s.e. 1.30]	Shape Restricted to 1

VII. VSL Estimates

To obtain estimates of the willingness to pay for the risk reductions, we combine the responses to the initial and follow-up payment question, and form intervals around the respondent's unobserved WTP amount. To further elaborate on our approach, suppose that a respondent answered "yes" to the initial bid amount of 7000 CZK and was subsequently asked whether he would pay 13000, which he declined to do. We infer that the respondent's WTP falls in the interval between 7000 and 13000 CZK. This respondent's implied VSL, therefore, falls between 7000/FILL3 and 13000/FILL CZK.[12]

Next, we assume that VSL follows a certain distribution in the population, and specify an interval-data model of the responses, which is estimated by the method of maximum likelihood. Formally, assuming that VSL is a random variate with cdf F(y,λ), where λ is the vector of parameters that index the distribution, the log likelihood function of the sample is:

(3) $$\sum_{i=1}^{n} \log\left[F(VSL_{Hi};\lambda - F(VSL_{Li};\lambda)\right],$$

where VSL_{Li} and VSL_{Hi} are the lower and upper bound, respectively, of the interval around the respondent's unobserved VSL amount.

As shown in table 13, we tried different two-parameter distributions for VSL, finding that the lognormal and the Weibull fit the data best. The Weibull model pegs mean VSL at 40.16 million CZK (s.e. 2.73 million CZK). This is equivalent to €1.27 million when the exchange rate is used, and €2.86 million at PPP.[13] Median VSL is 18.52

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[12] This presumes that WTP is proportional to the size of the risk reduction, as economic theory predicts to be the case for small risk changes (Hammitt and Graham, 1999).

[13] The current exchange rate is 31.5 CZK to the euro, and the PPP is 14.03 CZK to the euro.

million CZK (s.e. 1.14 million CZK), which corresponds to €0.58 million at the current exchange rate (1.32 million based on a PPP conversion).[14]

VIII. Interval Validity of the Responses

To test the internal validity of the responses, we run regressions relating VSL to experimental treatment variables and individual characteristics of the respondents. We use an accelerated life model with a Weibull baseline hazard. Formally, this implies that

(4) $$\log VSL_i^* = \mathbf{x}_i \boldsymbol{\beta} + \varepsilon_i ,$$

where VSL* is the unobserved VSL, and **x** is a vector of covariates. The error term is a type I extreme value variate with scale θ. This means that VSL* is a Weibull with scale $\sigma_i = \exp(\mathbf{x}_i \boldsymbol{\beta})$ and shape parameter θ, and that the log likelihood function is:

(5) $$\sum_{i=1}^{n} \log\left[\exp\left(-(VSL_{Li} / \sigma_i)^{\theta}\right) - \exp\left(-(VSL_{Hi} / \sigma_i)^{\theta}\right)\right].$$

Our vector of covariates includes a dummy for the abstract experimental treatment (ABSTRACT), age group dummies, a gender dummy (MALE), an education dummy (COLLEGE), annual household income expressed in thousand CZK (INC), a dummy equal to one if the respondent is married (MARRIED), and continuous variables for household size (HHSIZE) and number of children under the age of 18 (DEPENDENTS). To capture health status, we use a number of dummies denoting whether the respondent has heart disease (CARDIO), high blood pressure (PRESSURE), high cholesterol (CHOLESTEROL), is a diabetic (DIABETES), has a chronic respiratory condition (LUNGS), and has or has had cancer (CANC).

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[14] The lognormal model produces a substantially larger estimate of mean VSL, 60.29 million CZK (s.e. 7.25 million CZK) (€1.90 million, or €4.29 million with a PPP conversion). Median VSL is 16.60 million CZK (s.e. 0.99 million) (€0.53 million at the regular exchange rate, €1.18 with PPP conversion).

The results for this specification of the Weibull accelerated life model are shown in table 14.[15] The table shows that several covariates are significant predictors of the respondent's VSL. All else the same, WTP—and hence the VSL—is about 67% higher among those subjects who were assigned to the abstract risk reduction, but 34% lower for men.

The most striking result, however, is that the VSL declines monotonically with age. The youngest respondents in the sample have the highest VSL values, but by the time one is 70, the VSL is only about 23% of the VSL of respondents in the youngest age group. This finding is comparable to evidence from the Italian study based on the same questionnaire, and is in sharp contrast with Johannesson et al. (1997), and Alberini et al. (2004a).

We do not find any evidence of a statistically significant association between the VSL and the educational attainment of the respondent, but household income is, as predicted by economic theory, positively and significantly associated with a person's WTP, and hence his or her VSL. At the average level of household income in the sample (about 247,500 CZK), the median VSL is 18.30 million CZK (€0.58 at the current exchange rate).

If we raise income to bring it to levels closer to the average household income of Brno (264,000 CZK), the median VSL is 19.32 million CZK (€0.61 million), a 5.6 percent increase, and if we raise it to the average household income of Prague (290,000 CZK), the median VSL is 21 million CZK (€0.66 million), a 15% increase. If we then

[15] City dummies included in the model to account for differences in the cost of living in different cities do not have any further explanatory power for WTP, and are thus excluded from the specification reported in this paper.

further raise household income from 290,000 CZK to 365,000 CZK (a 25% increase) raises the VSL from €0.66 million to €88 million (a 33% increase).

Controls for household size and number of dependent children, however, do not have any additional explanatory power. We find little evidence of an association between the health status dummies and the VSL.[16] The coefficients on most of them, however, are positive, dispelling the notion that people in poor health would be willing to pay less to increase their chance of survival.

IX. Conclusions.

We have conducted a contingent valuation survey in three cities of the Czech Republic to elicit people's WTP for reductions in their risk of dying for cardiovascular and respiratory illnesses. These causes of death are typically associated with heat waves and with environmental exposures (e.g., air pollution).

Our questionnaire, which is self-administered by the respondents using the computer, is virtually identical—except for the language and other minor amendments required for adaptation to the Czech context—to a questionnaire previously developed and administered in Italy (Alberini et al., 2004b). Our study incorporated several experimental treatments in this study.

In this paper, attention is restricted to the immediate risk reduction. We compute the VSL as WTP divided by the size of the risk reduction given to the respondent. We obtain WTP responses that imply a mean VSL of 40.16 million CZK (€1.27 million at the

[16] The likelihood ratio test of the null that the coefficients on the health status dummies are jointly equal to zero is 9.34 (p value=0.16).

current exchange rate, €2.86 million at the PPP), while median VSL is 18.52 million CZK (€0.58 million at the current exchange rate, €1.32 million at the PPP).

VSL is higher among wealthier people, and we calculate the income elasticity of VSL to be about one. A striking result is that the VSL declines dramatically with the age of the respondent. For example, all else the same, a person in his 70s has a VSL that is about only one-quarter than that of a 30-year old. Finally, people that suffer from chronic illness or conditions that could lead to heart diseases are willing to pay no less than the respondents without these ailments.

To our knowledge, this is the first effort to obtain VSL values that could be used directly for valuing the mortality benefits of environmental and climate change policies in an eastern European country that has recently joined the European Union. The approach used in this paper involves a broader population than that studied in Johannesson et al. (1991), and can be compared directly with the results of the companion study in Italy (Alberini et al., 2004b).

Table 14. Weibull interval-data model of VSL

Number of Observations	875
Noncensored Values	0
Right Censored Values	278
Left Censored Values	255
Interval Censored Values	342
Missing Values	79
Name of Distribution	Weibull
Log Likelihood	-1139.264505

Parameter	DF	Estimate	Standard Error	95% Confidence Limits		Chi-Square	Pr > ChiSq
Intercept	1	3.1747	0.1825	2.8170	3.5324	302.61	<.0001
abstract	1	0.5166	0.0994	0.3217	0.7114	26.98	<.0001
male	1	-0.4194	0.1001	-0.6157	-0.2231	17.54	<.0001
age4049	1	-0.6605	0.1406	-0.9360	-0.3849	22.07	<.0001
age5059	1	-0.7447	0.1540	-1.0464	-0.4429	23.39	<.0001
age6069	1	-0.8577	0.1717	-1.1942	-0.5211	24.95	<.0001
ag70plus	1	-1.4688	0.2175	-1.8952	-1.0425	45.59	<.0001
college	1	0.0122	0.1166	-0.2164	0.2407	0.01	0.9169
inc	1	0.0022	0.0005	0.0012	0.0031	20.24	<.0001
HHSIZE	1	0.0079	0.0488	-0.0877	0.1035	0.03	0.8714
dependents	1	0.0470	0.0764	-0.1027	0.1967	0.38	0.5386
cardio	1	0.1222	0.1330	-0.1385	0.3829	0.84	0.3583
lungs	1	0.0656	0.1518	-0.2320	0.3632	0.19	0.6656
pressure	1	-0.1868	0.1396	-0.4604	0.0867	1.79	0.1807
cholesterol	1	0.2288	0.1214	-0.0092	0.4668	3.55	0.0596
diabetes	1	0.0968	0.1158	-0.1301	0.3238	0.70	0.4030
canc	1	0.3451	0.3248	-0.2914	0.9816	1.13	0.2879
Weibull Shape	1	0.8572	0.0373	0.7871	0.9335		

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