WORKING PAPER SERIES

WORKING PAPER NO 2, 2009

Swedish Business School at Örebro University

Sensitivity to scope in contingent valuation

– introducing a flexible community analogy to communicate mortality risk reductions

Björn Sund

Swedish Business School, Örebro University, Sweden

http://www.oru.se/esi/wps

SE-701 82 Örebro
SWEDEN

ISSN 1403-0586

Sensitivity to scope in contingent valuation

– introducing a flexible community analogy to communicate mortality risk reductions

Björn Sund[1]
Swedish Business School, Örebro University, Sweden

Abstract: Validity in contingent valuation (CV) is often tested through the sensitivity of estimated willingness to pay (WTP) to the size or quality of a good or service ('more is better' and near proportionality). We investigate the performance of two communication aids (a flexible community analogy and an array of dots) in valuing mortality risk reductions for out-of-hospital cardiac arrest. Our results do not support the prediction of expected utility theory, i.e. that WTP for a mortality risk reduction increases with the amount of risk reduction (weak scope sensitivity), for any of the communication aids. In fact, the array of dots even shows a decreasing WTP when the risk reduction is larger. We find some evidence that level of education influences how communication aids are perceived. Also, a larger municipal population results in lower WTP which may signal problems with strategic bias.

Keywords: Contingent valuation; Willingness to pay; Validity; Sensitivity to scope; Risk communication; Community analogy; Cardiac arrest

JEL Code: D6, D83, H4, I18

Acknowledgments: I would like to thank Daniela Andrén, Lars Hultkrantz, Lena Nerhagen, Mikael Svensson, Tore Söderqvist and seminar participants at Gothenburg University and Örebro University for helpful comments and Sandra Wallberg and Debbie Axlid for research assistance. Financial support from the Swedish Rescue Services Agency is gratefully acknowledged.

[1] Corresponding address:
bjorn.sund@oru.se
Örebro University, Swedish Business School, SE – 702 82 Örebro, Sweden
Tel: +46 (0) 31-786 52 49

1. Introduction

Ever since contingent valuation (CV) was introduced there has been a debate about its validity. Are the measured preferences 'real' or are they constructed using available heuristics (Bateman & Brouwer, 2006)? In many cases it is obviously difficult to establish whether preferences are 'real' or not. Instead, a common approach is to test whether the CV results are consistent with economic theory. Various tests are conducted, but most attention and criticism of the technique have focused on the problem of scope insensitivity and embedding (Carson et al., 2001).[2] Especially in the case of valuing low-level changes in health risks, bias is often found to be severe. The problems of communicating such risks, i.e. making respondents understand and deal with changes in low-level risks, are substantial and make valuation especially difficult (Loomis & duVair, 1993).

It is inconsistent with neoclassical economic theory if respondents are not willing to pay more for a larger risk-reduction than for a smaller one. Since the results of CV are increasingly used in cost-benefit analysis, on which decision-making is based, it is of great importance that we can trust the quality of the estimated willingness to pay (WTP) values. One important factor for safety and health policy implications is valuation of statistical lives (VSL). Since VSL values are calculated as the ratio of estimated WTP to the marginal risk reduction, it is necessary that WTP is sensitive to changes in risk levels in order to get a robust VSL estimate.

To improve communication of risk changes, a number of tools have been developed. Kunreuther et al. (1978) used a survival curve for newborns and Jones-Lee et al. (1985) used darkened squares on a graph paper containing 100 000 squares in displaying risk of death from transport accidents. Other graphical tools are 'risk ladders' (Mitchell & Carson, 1986; Hammitt, 1986, 1990) and pie charts (Smith & Desvousges, 1987). Carthy et al. (1999) used a chained approach of contingent valuation and standard gamble questions to break the task down into more manageable steps and thereby reduce various biases. Also, different kinds of analogies have been used to represent risks, such as 'probability analogies' (Hammitt &

[2] There exists some terminological confusion in this field, where scope/scale bias, embedding, nesting and part-whole bias are often used synonymously. We adopt the general distinction of Goldberg & Roosen (2007), following Carson & Mitchell (1995), that *scope insensitivity* 'is present when respondents do not sensitively react to the extent of improvements in a single risk to consumer safety but value the risk reduction in general', and *embedding* 'refers to the phenomenon that consumers do not respond adequately to health risk reductions for different diseases or symptoms.'

Graham, 1999) and community risk scales (Calman & Royston, 1997). Although there are many aids for risk communication, only a few studies (e.g. Corso et al., 2001; Loomis & duVair, 1993) have actually compared the performance of different aids in the same context.

In this paper we compare the sensitivity to scope for two different communication aids: (1) an array of 10 000 dots and (2) a 'flexible community analogy'. The array of dots has been shown to be strongly sensitive to the magnitude of risks (Corso et al., 2001) and would therefore be an appropriate benchmark. A flexible community analogy is a modified communication aid that has not been applied before. It uses the characteristics of the community risk scale (Calman & Royston, 1997) and also tries to generalise it in a way that is 'community specific' without having to assume that a certain community is representative for a larger society.

We investigate the performance of these two communication aids in valuing mortality risk reductions for sudden out-of-hospital cardiac arrest (OHCA). OHCA is a condition with a low probability of survival, often below 5 percent, and is one of the most frequent causes of mortality in the Western world (Hollenberg, 2008). Early defibrillation has been shown to improve the survival rate and we use a valuation scenario that contains an increased density of defibrillators in the municipality. In Sweden, it is rare that any group other than health care personnel or ambulance personnel perform defibrillation. Defibrillation in our scenario is explained to be initiated by firemen, policemen, security guards or nurses, and public-access defibrillators may be located in hotels, shopping malls, sports centres or theatres.

The performance of the communication aids is measured through the sensitivity to the size of the risk reduction predicted by standard economic theory: (1) WTP increases with the amount of risk reduction and (2) WTP is approximately proportional to the magnitude of risk reduction. Our results show that these predictions are rejected for both communication aids. In fact, the array of dots even shows a decreasing WTP when the risk reduction is larger. Comparing the results with Corso et al. (2001), the risk context of the valuation survey seems to be important for the performance of the array of dots and it may not be possible to generalise between different health and safety areas. We find some evidence that level of education influences how our communication aids are perceived. Also, a larger municipal population results in lower WTP which may signal problems with strategic bias.

The next section defines scope sensitivity and reviews some empirical background. Section 3 describes the characteristics of the flexible community analogy as well as the administration and structure of the CV survey. The empirical framework is introduced in Section 4 and the results are presented in Section 5. The concluding section includes a discussion of our findings.

2. Previous literature

2.1. Scope sensitivity – definition and tests

Before testing for scope sensitivity, it is important to define what it actually means. A significant difference between WTP estimates for two separate risk reductions is not the same as a reasonable difference. Goldberg and Roosen (2007) formulates two hypotheses of weak and strong scope sensitivity in the following propositions.

Proposition 1. Willingness to pay for a reduction in mortality risk increases with the amount of risk reduction (weak scope sensitivity).

Proposition 2. For small changes in risk, willingness to pay is almost proportional to the mortality risk reductions (strong scope sensitivity).

The theoretical background of these propositions is based on a standard expected utility model of one individual's baseline mortality risk (p) [$0 \leq p \leq 1$] (Jones-Lee, 1974; Corso et al., 2001; Goldberg & Roosen, 2007):

$$EU[p,y] = (1-p)u_a(y) + pu_d(y), \tag{1}$$

where $u_a(y)$ and $u_d(y)$ are the individual's utility as a function of income (y) conditional on staying alive (a) and dying (d).[3] Suppose that the individual is offered an opportunity to reduce the mortality risk by an amount r [$0 \leq r \leq p$] and that he or she is prepared to pay an amount of V that leaves him/her indifferent between the situation before and after the mortality risk reduction:

[3] The model is simplified to only consider a marginal change in the probability of one individual's own death and also within a specified time period.

$$(1-p)u_a(y)+pu_d(y)=(1-p+r)u_a(y-V)+(p-r)u_d(y-V). \qquad (2)$$

We assume the following: (1) survival is preferred to death [$u_a(y) > u_d(y)$], (2) marginal utility of income is non-negative [$u'_i > 0$] and (3) a concave utility function [$u''_i \leq 0$] for i=a,d.[4] Differentiating the right-hand side of equation 2 with respect to V and r respectively gives (Jones-Lee, 1974; Weinstein et al., 1980; Goldberg & Roosen, 2007):

$$\frac{dV}{dr}=\frac{u_a(y-V)-u_d(y-V)}{(1-p+r)u'_a+(p-r)u'_d}>0. \qquad (3)$$

According to this model, WTP for a mortality risk reduction is always positive and increasing, so we have theoretically proven the first proposition of weak scope sensitivity. To decide whether WTP may be assumed to be proportional to the mortality risk reduction (strong scope sensitivity) we differentiate equation 3 (ibid.):

$$\frac{d^2V}{dr^2}=\frac{-2(u'_a-u'_d)(u_a-u_d)+[(p-r)u''_d+(1-p+r)u''_a]\frac{dV}{dr}}{[(1-p+r)u'_a+(p-r)u'_d]^2}. \qquad (4)$$

From equation 4 alone we cannot predict whether WTP for mortality risk reductions is a concave or a convex function without making further assumptions about the sign of u'_a - u'_d (Goldberg & Roosen, 2007). If we assume that the marginal utility of income is non-negative and greater given survival than given death [$u'_a(y) > u'_d(y)$], then Eq. 4 will be concave [$d^2V/dr^2 < 0$] (Jones-Lee, 1974). However, based on empirical evidence it is often suggested that for reductions in small probabilities of death, WTP should be approximately proportionate to the change in probability (Jones-Lee, 1974; Weisman et al., 1980; Hammitt & Graham, 1999). This is what we define as strong scope sensitivity.

In general, a scope sensitivity test can be implemented either internally (within samples) or externally (between samples). An internal test asks the same

[4] $u'_a=\frac{\partial u_a(y-V)}{\partial V}$ and $u'_d=\frac{\partial u_d(y-V)}{\partial V}$.

individuals to value different risk reductions, while the external test splits the sample into several groups that value one level of risk reduction each. Internal scope tests often reject the hypothesis of scope insensitivity (Carson et al., 2001), but evidence of the opposite also exists (e.g. Hammitt & Graham, 1999) and it can be claimed that respondents only are behaving in an internally consistent way. External tests are more robust in this sense, but have shown mixed results. In a review of external tests of CV, Carson (1997) found that between 1984 and 1997 there were 31 studies that demonstrated scope sensitivity, while only 4 did not. However, it should be noted that this review included many surveys unrelated to valuing changes in small probabilities in health risks, which is the area where scope insensitivity seem to be most severe (Carson et al., 2001).

2.2. Empirical background of scope insensitivity and embedding

Historically the problem has been observed ever since the earliest health-related CV studies in the 1970s (e.g., Acton, 1973; Robertson, 1977). However, much of the attention of scope bias and embedding emerged in the beginning of the 1990s with two papers by Kahneman & Knetsch (1992) and Smith (1992). The seminal paper by Kahneman & Knetsch (1992) showed that WTP for a narrowly defined good is almost the same as for a much more comprehensive bundle of goods (where the first good is included). They named this phenomenon 'the embedding effect' and concluded that responses to contingent valuation questions reflect WTP for moral satisfaction and should not be mistaken for the economic value of the public good.

In Desvousges et al. (1993) WTPs for covering oil ponds to prevent (i) 2000, (ii) 20 000 or (iii) 200 000 birds from drowning were roughly the same: (i) \$80, (ii) \$78 and (iii) \$88. The large differences in scope should result in sizeable differences in WTP, casting doubt on the validity of CV. However, Carson et al. (2001) criticised this study for suffering from poor design regarding the sampling procedure (executed in a shopping mall) and the way the magnitude of the risk reduction was described (much less than 1 %, less than 1 % and about 2 % of a population of 8.5 million birds).

These papers and other studies (e.g. Hausman, 1993) influenced the National Oceanic and Atmospheric Administration (NOAA) panel report (Arrow et al., 1993) that recommended the use of a scope test to make CV studies acceptable for assessing natural resource damages. In a sense, NOAA's recommendation institutionalised the use of scope tests as the most important validity test of CV. This view has later been questioned (e.g. Heberlein et al., 2005). At the same time, the recommendation sharpened the incentives to be very clear on the levels of provision of the valued good in CV, and the scope bias was also further scrutinised.

NOAA's emphasis on insensitivity to scope for changes in small probabilities of health risk further triggered the issue of the amount and type of information to be included in a CV study. Both economists and psychologists, among others, have struggled with this issue for many years, since a clearly communicated context helps reduce these biases (e.g. Loomis et al., 1993; Loomis & duVair, 1993). Obstacles to effective risk communication are: '(1) risk information is often highly technical, complex, and uncertain; (2) experts provide widely different risk estimates; (3) regulatory agencies often lack public trust and credibility; (4) there are various ways to define risk; (5) strong beliefs held by the public are resistant to change; and (6) many people have difficulty with probabilistic information' (Loomis & duVair, 1993).

Carson et al. (2001) studied a sample of CV surveys and concluded that: 'Poorly executed survey design and administration procedures appear to be a primary cause of problems in studies not exhibiting sensitivity to scope.' They also listed four design factors that tend to mask sensitivity to scope: (1) vaguely described goods where the descriptions of the goods tend to confuse smaller (part) and larger (whole) goods, (2) questions that emphasise the symbolic nature of the good, (3) questions where the underlying metric on which respondents perceive the larger good is different from that on which respondents perceive the smaller good and (4) differences in the perceived probability of the different goods actually being provided. Although Carson et al. (2001) suggested that most problems with CV can be solved by better design and implementation, they pointed out the area of valuing changes in small probabilities of health risk as the most challenging. However, they saw this field as an active research area in the future and did point to some promising results.

Corso et al. (2001) tested various kinds of visual aids to communicate risk reductions in a better way and found that respondents presented with a logarithmic scale or an array of dots were sensitive to the magnitude of risks (strong scope sensitivity), while respondents presented with a linear scale or no visual aid were not. Another test of different visual aids in the same risk context (Loomis & duVair, 1993) showed that the WTP for three different risk reductions were statistically indifferent regardless of whether the respondents were exposed to a risk ladder or a pie chart. Foster & Mourato (2003) concluded that the choice of elicitation format can influence the sensitivity of scope, after finding that choice experiment (CE) values are more sensitive to scope than contingent valuation (CV) values. Goldberg & Roosen (2007) showed that both CE and CV are scope sensitive for single health risks, but that CV is insensitive to multiple disease risks (embedding).

Olsen et al. (2004) investigated the issue of scope insensitivity in the health care area. Both external (between samples) and internal (within samples) scope tests were performed and the result was that no statistically significant difference in WTP could be detected. They suggested that one possible solution to this problem could be to 'emphasise very strongly the differences in outcomes'. The authors believed that their study was the most systematic scope test on health to date and presented three propositions for further research: (1) a study with larger sample size, (2) tests of the cognitive capacity of the respondents to decide how much information can be included before attention is diverted from the size of the good, and (3) qualitative investigations (focus groups or 'think-aloud' methods) to better understand how preferences are formed.

Heberlein et al. (2005) questioned the routine of making scope tests an important criterion for validity in contingent valuation. The conventional scope test is based on average values and can reveal much more information when studied on an individual basis. By measuring WTP for parts and wholes for four environmental goods and expanding the concept of economic scope to 'attitudinal' and 'behavioural' scope, Heberlein et al. showed that failures to pass a scope test can be explained through psychological and economic theory. They concluded that the scope test as the only test of validity should be questioned and that comparing the mean values can lead to both false positives and false negatives.

3. Method and survey design

Extensive studies have been done on WTP for a stated magnitude of risk reduction, showing both that WTP is sensitive enough (according to economic theory) and that it is less sensitive than expected. We contribute to this literature with a new field (out-of-hospital cardiac arrest, OHCA) and an innovative communication aid to better communicate small risk reductions.

3.1. The flexible community analogy

We have already established that communicating changes in small probabilities of health risks is a challenging task. Cayman & Royston (1997) summarised the ways to present the risk magnitude in an understandable way into visual, analogue and verbal scales. Combinations of the three scales are possible and may even be clarifying. They suggested that a risk scale probably would be efficient if it anchored to something in everyday life, such as the size of human communities.[5] A community risk scale was presented in their study (see Appendix Table A1 for an example), although no test of its performance was made.

Adapted forms of the community risk scale have been used in contingent valuation to overcome scope insensitivity. Corso et al. (2001) included a 'community analogy' in combination with logarithmic and linear scales, with a successful result in the former case. Another adapted form of the 'community analogy' is to select one given area (e.g. city or municipality) for the CV and communicate the specific risk in that area (e.g. Hultkrantz et al., 2006). An indication of proportional sensitivity to scope among the most confident respondents on a self-reported scale was detected in their survey, but the precision of the estimates was too low.

A drawback of choosing one specific area, like a municipality or a city, is that it may be difficult to draw conclusions for a wider area such as a whole nation. For policy purposes, this can be an important factor. Also, administrating a large sample of questionnaires for various sizes of communities, where each questionnaire is 'community specific', is resource demanding. In our 'flexible community analogy' (FCA) we use a table where the respondent can trace his/her municipality, in terms of the size of the community, and follow the marginal risk change in relative frequencies. Therefore, we are able to find a result that can be generalised and also anchored to the respondents' municipality. Table 1 presents an example of our FCA that we used to communicate a risk reduction in mortality due to out-of-hospital cardiac arrest.

[Insert Table 1 here]

[5] Most people are better at dealing with risks when they are presented as relative frequencies instead of as probabilities (Viscusi et al., 1991; Desaigues & Rabl, 1995).

Our visualization of the array of dots, the remaining valuation scenario and WTP questions can be found in the appendix (Table A2).

3.2 Survey administration and structure

We use data from a mail CV survey conducted in June 2007 with one reminder in September of the same year. The questionnaire was sent to 1400 residents aged 18-75 in Sweden and the overall response rate was 43 %.[6,7] Elicitation of WTP was conducted through a discrete-continuous CV format, where both dichotomous choice (DC) and open-ended (OE) questions are asked to the same sample of respondents. Also, a follow-up certainty scale of 1 (very uncertain) to 10 (very certain) is used after both WTP questions. The responses to the OE question and certainty questions are used in our sensitivity analysis of the results. Bid levels for the DC question were determined by a pilot survey from a sample of 100 individuals in May 2007.

Our sample was split into a main sample and a scope test sample for both communication aids (Table 2). Two bid levels close to the expected mean WTP, SEK 500 and SEK 1000, were chosen for the scope test and all bids in all dimensions were assigned 100 residents each in the randomised selection. The general outline of the questionnaire was (1) an introduction, explaining the aims of the study, some facts about cardiac arrest in general as well as local circumstances, and the random sampling procedure (explaining how the respondents were chosen), (2) socio-economic characteristic questions, including a question eliciting the individual baseline risk compared to the average inhabitant and (3) a valuation section.

[Insert Table 2 here]

The valuation scenario is a public programme to increase the survival rate after out-of-hospital cardiac arrests, by increasing the density of defibrillators in the municipality. Defibrillation is explained to be initiated by firemen, policemen, security guards or nurses, and public access defibrillators may be located in hotels, shopping malls, sports centres or theatres. The willingness to pay for an increased survival rate is elicited and the key phrase is: "*The programme will reduce your own and others' risk* [of dying from cardiac arrest] *and the survival rate will be increased*

[6] The population in Sweden was 9 166 604 in September 2007 (Statistics Sweden).

[7] 590 questionnaires were returned. 21 addresses were wrong, so the total sample was actually 1379.

from 5 to 10 percent on average". For the scope sample we use an increased survival rate from 5 to 15 percent. Baseline survival rates are based on Swedish data and increase in the ranges we propose are feasible to achieve, since survival varies markedly among countries and even within countries (Hollenberg et al., 2005).

4. Empirical framework

To parametrically estimate mean and median WTP and study how the observables affect variations in WTP, we chose an exponential probit (lognormal) model.[8] The reason why this model was chosen was because: (1) it restricts WTP to be positive (>0) and (2) it results in the highest value on the likelihood function ('best fit'). The model restricts WTP to be non-negative by using an exponential WTP function:[9]

$$WTP_k = \exp(\beta z_k + \varepsilon_k) \qquad \varepsilon \sim \mathrm{N}(0,\sigma^2), \tag{5}$$

where z_k is a vector of covariates for individual k, β is the corresponding parameter vector and ε_k is the error term. The probability of accepting a certain bid (t_k) is then:

$$P[Yes] = 1 - \Phi\left(\frac{\ln t_k - \beta z_k}{\sigma}\right) = 1 - \Phi(\lambda \ln t_k - \beta^* z_k) \qquad \lambda = 1/\sigma,\ \beta^* = \beta/\sigma \tag{6}$$

and:[10]

$$Median\ WTP = \exp(\beta z_k) = \exp\left(\frac{\beta^* z_k}{\lambda}\right) \tag{7}$$

$$Mean\ WTP = \exp(\beta z_k)\exp\left(\frac{1}{2}\sigma^2\right) = \exp\left(\frac{\beta^* z_k}{\lambda}\right)\exp\left(\frac{1}{2\lambda^2}\right). \tag{8}$$

[8] All data analyses are made in Stata/SE 9.1.

[9] Negative WTP is plausible since we are valuing a public good, but we assume that no one would reject the programme if it was offered for free.

[10] For a constant-only bid function, median WTP is equal to $\exp(-\beta_{constant}/\beta_{logbid})$ and mean WTP is equal to $\exp(0.5\times(1/\beta_{logbid})^2-\beta_{constant}/\beta_{logbid})$. Mean and median WTP for continuous data (OE) are calculated by taking the logs of WTP, performing the calculations of mean/median and then transforming the results back to the original scale.

The median is often chosen instead of the mean of the distribution, since the latter is very sensitive to outliers in the data and to distributional assumptions. For a non-parametric estimate of mean WTP the Spearman-Karber estimator is applied:

$$Mean\ WTP = \overline{WTP} = \sum_{k=1}^{K} \frac{(t_k + t_{k+1})(P_k - P_{k+1})}{2}, \qquad (9)$$

where K is the number of bids, t_k is the bid level and P_k is the observed share of yes-responses at bid level t_k. t_{K+1} is the upper interval, t_0=0, P_0=1 and P_{k+1}=0. To construct a confidence interval we estimate the variance of WTP:

$$\mathrm{var}(WTP) = \sum_{k=0}^{K} \left(t_k - \overline{WTP}\right)^2 \left(P_k - P_{k+1}\right). \qquad (10)$$

The variance of mean WTP is: $\mathrm{var}\left(\overline{WTP}\right) = \mathrm{var}(WTP)/N$, where N is the sample size. Finally, we construct the 95 % confidence interval by:

$$\overline{WTP} \pm 1.96\sqrt{\mathrm{var}\left(\overline{WTP}\right)}. \qquad (11)$$

5. Results

5.1 General results by communication aid

Table 3 presents the mean and standard deviation of the main and scope samples variables for both communication aids. The specifications of the variables can be found in the appendix (Table A3). We can see some absolute differences in means between the sub-samples, but there are not many significant differences (p<0.1). The proportion of females is lower in the main sample for FCA than in the main sample for Dots. Comparing the main samples to the scope samples, we find that the proportion of respondents with low own perceived risk of cardiac arrest is lower in the main sample than in the scope sample (Dots).

[Insert Table 3 here]

The proportions of yes-responses (Table 4) are monotonically decreasing as the bid level increases. The samples can be cross-compared between the main and scope samples. First, the proportions for FCA in the main and scope samples are not statistically different. Second, for the scope sample of Dots, the proportions are *lower* than for the main sample and the differences are statistically significant.[11] This is opposite of what we expect, since the risk reduction is higher for the scope sample. Third, the differences between the main samples of FCA and Dots are largest at bid level SEK 1000, but none of the differences in proportions is significant (chi2-test, p>0.1).

[Insert Table 4 here]

If we construct 95 % confidence intervals for the difference in proportions (main-scope sample) at both bid levels for Dots, they are: -1.4 to 45.4 percent (SEK 500) and -0.9 to 51.8 percent (SEK 1000).

5.2 Mean and median WTP

Using an exponential WTP constant-only bid function with a normally distributed error term we estimate the median WTP of the four samples (Table 5). Median WTP is more robust and, since we only have two bid levels, estimates of the mean WTP are highly unstable. The results seem to imply that the estimated WTPs for the main samples are higher than for the scope samples. This is contrary to our prior beliefs, but consistent with our findings in Section 5.1. By employing the bootstrapping method with 1000 estimations we also derive 95 % confidence intervals. The overall lognormal model for the scope samples are not statistically significant (FCA: LR chi2 2.49, p=0.114; Dots: LR chi2 0.65, p=0.419).[12] This is not very surprising since we have only two bid levels for these samples. Also, the estimates of the confidence intervals are very wide. While the intervals range from SEK ~1000 to 2500 for the main sample, the intervals for the scope sample cover a range from SEK ~0 to 25 000/120 000.

[11] The expression ‘Dots’ is used interchangeably with ‘array of dots’.
[12] A non-significant model implies that the null hypothesis that all of the model parameter estimates are equal to zero cannot be rejected.

[Insert Table 5 here]

However, we can still see that the point estimate of median WTP for the scope sample (Dots) is below the confidence interval of the main sample. We also use non-parametric methods to calculate mean WTP. In this case the Spearman-Karber estimator is calculated with linear interpolation, and the lower/higher endpoints are set to SEK 0/5000. From Table 5 we can see that the estimated WTP is significantly lower for *both* scope samples compared to the main samples.

5.3 Explaining variations in estimated WTP

Table 6 presents the estimated WTP (probability of a yes-answer to the WTP question) by the two compared communication aids and socio-demographic variables of interest in an exponential probit regression. As we have noted earlier, the parameter estimate of scope is significantly lower than zero for Dots (p=0.07). The interpretation of the marginal effect is that the probability of a yes-answer decreases by 15 percent in the case of a *larger* risk reduction when using Dots as the communication aid. No significant difference in scope could be found for FCA.

[Insert Table 6 here]

For the FCA model we can see that stating a self-assessed low risk of suffering from a cardiac arrest decreases WTP. For both FCA and Dots the population size in the municipality does matter: the larger the population, the lower the WTP. The probability of stating a yes decreases by approximately 3 percent per 100 000 inhabitants in a municipality. Age^2 has a positive significant effect on WTP in the Dots model. As expected, we also see a negative effect on the proportion of yes-responses as the (log)bid level increases.

The model for the full sample is also presented in Table 6. We recognise some of the significant variables from the models for the communication aids. Low risk and a larger population both result in lower WTP. The negative effect of the (log)bid level is also comparable to the previous models. Both age and age^2 is negative respectively positive significant, implying a U-shaped relation between age and WTP. What is particularly interesting to see in this model is the non-significant effect of the interaction variable Dots×Scope. The parameter estimate implies that the

WTP for the large risk reduction is 17 percent *lower* than the WTP for the small risk reduction, where both values are for the respondents exposed to Dots, but it is not significant. Since we cannot explain the negative scope sensitivity by differences in communication aids, we continue by analysing interactions with the other variables.

[Insert Table 7 here]

Interaction of the explanatory variables with the scope variable results in some interesting variations. We find significant differences in the parameter estimate of the interaction variable for three variables (all in the Dots sample), indicating that the variations in slopes are different for the respective group (Table 7).[13] Higher educated respondents show a 43 percent lower WTP for the large risk reduction than for the small risk reduction, while the parameter estimates on high education and scope are insignificant. For the low education model, the scope effect is initially -22 percent while conditional on being low educated more than offsets this effect.[14] Interacting the dummy variable for a population over 50 000 individuals with scope results in a negative significant effect (-31 percent).[15] Surprisingly, the parameter estimate for the population is positive (+17 percent).

5.4 Sensitivity analysis using open-ended data and certainty calibration

Since elicitation of WTP was conducted through a discrete-continuous CV format, we have data on both dichotomous choice (DC) and open-ended (OE) distributions. As a sensitivity analysis of our results we estimate the effects of scope for the OE distribution. Table 8 shows estimated mean WTPs, and we can see that the same pattern as before is revealed, i.e. mean WTP for the scope samples are lower than for the main samples. A Student's t-test does not support that the difference in mean WTP is significant for FCA (p=0.273), while the difference in mean WTP for Dots is (p=0.011).[16]

[Insert Table 8 here]

[13] The models in Table 7 are identical to those in Table 6, except for the interaction variables.
[14] The effect of the large risk reduction for low educated respondents is -22+33 percent = 11 percent, which is not significantly different from the small risk reduction.
[15] Other cut-off levels for population was also tested, but came out insignificant.
[16] A non-parametric test (Wilcoxon-Mann-Whitney ranksum test) gives the same results: FCA (p=0.726) and Dots (p=0.041).

What happens if we use OE data to explain variations in estimated WTP? An exponential WTP function gives the somewhat surprising result that the parameter estimate of the scope variable is not significant for Dots (Table 9).[17] Nor is it significant for FCA or the full sample, although we see a positive indication from the effect of the determinant. Neither (1) a Tobit model on WTP, (2) an OLS model on WTP, (3) an OLS model on WTP>0 or (4) an exponential WTP function with WTP=OE+1 shows that the parameter estimate on scope is positive and significant in any of the specifications. However, dropping age^2 as a determinant results in a significant positive parameter estimate on scope for the FCA model (p=0.085), implying that the estimated WTP is *higher* for the scope sample than for the main sample, but this result seems to be a special case.

[Insert Table 9 here]

After both DC and OE valuation questions, we asked the respondents to assess their certainty on a scale from 1 ('very uncertain') to 10 ('very certain'). We tested the probit models from Section 5.3 after certainty calibration of the DC responses in two different treatments: (1) by only using the sub-sample of the completely certain respondents (providing a rating of 10) and (2) by recoding all 'yes' responses as a 'no' if the respondent was not completely certain (the 'asymmetric uncertainty model' by Champ et al., 1997). In both treatments the parameter estimates of the scope variable were not significantly different from zero in any of the models.

6. Discussion

Our study investigates the performance of two communication aids (a flexible community analogy and an array of dots) in valuing mortality risk reductions for out-of-hospital cardiac arrest. The performance is measured through the sensitivity to the size of the risk reduction ('more is better' and near proportionality). Our survey results show that the prediction of expected utility theory, i.e. that WTP for a mortality risk reduction increases with the amount of risk reduction (weak scope

[17] For continuous OE data the exponential WTP function is $\ln WTP_k=\beta z_k+\varepsilon_k$, $var(\varepsilon)=\sigma^2$.

sensitivity), is rejected for both communication aids. In fact, the array of dots even shows a decreasing WTP when the risk reduction is larger.

Although our results are not as expected according to neoclassical theory, they are not unique in this respect (Hammitt & Graham, 1999). Olsen et al. (2004) did not find statistical differences in WTP for different size health effects in either within-sample or between-sample tests. Generally, evidence of scope insensitivity has been found in other areas than health (Beattie et al., 1998; Carthy et al., 1999; Jones-Lee & Loomes, 1995). However, Corso et al. (2001) and Loomis & duVair (1993) found sensitivity to scope using different risk communication aids. Corso et al. (2001) even found evidence of strong scope sensitivity for the array of dots. One difference compared to our study is that they used a double-bounded format when eliciting WTP.[18]

Also, the valued good in their case was a side-impact airbag for cars, which has the characteristics of a private good. The standard expected utility model is based on an individual's trade-off between her own risk and wealth levels. In our survey we consider a public programme that affects the outcome of mortality risks for others as well as for the individual. The empirical evidence is mixed regarding the differences between WTP for a private and a public risk reduction. Most studies of equal risk reductions reveal a higher WTP for a private safety good than for a public safety good (e.g. deBlaeij et al., 2003; Hultkrantz et al., 2006), but the reverse relation has also been found (Arãna & León, 2002). A number of explanations for this discrepancy are plausible, e.g. altruism, strategic bias ('free-riding'), attitudes towards the provider and uncertainty of provision. Whether these effects influence the sensitivity of scope in our public WTP programme is not clear, but plausible.

One possible indication of strategic bias is that our parameter estimate of the population size is significant and negative. Common explanations for free-riding are altruism (e.g. Becker, 1974), warm-glow (e.g. Andreoni, 1989, 1990), conditional cooperation (e.g. Fischbacher et al., 2001), reciprocity (e.g. Sugden, 1984) and the fact that people make errors (e.g. Anderson et al., 1998). Most subjects in public goods games, except for a few unconditional cooperators, are only willing to contribute if they expect others to contribute as well (e.g. Sugden, 1984; Fischbacher

[18] When estimating a single-bounded dichotomous choice model, by only using the responses to the first dichotomous choice question, the authors could also reject the hypothesis that WTP was insensitive to scope for the array of dots.

et al., 2001; Gächter et al., 2003). Gächter (2006) argued that conditional cooperation is a primary motivation for many people to contribute (or not) to the public good. This allows us to speculate that the lower WTP for our public goods programme in larger populations and the sensitivity to scope may have something to do with conditional cooperation.

Another explanation for scope insensitivity in health risks is that the often small changes in probabilities are only perceived as 'very small numbers' (Beattie et al., 1998). By using the flexible community analogy (FCA) as a communication aid we present the particular number of mortalities in given populations. Also the hypothesised survival rate is chosen to be perceived as significant (from 5 percent to 10/15 percent). Although improvements in survival rates are plausible (Hollenberg, 2008), we are not sure whether the respondents believe they are. If so, our survey may be exposed to some form of scenario rejection, and the 15 percent version then carries a higher risk of being rejected.

Although we have tried to keep all factors constant between the two communication aids, there are some potentially important differences. One is that the table in the FCA alone displays both the risk level and the risk change at the same time, while the array of dots only displays the risk level. Combined with the text the array of dots is assumed to present the same information that the FCA does, but we do not know for sure if this is how it is perceived by the respondents. Also, if an individual primarily care about the *number* of lives saved the information in the FCA may be clearer to him/her than in the array of dots, where we present the numbers of a 10 000 individual's municipality. It is possible that the projection of the risk to the individuals own, larger, municipality in numbers is underestimated. These differences may increase scope sensitivity for the FCA.

Beattie et al. (1998) conclude that the reason for scope insensitivity seems to depend on the risk reference: (1) using changes in small probabilities results in respondents being unable, or unwilling, to discriminate between the levels and (2) using relative frequencies, i.e. a particular number of mortalities in a given population, results in respondents purchasing 'moral satisfaction' for the good, without concern for the quantity of the good (Kahneman & Knetsch, 1992). The problem of 'moral satisfaction' seems to be especially severe regarding public goods and some respondents construct 'mental accounts' for 'good things' in the range of £50-£200 per year (Beattie et al., 1998). While we may experience this phenomenon in our survey, it does not explain why our scope sample for the array of dots shows lower estimated mean WTP.

However, despite the lack of scope sensitivity, our results point at some interesting circumstances. The level of education is found to be an important determinant of scope sensitivity when using the array of dots as a communication aid. Having high education reduces estimated WTP by 43 percent for the large risk reduction, while having low education actually offsets the negative scope sensitivity. In our case the high educated individuals respond to the magnitude of the risk reduction in a way we would not expect. Andersson & Svensson (2008) found that respondents with higher cognitive ability are less flawed by scope bias in an experimental study. In our study we find a relation between education level/cognitive ability and scope sensitivity that seems to be the other way around. An interesting correlation for further research does emerge.

We have to notice that sensitivity to scope is *one* test of the validity of CV. There are other ways to evaluate the performance of the two communication aids. In our data analysis we find indications of 'well-behaved' respondent behavior, e.g. the proportion of yes-responses decreases with the bid level and low own perceived risk of cardiac arrest results in lower WTP. Since much weight in judging the validity for CV is awarded the scope test we should give it attention, but maybe not as the only test. Lately the scope test has been criticized as a criterion for validity in CV (Heberlein, 2005).

The use of two bid levels is a factor of uncertainty for our results in general, but we arrive at negative scope sensitivity for open-ended WTP as well. The mean/median WTP values of our models give information on the total value of a statistical life (VSL) regarding out-of-hospital cardiac arrest. For the main sample the VSL is SEK 39 million (DC) for FCA and SEK 44 million (DC) for the array of dots.[19] The difference in means is not statistically different. For our scope samples the VSL is SEK 18 million (FCA) and SEK 13 million (Dots),[20] which is lower and can potentially make a difference for policy purposes in e.g. cost-benefit analysis.[21] For

[19] In this case we use the median WTP (DC) and divide by the marginal risk reduction (Δp=3.35/100 000).
[20] Δp=6.7/100 000
[21] Non-parametric (Spearman-Karber) mean WTP gives VSL estimates of SEK 65 million (both FCA and array of dots) for the main sample and SEK 28 million (FCA)/SEK 24 million (Dots) for the scope sample. Open-ended mean WTP results in VSL estimates of SEK 28 million (FCA)/SEK 30 million (Dots) for the main sample and SEK 11 million (FCA)/SEK 8 million (Dots) for the scope sample.

now we trust the VSL estimates of the main sample more, especially since we only use two bid levels in the scope sample.

To summarise, valuing changes in small probabilities of health risk continues to be a challenging and difficult task. We tested two communication aids and found that neither of them showed sensitivity to scope. In fact, the array of dots, which previously has performed well in this respect, even showed negative sensitivity to scope. The risk context of the valuation survey seems to be important for the performance of the array of dots and it may not be possible to generalise between different health and safety areas. In the context of out-of-hospital cardiac arrest, our flexible community analogy is preferable to the array of dots, even though neither worked quite satisfactory according to expected utility theory. We find some evidence that level of education influences how different communication aids are perceived. The fact that a larger municipal population results in lower WTP may signal problems with strategic bias.

References

Acton, J., (1973). Evaluating public programs to save lives: The case of heart attacks. R-950-RC. RAND, Santa Monica.

Anderson, S.P., Goeree, J.K. &Holt, C., (1998). A theoretical analysis of altruism and decision error in public goods games. Journal of Public Economics 70, 297–323.

Andersson, Henrik & Svensson, Mikael, (2008). Cognitive ability and scale bias in the contingent valuation method. An analysis of willingness to pay to reduce mortality risk. Environmental and Resource Economics (2008) 39: 481-495.

Andreoni, James, (1989). Giving with impure altruism: Applications to charity and ricardian equivalence. Journal of Political Economy, 1989, vol. 97, pp.1447-1458.

Andreoni, James, (1990). Impure altruism and donations to public goods: A theory of warm-glow giving. Economic Journal, 1990, vol. 100, pp. 464-477.

Arãna, J.E. & León, C.J., (2002). Willingness to pay for health risk reduction in the context of altruism. Health Economics, 11(7), 623-635.

Arrow K., Solow R., Leamer, E., Radner, R. & Schuman H., (1993). Report of the NOAA panel on contingent valuation. Federal Register 58, 4601-4614.

Bateman, Ian J. & Brouwer, Roy, (2006). Consistency and construction in stated WTP for health risk reductions: A novel scope-sensitivity test. Resource and Energy Economics 28 (2006), 199-214.

Beattie, Jane, Covey, Judith, Dolan, Paul, Hopkins, Lorraine, Jones-Lee, Michael, Loomes, Graham, Pidgeon, Nick, Robinson, Angela & Spencer, Anne, (1998). On the contingent valuation of safety and the safety of contingent valuation: Part 1: caveat investigator. Journal of Risk and Uncertainty, 17:5-25.

Becker, Gary, (1974). A theory of social interactions. Journal of Political Economy, 1974, vol. 82, pp. 1063-1093.

De Blaeij, Arianne, Florax, Raymond J.G.M., Rietveld, Piet & Verhoef, Erik, (2003). The value of statistical life in road safety: a meta-analysis. Accident Analysis and Prevention 35 (2003): 973-986.

Calman, Sir Kenneth C. & Royston, Geoff, (1997). Risk language and dialects. British Medical Journal 1997, 315, 939-942.

Carson, Richard T., (1997). Contingent valuation surveys and tests of insensitivity to scope. In R.J. Kopp, W. Pommerhene and N. Schwartz, eds. Determining the value of non-marketed goods: Economic, psychological, and policy relevant aspects of contingent valuation methods. Boston: Kluwer, pp. 127-163.

Carson, Richard T., Flores, Nicholas E. & Meade, Norman F., (2001). Contingent valuation: Controversies and evidence. Environmental and Resource Economics 19: 173-210, 2001.

Carson, Richard T. & Mitchell, Robert Cameron, (1995). Sequencing and nesting in contingent valuation surveys. Journal of Environmental Economics and Management, 28(2), 155-173.

Carthy, T., Chilton, S., Covey, J., Hopkins, L., Jones-Lee, M., Loomes, G., Pidgeon, N. & Spencer, A., (1999). On the contingent valuation of safety and the safety of contingent valuation: Part 2 – The CV/SG "chained" approach. Journal of Risk and Uncertainty, 17 (3), 187-213.

Champ, P.A., Bishop, R.C., Brown, T.C. & McCollum, D.W., (1997). Using donation mechanism to value nonuse benefits from public goods. Journal of Environmental Economics and Management 33, 151-162.

Corso, Phaedra S., Hammitt, James K. & Graham, John D., (2001). Valuing mortality risk-reduction: Using visual aids to improve the validity of contingent valuation. Journal of Risk and Uncertainty, 23:2, 165-184.

Desaigues, B. & Rabl, A., (1995). Reference values for human lives: An econometric analysis of a contingent valuation in France. In Schwab Christe, N.G., and Soguel, N.C. (eds.). Contingent valuation, transport safety and the value of life, Boston, Kluwer.

Desvousges, W.H., Johnson, F.R., Dunford, R.W., Boyle, K.J., Hudson, S.P. & Wilson, K.N., (1993). Measuring natural resource damages with contingent valuation: Test of validity and reliability. In J.A. Hausman , ed., *Contingent valuation: A critical assessment*. Amsterdam: North-Holland, pp. 91-164.

Fischbacher, Urs, Gächter, Simon & Fehr, Ernst, (2001). Are people conditionally cooperative? Evidence from a public goods experiment. Economic Letters 71 (2001) 397-404.

Foster, Vivien & Mourato, Susana, (2003). Elicitation format and sensitivity to scope. Do contingent valuation and choice experiments give the same results? Environmental and Resource Economics, 24: 141-160, 2003.

Goldberg, Isabell & Roosen, Jutta, (2007). Scope insensitivity in health risk reduction studies: A comparison of choice experiments and the contingent valuation method for valuing safer food. Journal of Risk and Uncertainty (2007) 34: 123-144.

Gächter, Simon, Herrmann, Benedikt & Thöni, Christian, (2003). Understanding determinants of social capital: cooperation and informal sanctions in a cross-societal perspective. Mimeo, University of St. Gallen.

Gächter, Simon, (2006). Conditional cooperation: Behavioural regularities from the lab and the field and their policy implications. The University of Nottingham. CeDEx Discussion Paper no. 2006-03.

Hammitt, J.K., (1986). Estimating consumer willingness to pay to reduce food-borne risk. R-3447-EPA, Santa Monica, CA: RAND Corporation.

Hammitt, J.K., (1990). Risk perception and food choice: An exploratory analysis of organic- versus conventional-produce buyers. Risk Analysis, 10, 367-374.

Hammitt, J.K. & Graham, J.D., (1999). Willingness to pay for health protection: Inadequate sensitivity to probability? Journal of Risk and Uncertainty, 18, 33-62.

Hanemann, W.M., (1984). Welfare evaluations in contingent valuation experiments with discrete responders. American Journal of Agricultural Economics, 66, 332-341.

Hausman, J., ed. (1993). Contingent valuation: A critical assessment. Amsterdam: North-Holland.

Heberlein, T.A., Wilson, M.A., Bishop, R.C. & Schaeffer, N.C., (2005). Rethinking the scope test as a criterion for validity in contingent valuation. Journal of Environmental Economics and Management 50 (2005), 1-22.

Hollenberg, J., Bång, A., Lindqvist, J., Herlitz, J., Nordlander, R., Svensson, L. & Rosenqvist, M., (2005). Difference in survival after out-of-hospital cardiac arrest between the two largest cities in Sweden: a matter of time? Journal of Internal Medicine 2005; 257; 247-254.

Hultkrantz, Lars, Lindberg, Gunnar & Andersson, Camilla, (2006). The value of improved road safety. Journal of Risk and Uncertainty (2006) 32: 151-170.

Jones-Lee, Michael, (1974). The value of changes in the probability of death and injury. Journal of Political Economy, 82(4), 835-849.

Jones-Lee, M.W., Hammerton, M. & Phillips, P.R., (1985). The value of safety: Results of a national survey. Economic Journal, 95, 49-72.

Jones-Lee, M.W. & Loomes, G., (1995). Scale and context effects in the valuation of transport safety. Journal of Risk and Uncertainty, 11:183-203 (1995).

Kahneman, D. & Knetsch, J.L., (1992). Valuing public goods: The purchase of moral satisfaction. Journal of Environmental Economics and Management 22, 57-70.

Kunreuther, H., Ginsberg, R., Miller, L., Sagi, P., Slovic, P., Borkan, B. & Katz, N., (1978). Disaster insurance protection: Public policy lessons. New York: John Wiley and Sons.

Loomis, John, Lockwood, Michael & DeLacy, Terry, (1993). Some empirical evidence of embedding effects on contingent valuation of forest protection. Journal of Environmental Economics and Management 25 (1), 45-55.

Loomis, John B. & duVair, Pierre H., (1993). Evaluating the effect of alternative risk communication devices on willingness to pay: Results from a dichotomous choice contingent valuation experiment. Land Economics, August 1993, 69 (3), 287-98.

Mitchell, R.C. & Carson, R.T., (1986). Valuing drinking water risk reductions using the contingent valuation method: A methodological study of risks from THM and Giardia. Draft report to the U.S. Environmental Protection Agency, Washington, DC.

Olsen, Jan Abel, Donaldson, Cam & Pereira, João, (2004). The insensitivity of ‘willingness-to-pay’ to the size of the good: New evidence for health care. Journal of Economic Psychology, 25 (2004), 445-460.

Robertson, L.S., (1977). Car crashes: Perceived vulnerability and willingness to pay for crash protection. Journal of Community Health 3, 136-141.

Smith, V.K., (1992). Arbitrary values, good causes, and premature verdicts. Journal of Environmental Economics and Management 22, 71-89.

Smith, V.K. & Desvousges, W.H., (1987). An empirical analysis of the economic value of risk changes. Journal of Political Economy, 95, 89-114.

Sugden, Robert, (1984). Reciprocity: The supply of public goods through voluntary contributions. Economic Journal, 1984, vol. 94, pp. 772-787.

Viscusi, W.K., Magat, W.A. & Huber, J., (1991). Pricing environmental health risks: Survey assessments of risk-risk and risk-dollar trade-offs for chronic bronchitis. Journal of Environmental Economics and Management, 21, 32-51.

Weinstein, Milton C., Shepard, Donald S. & Pliskin, Joseph S., (1980). The economic value of changing mortality probabilities: A decision-theoretic approach. Quarterly Journal of Economics, 94(2), 373-396.

Tables

Table 1. The flexible community analogy (including information)

What is the effect of the programme?

The programme will result in **your own risk as well as the risk of all other individuals** in your municipality being reduced, and **the survival rate will increase from 5 % to 10 % on average**. In the table the effect of the programme for various municipality sizes are presented.

Observe that the table represents effects over 10 years!

10 000	70	3	7	+4
20 000	130	6	13	+7
30 000	200	10	20	+10
50 000	330	16	33	+17
75 000	500	25	50	+25
100 000	670	33	67	+34
150 000	1000	50	100	+50
250 000	1670	83	167	+84
500 000	3350	167	335	+168
750 000	5020	251	502	+251

Example from the table: In a municipality of 10 000 individuals, 70 persons will suffer from out-of-hospital cardiac arrest during a 10 year period on average. Now 3 persons will survive and after the programme 7 persons will survive, which implies an increase of 4 persons over 10 years.

Table 2. Sub-samples of the survey

	Communication aid	*Sample*	*Magnitude of risk reduction*	*Bid levels**	*Number of questionnaires*
1	Flexible community analogy	Main sample	From 5 % to 10 % survivors per year	All levels	500 (100 per bid)
2	Flexible community analogy	Scope test sample	From 5 % to 15 % survivors per year	SEK 500 and 1,000	200
3	Array of dots	Main sample	From 5 % to 10 % survivors per year	All levels	500
4	Array of dots	Scope test sample	From 5 % to 15 % survivors per year	SEK 500 and 1,000	200

Notes: **Bid levels are SEK 200, 500, 1000, 2000, 5000.*

Table 3. Mean and standard deviation (in parentheses) of the variables

Variable	*Main sample (FCA)*	*Scope sample (FCA)*	*Main sample (Dots)*	*Scope sample (Dots)*
Number of returned questionnaires*	175	68	158	66
Gender (1=female)	0.46	0.49	0.55**	0.50
	(0.50)	(0.50)	(0.50)	(0.50)
Age (18-75)	47.5	46.9	49.2	48.0
	(15.1)	(16.9)	(15.4)	(15.3)
High education	0.47	0.49	0.41	0.32
	(0.50)	(0.50)	(0.49)	(0.47)
Low education	0.16	0.12	0.20	0.17
	(0.37)	(0.33)	(0.40)	(0.38)
High risk	0.13	0.10	0.19	0.16
	(0.33)	(0.31)	(0.39)	(0.37)
Low risk	0.40	0.44	0.42	0.61***
	(0.49)	(0.50)	(0.49)	(0.49)
Income[22]	19 139	21 262	19 315	17 828
	(10 204)	(13 878)	(11 829)	(8 782)
Population	139 644	137 489	156 458	163 162
	(221 611)	(217 726)	(234 416)	(265 563)
Heart	0.11	0.07	0.11	0.12
	(0.31)	(0.26)	(0.32)	(0.33)

Notes: **=totally blank questionnaires, WTP>0.05×Income and inconsistent respondents are not included.[23] The number of respondents in these three groups is 45+12+54=111. **=statistically significant from proportion of main sample FCA (chi2-test, p=0.09). ***=statistically significant from proportion of main sample (chi2-test, p=0.01).*

Table 4. Proportions of yes-responses (in percent) at different bid levels

Bid level (SEK)	*Main sample (FCA)*	*Scope sample (FCA)*	*Main sample (Dots)*	*Scope sample (Dots)*
200	84.1 (n=44)		87.1 (n=31)	
500	73.0 (n=37)	73.7 (n=38)	78.8 (n=33)	58.3* (n=36)
1000	58.8 (n=34)	55.2 (n=29)	70.3 (n=37)	48.3* (n=29)
2000	44.8 (n=29)		39.1 (n=23)	
5000	16.7 (n=30)		15.6 (n=32)	

Notes: *n=number of respondents. *=statistically significant from proportion of main sample (chi2-test, SEK 500: p=0.069, SEK 1000: p=0.070).*

[22] We are aware that it is theoretically problematic to include income as an independent variable in the WTP regression for DC questions, since utility is assumed to be linear in income (Hanemann, 1984). However, we do not interpret income as 'income per se' but instead as a proxy for household characteristics and focus on the empirical relationship.

[23] An inconsistent respondent answered yes (no) to the DC bid and then gave an OE answer that was lower (higher) than the bid.

Table 5. Estimated WTP (in SEK) for each communication aid, main and scope sample

	Main sample (FCA)	*Scope sample (FCA)*	*Main sample (Dots)*	*Scope sample (Dots)*
Lognormal model				
Median WTP	1308	1196	1482	889
95 % CI (median)	1085 - 2558	9 – 120 275	1061 - 2130	80 – 25 321
Spearman-Karber				
Mean WTP S-K	2190	1860	2176	1628
95 % CI (mean S-K)	2085 – 2295	1764 – 1956	1911 – 2441	1338 – 1918
n	174	67	156	65

Notes: *n=number of respondents.*

Table 6. Estimated WTP by communication aid, marginal effects (exponential probit model)

Variable	*FCA*	*Dots*	*Full sample*
Gender	0.080	0.092	0.077
	(0.257)	(0.229)	(0.136)
Age (10 years)	-0.16	-0.21	-0.17*
	(0.238)	(0.176)	(0.093)
Age^2 (10 years)	0.0016	0.0027*	0.0020*
	(0.288)	(0.096)	(0.069)
High education	-0.082	-0.064	-0.059
	(0.303)	(0.490)	(0.307)
Low education	-0.092	-0.017	-0.059
	(0.461)	(0.874)	(0.467)
High risk	-0.023	-0.11	-0.062
	(0.858)	(0.380)	(0.471)
Low risk	-0.15*	-0.098	-0.12**
	(0.054)	(0.297)	(0.035)
Income (SEK 10 000)	-0.014	0.078*	0.025
	(0.679)	(0.069)	(0.361)
Population (in 100 000)	-0.027*	-0.031**	-0.025**
	(0.073)	(0.049)	(0.014)
Heart	-0.043	0.052	0.021
	(0.737)	(0.714)	(0.819)
logbid	-0.23***	-0.30***	-0.27***
	(0.000)	(0.000)	(0.000)
Scope	0.030	-0.15*	0.017
	(0.685)	(0.074)	(0.833)
Dots			0.037
			(0.552)
Dots×Scope			-0.17
			(0.129)
Log-likelihood	-120.82	-109.03	-234.62
n	220	206	426
Pr(yes) predicted	0.66	0.60	0.62

Notes: *Significant for α = 0.01***, α = 0.05**, α = 0.10*, based on robust standard errors, p-values in parentheses.*

Table 7. Interacting scope sensitivity with explanatory variables, marginal effects (exponential probit model)

Interaction variable	*Sample*	*Interaction variable*	*Scope*	*Interaction variable×Scope*
High education	FCA	-0.092	0.011	0.037
		(0.316)	(0.914)	(0.804)
	Dots	0.060	0.0094	-0.43***
		(0.566)	(0.929)	(0.001)
	Full	-0.019	-0.012	-0.12
		(0.772)	(0.879)	(0.274)
Low education	FCA	-0.012	0.069	-0.29
		(0.930)	(0.391)	(0.182)
	Dots	-0.13	-0.22**	0.33***
		(0.313)	(0.015)	(0.004)
	Full	-0.081	-0.079	0.080
		(0.377)	(0.194)	(0.589)
Population>50 000	FCA	-0.11	-0.063	0.17
		(0.181)	(0.584)	(0.179)
	Dots	0.17*	0.017	-0.31**
		(0.071)	(0.893)	(0.043)
	Full	0.021	-0.042	-0.034
		(0.741)	(0.614)	(0.756)

Notes: *Significant for α = 0.01***, α = 0.05**, α = 0.10*, based on robust standard errors, p-values in parentheses.*

Table 8. Estimated WTP (in SEK) for each communication aid, open-ended data

	Main sample (FCA)	*Scope sample (FCA)*	*Main sample (Dots)*	*Scope sample (Dots)*
Mean WTP	931	758	1016	543
95 % CI (mean)	745 – 1117	585 - 931	777 – 1254	434 – 652
n	158	65	135	60

Notes: *n=number of respondents.*

Table 9. Estimated WTP by communication aid, open-ended data (exponential probit model)

Variable	*FCA*	*Dots*	*Full sample*
Constant	8.25***	5.79***	7.09***
	(0.000)	(0.000)	(0.000)
Gender	0.086	0.049	0.081
	(0.553)	(0.706)	(0.423)
Age (10 years)	-0.99***	-0.12	-0.57***
	(0.000)	(0.664)	(0.003)
Age^2 (10 years)	0.011***	0.0027	0.0069***
	(0.000)	(0.353)	(0.001)
High education	0.088	-0.057	0.061
	(0.616)	(0.707)	(0.607)
Low education	-0.58**	-0.018	-0.29**
	(0.011)	(0.918)	(0.047)
High risk	0.15	0.088	0.063
	(0.530)	(0.675)	(0.663)
Low risk	-0.58***	-0.20	-0.41***
	(0.002)	(0.218)	(0.001)
Income (SEK 10 000)	-0.012	0.13**	0.063
	(0.890)	(0.029)	(0.256)
Population (in 100 000)	-0.0011	0.042	0.0097
	(0.973)	(0.132)	(0.647)
Heart	0.12	0.040	0.031
	(0.499)	(0.866)	(0.812)
Bid (SEK 1000)	0.24***	0.19***	0.20***
	(0.000)	(0.000)	(0.000)
Scope	0.21	0.000047	0.21
	(0.174)	(1.000)	(0.169)
Dots			0.030
			(0.822)
Dots×Scope			-0.17
			(0.411)
R-squared	0.216	0.243	0.188
n	181	167	348

Notes: *Significant for α = 0.01***, α = 0.05**, α = 0.10*, based on robust standard errors, p-values in parentheses.*

Appendix

Table A1. A community risk scale by Calman & Royston (1997)

Risk	*Risk magnitude*	*Risk description (unit in which one adverse event would be expected)*	*Example (based on no. of deaths in Britain per year)*
1 in 1	10	Person	
1 in 10	9	Family	
1 in 100	8	Street	Any cause
1 in 1000	7	Village	Any cause, age 40
1 in 10 000	6	Small town	Road accident
1 in 100 000	5	Large town	Murder
1 in 1 000 000	4	City	Oral contraceptives
1 in 10 000 000	3	Province or country	Lightning
1 in 100 000 000	2	Large country	Measles
1 in 1 000 000 000	1	Continent	
1 in 10 000 000 000	0	World	

Table A2. The valuation scenario and WTP questions (translated from Swedish)

1. Valuation scenario: for FCA and array of dots questionnaires both

A number of individuals suffer from cardiac arrests each year in your municipality. Imagine that there exists a possibility to **reduce mortality risks** for cardiac arrests. We will ask you about your willingness to pay for such measures. Please consider that the money you are willing to pay for the increased safety will reduce your possibilities for other consumption.

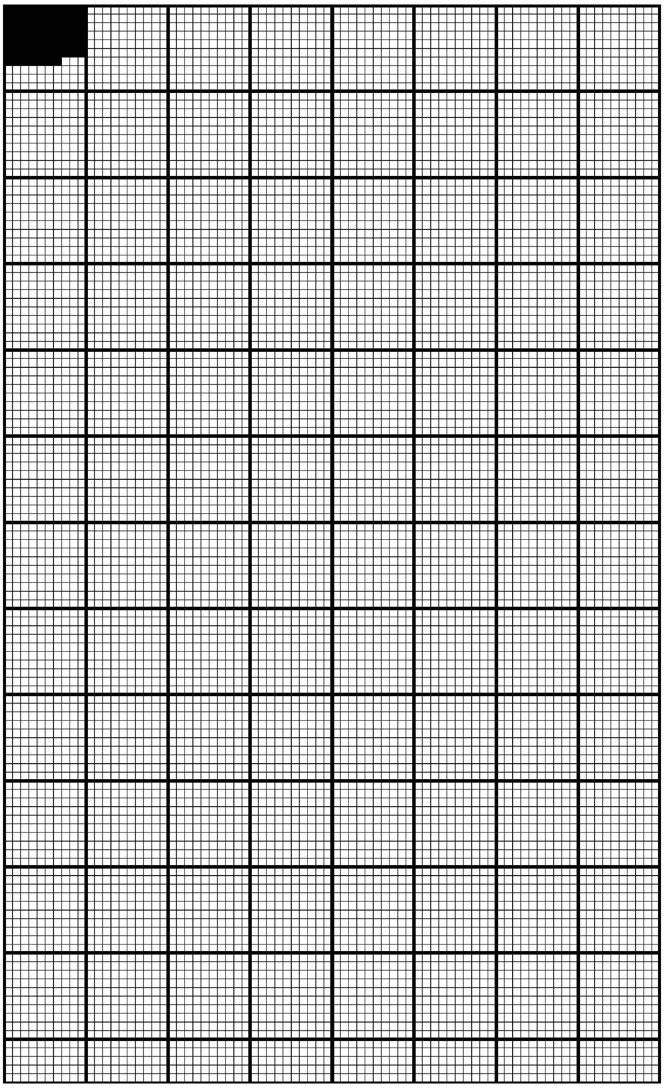
To reduce the mortality risk a public programme to increase the density of defibrillators is considered. One possibility is to equip and educate employees within certain professions in the municipality which may respond faster than the ambulance. These professions might be firemen, policemen, security guards or nurses. Public access defibrillators may also be located in hotels, shopping malls, sports centres or theatres.

A prerequisite for the programme to be implemented is that at least 50 % of the individuals in your municipality are positive to the introduction of the programme. The cost is paid as an annual fee. If not enough individuals will help with the fee, the programme will not be introduced.

2.1 Valuation scenario continued: for FCA

See Table 1

2.2 Valuation scenario continued: for the array of dots



A total of 10 000 squares in the array.

The black squares symbolise the number of out-of-hospital cardiac arrests over 10 years.

What is the effect of the programme?
The programme will result in **your own risk as well as the risk of all other individuals in your municipality** being reduced, and the **survival rate will increase from 5 % to 10 % on average**.

What does this really mean? Imagine that we have a society with 10 000 individuals, which is comparable to a small municipality like e.g. Vaxholm, Sävsjö, Vårgårda, Surahammar, Rättvik, Åre or Haparanda. Above you can see an array where every individual is represented by one square and the larger squares represent 100 individuals.

The risk of suffering from an out-of-hospital cardiac arrest **over a 10 year period** is 67 per 10 000 individuals. This risk is represented in the array by the 67 blackened squares.

Please observe that the risk is represented over a 10 year period!

The programme will lead to a decreased risk of dying for these 67 individuals. Today, the survival rate is 5 % on average, which implies that 3 persons will survive. After the programme the survival rate will increase to 10 % on average, which implies that 7 persons will survive.

Summary:

** In a municipality with 10 000 individuals, 67 persons will suffer from out-of-hospital cardiac arrest over a 10 year period on average. Of these, 3 persons will survive.*

** If the programme is conducted, then 7 persons will survive, which implies an increase of 4 persons over 10 years.*

3. The WTP questions: for FCA and array of dots questionnaires both

Question 10. How would you vote if your personal fee was SEK 200 **per year** (i.e total SEK 2000 for 10 years), for this programme to be implemented in your municipality?

I would vote: □ Yes □ No

Question 11. How confident are you in your answer to the above question, where 1 is very uncertain and 10 is very certain? Circle your answer.

1 2 3 4 5 6 7 8 9 10

very uncertain ... *very certain*

Question 12. Provided that the programme is carried out, how much would you most be willing to pay **annually** for the implementation of the programme that reduces your own risk as well as the risk of all other individuals in your municipality for cardiac arrest mortality?

Answer: ……………SEK per year

Question 13. Same as question 11.

Table A3. Specifications of the variables

Variable	*Characteristics*
Gender	Unit dummy variable for gender of the respondent, one if female
Age	Age of respondent, between 18-75
High education	Unit dummy variable if education level is at least one term at a university; zero otherwise
Low education	Unit dummy variable if education level is at most nine-year compulsory school; zero otherwise
High risk	Unit dummy variable if the own perceived risk of cardiac arrest is higher than average; zero otherwise
Low risk	Unit dummy variable if the own perceived risk of cardiac arrest is lower than average; zero otherwise
Income	The income per consumption unit given by the total household income* divided by the number of household members weighed as follows: adult person # 1 = 1.16, adult person # 2 = 0.76, children 0-3 years old = 0.56, children 4-10 years old = 0.66 and children 11-17 years old = 0.76
Population	Number of inhabitants (self assessed by respondents) in the municipality
Heart	Unit dummy variable if the respondent have suffered from heart disease; zero otherwise
Aid	Unit dummy variable if communication aid is an array of dots; zero if 'flexible community analogy'
Bid	The predetermined bid level: SEK 200, 500, 1000, 2000 or 5000
Scope	Unit dummy variable for a larger risk reduction

** The respondents were asked to mark an interval with a range of SEK 4999. The income was then approximated by using the mid value of the interval.*