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Cost of Illness and Contingent Valuation : Controlling for the Motivations of Expressed Preferences in an Attempt to Avoid Double-Counting

Résumé

Cette contribution traite de la problématique du double-compte des impacts sur la santé humaine dans le cadre de l'évaluation du coût de la maladie. Un double-compte surgit lorsque des estimations sont utilisées conjointement, alors qu'elles sont issues de méthodes de monétarisation qui se recoupent partiellement. Afin d'y remédier, nous proposons de restreindre le champ d'investigation de chaque méthode à un domaine spécifique d'impacts. De manière à appliquer la méthode d l'évaluation contingente exclusivement à la monétarisation des coût intangibles, nous suggérons une approche en trois temps : (1) laisser les personnes interrogées libre d'évaluer les conséquences auxquelles elles sont sensibles, (2) obtenir de ces personnes des explications sur ce qui motive leur réponse, (3) contrôler l'influence de ces motivations sur leurs évaluations. Cette procédure a été appiquée

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lors d'une évaluation contingente menée en Suisse. Un traitement économétrique a été utilisé afin de limiter la portée des estimations contingentes aux seules intangibles, permettant ainsi de combiner les méthodes de monétarisation tout en réduisant au maximum le risque de double-compte et de surestimation.

mots clés : coût de la maladie, coûts intangibles, méthode de l'évaluation contingente, double-compte

Summary

This paper addresses the issue of double counting of health impacts in the context of cost of illness valuation. Double counting occurs when estimates are jointly used, which rely on valuation techniques that overlap. As a solution, we propose to limit the scope of each of the valuation method to a specific range of impacts. In order to limit the contingent-valuation method to the exclusive valuation of intangible costs, we propose a three steps approach : *(1)* leave the respondents free to valuate the consequences which matter to them, *(2)* elicit respondent's motivations, *(3)* control for the influence motivations have on elicited values. This procedure was applied in a Swiss contingent-valuation. An econometric treatment was applied in order to limit the scope of the estimates of the contingent valuation method to intangibles, therefore the possibility to a combination of methods with the risk of double-counting and underestimating costs being kept to a minimum.

Key words : cost of illness, intangible costs, contingent-valuation method, double-counting

J.E.L. : I12, D61, D46

Introduction

Most cost-of-illness studies carried out so far apply several techniques to value the full range of consequences, comprising tangible costs (notably lost production) on the one hand, and intangible costs (namely pain and suffering) on the other. The joint use of techniques entails a risk that damage to health may be underestimated, if techniques do not match perfectly, or that this damage may be double-counted. The risk of double-counting is particularly high when using two well-known techniques – the human-capital method (HCM) and the contingent-valuation method (CVM) – since the results obtained by both HCM and CVM may include an estimate of the lost consumption of deceased victims. In HCM cost is estimated as the victim's discounted stream of expected production or earnings over his or her life expectancy. In CVM, cost is estimated on the basis of the individual's willingness to pay to avoid the risk of damage to health.

Several solutions have been proposed to avoid double-counting. One solution is to peremptorily subtract from the overall value an amount of money equal to the lost consumption of deceased persons. Another solution is to prompt respondents, when eliciting their willingness to pay (WTP), to ignore the financial consequences of damage to health (*i.e.* the impact on the income available for consumption) and to concentrate on the valuation of pain and suffering.

In this paper we propose an alternative solution which leaves respondents free to consider the consequences which matter to them. Such a solution requires a contingent-valuation questionnaire with an extensive retrospective protocol to elicit respondents' WTP motivations. An econometric analysis is subsequently carried out to control for the influence of these motivations on the WTP. Once the estimated WTP function has been obtained, it is used to clear the estimated WTP from elements unrelated to pain and suffering. This new estimated WTP can then be integrated into a combination of valuation techniques without risk of double-counting.

The conceptual framework is outlined in Section 2. This is followed by empirical illustrations : the main findings of a contingent valuation conducted in Switzerland in the area of air pollution are presented in Section 3 and the econometric analysis carried out to separate tangible and intangible costs is explained in Section 4. Section 5 shows how it is possible to combine contingent-valuation methods and other valuation techniques in cost-of-illness studies by controlling for WTP estimates. Section 6 concludes.

1. The joint use of HCM and CVM and the risk of double-counting

The traditional cost-of-illness approach (COI) permits the valuation of the economic burden of diseases and premature deaths. In this framework, costs related to the consumption of the health care system resources are estimated by the restoration-cost method (RCM) and the forfeited income (or lost production) by the human-capital method (HCM). Alternatively, the willingness to pay approach – usually the contingent valuation method (CVM) – offers the advantage of enabling the calculation of the intangible costs (pain and suffering) as well. As a result, the cost-of-illness approach is often extended using a contingent valuation so as to value each component of the social cost (Priez et al. 1999, pp.129-130).

Actually one important drawback of HCM, together with RCM, is that it does not measure the pain and suffering due to injuries and death[1]. Several studies therefore include in the valuation allowances aimed at taking this loss of welfare into account. These studies typically use contingent-valuation methods to elicit people's willingness to pay for health improvements, including the avoidance of pain and suffering (Jones-Lee 1976). Both the challenge and the risk of using HCM and CVM jointly are great since the chosen combination of methods must lead to a valid (unbiased) measure of the total loss of social utility. The challenge is all the greater as most authors acknowledge that HCM is simply not consistent with the individualistic foundation of welfare economics (Freeman 1993, Johansson 1995, Soguel 2000).

In general the indirect utility function (1) is used to define money measures of utility change due to damage to health. An individual derives satisfaction from consuming different private commodities x, but also from his health status z; moreover, the quantity of x demanded by individuals is a function of prices, income and health profile :

$$V = U\left[x\left(p, y, z\right), z\right] = V(p, y, z) \tag{1}$$

The change in utility caused by damage to health can be written as :

$$\Delta V = V(p, y, z^1) - V(p, y, z^0) \tag{2}$$

where z^0 is the health profile before it was damaged and z^1 is the health profile after it was damaged. The compensating and equivalent variations are the conventional money measures used to value the change in utility since the utility function is not observable. The compensating variation (CV) is defined as the minimum amount of money that must be given to the individual in order to compensate him for damage to health :

$$V(p, y + CV, z^1) = V(p, y, z^0) \tag{3}$$

When aggregating over all individuals, the compensating variation reflects the money value of the full range of consequences of damage to health for each individual. Traditionally, the consequences of injuries or death are viewed as plural. In the first place, *resources* are used to *correct* (RC) adverse effects (e.g. in the health care system), giving rise to an opportunity cost[2]. Secondly, productivity is affected

[1] HCM is sometimes also called « production loss method » by some authors.

[2] Administrative consequences, etc., are not mentioned here. However, this type of consequences belongs to the same category as health care consequences.

since society is deprived of the resources that would have been created had some of its members not been killed or incapacitated : indeed, if no damage had occurred, these people would have been able to work and contribute to the production of goods and services. This *lost production* (LP) also represents an opportunity cost since the goods and services involved could have increased people's welfare[3]. Apart from these two categories of *tangibles*, damage to health has a direct negative effect on the welfare of the victims, who experience *pain* and *suffering* (PS). These *intangibles* enter their utility functions as negative elements.

The aggregate compensating variation CV_w is therefore equivalent to the money value of all of the consequences :

$$CV_w = RC + LP + PS \qquad (4)$$

To provide a valid measure of the loss of welfare, the chosen combination of valuation techniques should cover the full range of consequences. The fundamental question is whether the common combination of a *restoration-cost method* (RCM), a *human-capital method* (HCM) and a *contingent-valuation method* (CVM) can provide such a measure, *i.e.* whether the sum of the estimates E provided by the three methods is identical to the aggregate compensating variation. Several authors argue that the combined use of these methods would lead to an overestimation of the aggregate compensating variation, *i.e.* :

$$CV_w = (RC + LP + PS) < (E_{RCM} + E_{HCM} + E_{CVM}) \qquad (5)$$

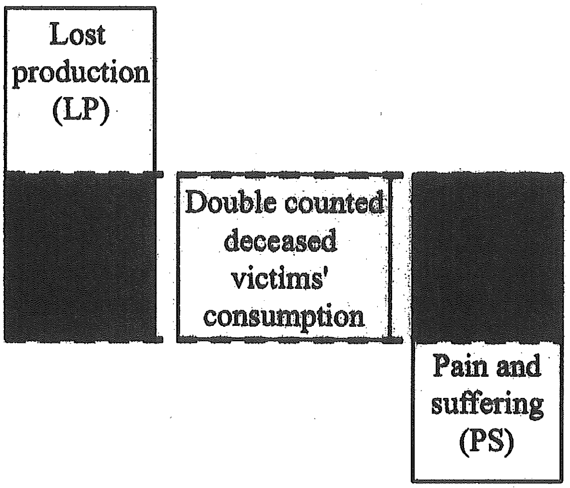
According to the authors, overestimation occurs because of an overlapping between HCM and CVM. On the one hand, HCM provides a gross estimate of lost production since the total value obtained is not reduced to make up for the fact that the consumption of the deceased victims can be handed over to the rest of the society. On the other hand, when asked in a CVM survey about their willingness-to-pay to reduce the risk of death and injuries, individuals may take into account the risk of losing their opportunity to consume if they die. Adding up HCM and CVM estimates may therefore result in counting the deceased victims' consumption twice (Person, 1992) (see Figure 1).

When CVM is used jointly with RCM, there is also a risk of double-counting if WTP even partially covers some restoration costs. However, this risk is dismissed by most authors.

In a first attempt to reduce the risk of double-counting in contingent-valuation studies, Jones-Lee *et al.* (1985) and Persson (1989) adopted a solution that was both radical and simple. Persson merely asked his respondents : "*How much would you*

3 The literature contains extensive discussion about the notion of lost production and whether or not it covers the lost output of employed persons, lost non-market production (e.g. domestic work, voluntary work) and potential loss of production (e.g. the unemployed) (Castiel 1993).

Figure 1 : *Adding up HCM and CVM estimates results in a double-counting of victims' consumption*

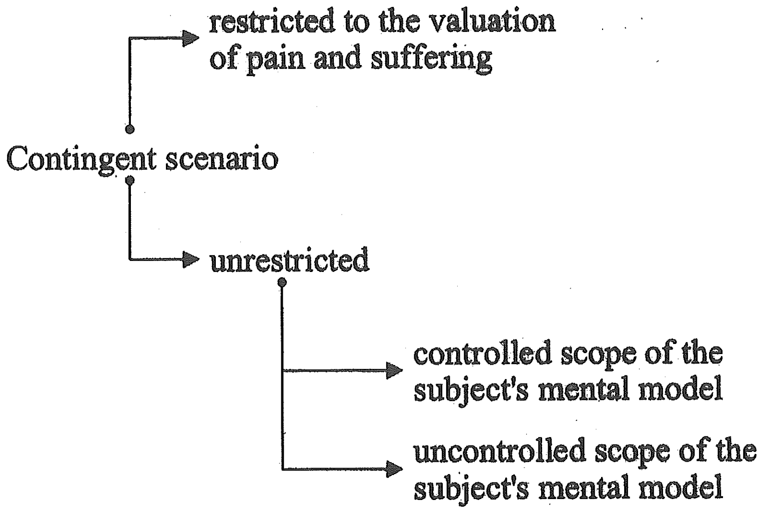


be prepared to pay to have a safety feature fitted to your car that would reduce the risk of the driver being killed by 25% *?*". He then postulated that his respondents had included lost consumption in their WTP. On the basis of this postulate, he peremptorily subtracted the estimated lost consumption of deceased persons from the overall amount.

In more recent contingent-valuation studies, *respondents* were asked not to take tangibles into account (Jones-Lee *et al.* 1993, Schwab Christe and Soguel 1996, Jeanrenaud *et al.* 1998). This *restricted contingent scenario* required the introduction of an additional instruction of the following kind : "*In answering the questions, please ignore the direct economic effects of accidents, such as losses of income or damage and medical costs.*" Both Jones-Lee *et al.* (1985, 1993) and Schwab Christe and Soguel (1995) introduced a debriefing question in order to determine whether or not respondents had taken direct economic effects into account. The results show that about 20% of the respondents had not confined their WTP to pain and suffering. Schwab Christe and Soguel (1995) carried out an econometric analysis to discover whether WTP was higher among these persons than among the others in the sample, but they were unable to find any correlation.

Given that it increases the abstract – or even over-elaborated – wording of the scenario, restricting the contingent scenario increases the *hypothetical risk.* Instead of using a restricted contingent scenario, it is also possible to use an *unrestricted contingent scenario* leaving respondents free to include in their WTP the consequences of damage to health which matter to them. This was the option chosen by Persson (1992). However, Persson made no effort to understand how his respondents pictured these consequences in their mind before expressing their WTP. To our knowledge, no author has yet attempted to use an unrestricted scenario, then to find out how respondents imagined the consequences of damage to health, and finally to control this "mental model" during the econometric analysis with a view to clearing the WTP for pain and suffering alone.

Figure 2 : *Restricted vs. unrestricted scenario for the valuation of intangibles*



By using the unrestricted contingent scenario instead of the restricted one, it is possible to reduce the risk of what Mitchell and Carson (1989, 246) call *scenario misspecification bias*. Indeed, the scenario must seem realistic to respondents, and whether it does or not depend on various factors. An obvious factor is the degree to which respondents are familiar with the key aspects of the scenario. Another one is the ease with which the volume and nature of the information provided can be grasped by respondents, however familiar or unfamiliar they may be with such information.

If we consider the attempts that have been made to restrict the good to be valued in a contingent scenario to pain and suffering alone, we must admit that by its very nature the information provided is highly unusual : to begin with, respondents are thrust into a world where they must gauge the probabilities of damage to health; then they have to imagine being able to pay a sum of money in exchange for a reduction in the risk of such damages; finally, they must restrict the benefits being valued to a sole reduction in pain and suffering. Moreover, it is far from certain that the amount of information needed to present such a scenario can be processed by the human mind[4].

[4] For example, Schwab Christe and Soguel (1996, 282) include seven valuation conditions in the WTP question, two of which are aimed at restricting WTP to pain and suffering.

As noticed by Schulze *et al.* (1994 : 17), "some respondents will accept the implicit mental model used by the researcher in designing the survey, while others will not". If they find the scenario unrealistic, respondents may not behave as the researcher would like them to. In that case, at least three types of reaction are possible. Respondents may simply give a "Don't know" answer. While such a reaction is a problem, it is far less of one, as regards the validity of results, than are the other two types of reaction. Indeed, the results are seriously called into question when respondents choose a WTP at random or base their WTP on indications which they think they detect in the questionnaire or in the behaviour of the interviewer.

The need to simplify the nature and reduce the volume of the information contained in contingent scenarios led us to adopt the solution of an unrestricted scenario and to abandon scenarios restricted to pain and suffering. In so doing, we made two hypotheses : in the first place, the mental models used by respondents in choosing their WTP can be discovered thanks to a retrospective protocol; secondly an estimate exclusively confined to pain and suffering can be obtained by carrying out an econometric analysis to determine and control for the influence which these models have on WTP.

2. Design of the contingent market

These two hypotheses were tested within the framework of a contingent evaluation survey carried out in the city of Lausanne, in Switzerland, in the autumn of 1998[5]. The purpose of the survey was to investigate people's WTP for the reduction in damage to health that could be obtained by suppressing pollutants emitted by the urban waste incinerator, thereby improving the quality of the air. A two-step approach was adopted : (1) elicit WTP without constraint; (2) ask respondents to express their motivations.

2.1. Eliciting WTP without constraint

By improving the quality of the air, it is possible to reduce various types of damage to the environment (visibility, smell, damage to buildings, damage to wildlife and flora etc.) and to health (mortality and morbidity). Most studies choose to value damage separately, particularly damage to health (Tolley *et al.* 1994, Navrud 1998), as do most of textbooks such as Cropper and Freeman (1991 : 167) which "follows the conventional economic practice in distinguishing between mortality and

[5] This survey was part of the European Project *Impact Assessment and Authorization Procedure for Installations with Major Environmental Risks*, EC DG XII, Environmental Research Programme, Research Area III. See Soguel and van Griethuysen (2000). Focus groups took place between March and May 1998 and face-to-face debriefing interviews in September 1998.

morbidity". Whatever the conventional economic practice, there is no theoretical reasons why both impacts (mortality and morbidity) cannot be jointly valued[6]. As a matter of fact, several studies globally value the impacts of air pollution without even distinguishing between environmental and health damage (Brookshire *et al.* 1982 ,Rogat 1995). For the purpose of the present study, it was decided to opt for an "in-between" scenario, *i.e.* evaluating damage to health only, but evaluating morbidity and mortality together as a single overall consequence of air pollution. This choice was made for several reasons apart from the lack of opposing theoretical grounds.

Firstly, the distinction between mortality and morbidity was introduced in existing studies and textbooks to some extent to simplify the depiction of the outcomes of an environmental change that would affect people's health or to control for the validity of the expressed WTP better. However, in the real world, the distinction can only be made *ex post, i.e.* once the health status is actually impaired. However, when using CVM, respondents are placed in an *ex ante* situation in which they must express their WTP for a change in the condition of the environment and, as a result, for a change in their expected health condition. Except when the change is dramatic or for people already at risk, the outcome (death or illness) is unknown and random from the respondent's perspective. Therefore it is quite implausible to claim in the contingent scenario that a reduction in air pollution leads to a reduction in the probability of falling victim to just one type of damage to health, either morbidity or mortality. Thus, asking respondents to consider one type of damage alone undermines the realism of the contingent scenario. Moreover, the dose-response models generally used show a correlation between the incidence of various types of damage (e.g. ExternE Project, EC 1995).

Secondly, when it comes to air-pollution-related morbidity or mortality, the boundary between the two impacts is not as clear-cut as it is, for example, in the field of road traffic accidents. Death can occur suddenly (short term or acute mortality) or after a long period and possibly after the victim having suffered illness for a long time. Again, the absence of a clear dichotomy between the two impacts reduces the credibility of a scenario that would try to make an artificial distinction between them.

Thirdly, and from a strictly practical viewpoint, with the most significant health impacts grouped in one bundle, there is only one good to value as far as damage to health is concerned. This made it possible to reduce the number of evaluation procedures and thus avoid tiring our respondents out.

Fourthly, and since the study also aimed to identify the value of reducing the risk of overall damage to health, this scenario reduces the risk of embedding effect which

6 Although Johansson (1993, p.159) also presents both outcomes separately, he makes it clear that health state is a continuum of n different health states where z^1 refers to full health, z^2 to some well-defined minor health deficiency, z^i to the more serious health deficiency, and z^n to death.

may appear when aggregating WTPs for individual outcomes. This risk exists for at least two reasons; firstly, because respondents may include a broader range of impacts than intended by the researcher (i.e. thinking of all impacts instead of only, say, mortality); secondly because if respondents are asked sequentially for their WTP for mortality and then for morbidity effects (or the other way round), they may not adapt their budget constraint (*i.e.* forgetting to deduct the previously expressed WTP and, as a result not taking into account the exact marginal utility of their remaining income).

All these reasons made us choose a scenario where we clearly indicated air pollution as the cause of individual health impacts and where the "bundle" of damage included the expected decrease in life expectancy, the risk of suffering from an air-pollution-related illness and the risk of suffering from minor health problems resulting in days with restricted-activity, *i.e.* both morbidity and mortality outcomes.

The good to be valued was described by means of three cards, each card presenting a type of damage to health, including the possible symptoms, the consequences for everyday activities, the usual medical treatment, the duration of the damage and its yearly incidence within the population of the city of Lausanne[7]. The incidence of the health damages due to the pollution caused by the urban waste incinerator was presented in terms of risk for the respondent.

The question concerning WTP was phrased in such a way as to test the potential of an unrestricted scenario. To begin with, respondents were told :

"*Because you live in Lausanne, and because waste is incinerated there, each year you personally run the risk of incurring all the damages we have just spoken of.*"

The three types of damage and their incidence were repeated by the interviewer and then respondents were asked :

"*Would you be willing to pay a sum of money to remove the risk of being a victim of these consequences ? Yes or no ?*"

The respondents who answered "Yes" were then asked :

"*Now I would like to know how much you would be willing to pay to completely remove the risk of being a victim of these consequences for one year. Remember that we are only talking about damages caused by waste incineration, not about those caused by other forms of air pollution. The amount that you would be willing to pay would ensure that you would not be a victim of these damages for one year and no more.*"

[7] The *illness category* included all the cases of respiratory illnesses, including chronic diseases, such as chronic bronchitis and asthma ; as a whole, Lausanne's urban incinerator induces 500 new episodes of illness in the city's population each year. The *discomfort category* included several minor symptoms, such as itching eyes, sinus congestion or headache ; these symptoms can result in *restricted activity days*, as the term is defined by epidemiologists ; each year there are 1, 200 episodes of daily discomfort due to incineration in Lausanne. The decrease in life expectancy consisted of 6, 000 days of life lost, with an average loss of one hour lost yearly per inhabitant (numbers in years of life lost (YOLL) were avoided as they were very small).

In order to help respondents express their individual WTP, we used a three-stage valuation procedure based on a *list of payments* comprising 18 annual bids between 1 and 1,000 Swiss francs[8]. Respondents were first asked to give the maximum amount they would definitely be *willing* to pay, starting at 1 franc and moving upwards. Then they were asked to give the minimum amount they would definitely be *unwilling* to pay, starting at 1,000 francs and moving downwards. Thus, stages (1) and (2) determined an *uncertainty zone*, where respondents were unsure whether or not they would be willing to pay. The last step consisted in letting respondents reconsider the uncertainty zone and express a final WTP[9].

2.2. Expressing motivations in retrospective protocols

So as to be able to analyse the scope of the valued good later on, a retrospective protocol was included in the survey : two questions were aimed at discovering the motivations influencing respondents' WTP. The first question was an open question encouraging respondents to express freely whatever considerations they had in mind when expressing their WTP :

"*Concerning the amount you have just chosen, can you tell me the reasons why you indicated one amount rather than another ?*"

The second question was a closed one in which respondents were asked whether or not they had thought about various motivations when expressing their WTP. The 13 motivations suggested to them were taken from focus group discussions. They are presented in detail in Section 4.

2.3. Organization of the survey

The questionnaire was designed jointly by economists and psychologists. Preliminary versions were extensively discussed in three focus groups and refined on the basis of seven verbal protocols. The in-person, at-home survey was conducted in the city of Lausanne by 10 trained interviewers over a period of 65 days (from October 10 to December 15 1998). A non-probability quota sampling technique was used to build up a sample of 199 observations. Respondents were chosen according to four criteria : area of residence, gender, age and social class (*i.e.* educational level). 45 respondents were not willing to pay any sum of money. They justified their stance either with egoistic reasons, stating that it is not up to them to pay (*i.e.* they behaved like free riders), or with ethical reasons, arguing that it is not possible to make a trade-off between life and money. As a result, 154 observations were adopted for the analysis.

8 All amounts of money are expressed in Swiss francs, worth US$ 0.72 at the time of the study.

9 This procedure was initially suggested by Jones-Lee *et al.* (1993) and Dubourg *et al.* (1994).

3. Elicited WTP and motivations, isolating the value of pain and suffering

After expressing their WTP, respondents were asked whether they had taken into account any of the motivations mentioned in the focus groups. Table 1, which lists the number of positive answers given for each motivation, clearly shows the collective aspect of such motivations as concern for air quality and altruism, which were the ones most commonly given for individual WTP : 118 out of 154 respondents (77% of the sample) said that they had been motivated by the fact that their individual payment would help improve the quality of the air, and 106 people (69%) expressed solidarity with sick people. Considerations which had a more direct effect on individual welfare came far behind : only 58 people (38%) mentioned fear of suffering as a motivation for their WTP, only 46 people (30%) cited medical costs and only 44 people (29%) expressed fear of losing their jobs. Note that the motivations listed were not self-excluding and that respondents could choose as many of them as they wished. For example, a respondent who expressed fear of suffering could be one of the 44 to have expressed fear of losing his job.

Table 1 : *WTP motivations expressed by the 154 respondents*

Motivation	Nb. positive answers	
	Absolute	Relative (%)
A. I may suffer	58	38
B. I don't like to go to the doctor	38	25
C. I'm afraid of going to the hospital	25	16
D. I may have medical expenses	46	30
E. I may not live as long, and that scares me	31	20
F. I may not be able to do some domestic chores	30	20
G. Life may become more complicated for my family	58	38
H. I may have to curtail my leisure activities	58	38
I. I may lose part of my salary	27	18
J. If I become seriously ill, I may loose my job	44	29
K. I may be a financial burden on society	39	25
L. In paying, I will help improve air quality	118	77
M. In paying, I am showing solidarity with sick people	106	69

When collective motivations are left aside, there seems to be no homogenous good that corresponds to what individuals were valuing. This means that WTP was based on a good that was individually perceived, represented and valued. However, in order to value all the socio-economic consequences of health impacts, there was a clear need to standardise the good under consideration. Econometric analysis was used to overcome this difficulty.

Moreover, the fact that a person claimed that he had been motivated by one factor rather than another does not necessarily mean that this was the case, since he may simply have been trying to artificially justify his WTP after the event. It was therefore necessary to make sure that the factors mentioned truly had an influence on this person's WTP. That is why the influence of these various motivations was tested during the econometric analysis.

3.1. Econometric analysis

To select the appropriate functional forms of the WTP valuation function, the elicited WTP values were transformed according to a Box-Cox model[10]. The Breush-Pagan test showed that while there was no risk of heteroscedasticity in our model as a whole, the variable income was a potential source of heteroscedasticity. This variable represents the monthly income earned by the household (in thousands of Swiss francs). To overcome this problem, we used a logarithmic transformation of the variable ln(income) so as to obtain a corrected model.

Table 2 presents the results for these two models. Although the exponential model, in which $\lambda_1 = 0$, does not maximise the likelihood function, results for this model are also reported as they allow it for a more intuitive interpretation of the coefficients[11].

The most statistically significant independent variables retained for the analysis can be grouped in three categories representing : (a) respondents' socio-economic situation, (b) their perception of health impacts and (c) their motivations.

Three variables correspond to the respondent's socio-economic situation. The first one is social_class, a discrete numerical variable indicating the respondents' educational level (out of a possible choice of five). Social_class is a highly significant variable (99%) and has a positive effect on WTP : the higher the educational level, the higher the WTP. The second socio-economic variable, income, represents the monthly income earned by the household (in thousands of Swiss francs). Its significance level is always higher than 95%. In the exponential model, an increase of $1,000$ francs leads to a 14% increase in WTP. The third variable related to the socio-economic situation is age_dev2. This variable corresponds to the difference

10 We used the general transformation proposed by Box and Cox (1964) to transform the elicited WTP values according to the formula $WTP^{(\lambda_1)} = \left[(wtp + \lambda_2)^{\lambda_1} - 1\right] / \lambda_1$, where λ_1 is a Box-Cox parameter determined to normalise the error distribution. A second parameter λ_2 was introduced in cases where expressed WTP equalled zero. Following the proposal made by Mitchell and Carson (1989 : 372), we fixed the value of this parameter at 1. The value of λ_1 was set in such a way as to maximise the likelihood function.

11 In the exponential model, the variation rate of WTP ($dWTP$) is proportional to the variation of the explanatory variable (dx) : $\frac{dWTP}{WTP} = \beta' dx$, where β' is the vector of estimated coefficients. These coefficients express the relative change in WTP associated with a marginal change in the independent variable.

Table 2 : *WTP functions estimated with Box-Cox models*[a]

		Box-Cox Models		
			Uncorrected	Corrected[b]
Independent variable		$\lambda_1 = 0.000$ (exponential)	$\lambda_1 = 0.157$	$\lambda_1 = 0.148$
CONSTANT		−3.035 (−1.898)	−5.869* (−2.156)	−5.770* (−2.153)
SOCIAL_CLASS	numeric discrete	0.244* (2.491)	0.456** (2.732)	0.458** (2.803)
INCOME[b]	numeric (1,000 Sfr.)	0.140* (2.345)	0.305** (3.008)	0.729* (2.399)
AGE_DEV2	numeric	−0.001** (−2.849)	−0.001* (−2.113)	−0.001* (−2.110)
SERIOUSNESS	numeric	0.319** (2.868)	0.493* (2.607)	0.499** (2.691)
INCINERATOR	numeric discrete	0.191 (1.672)	0.350 (1.801)	0.366 (1.923)
SUFFERING	dummy	1.004** (3.818)	1.645** (3.673)	1.517** (3.469)
LOSS_OF_JOB	dummy	0.956** (3.292)	1.756** (3.551)	1.704** (3.516)
λ_1		0.000 (−)	0.157** (3.957)	0.148** (3.765)
n		154	154	154
Likelihood function value		−852.597	−844.796	−846.364
Adjusted R^2		0.332	0.331	0.317

[a] The coefficients with double asterisks are significant at the 99% level, those with single asterisks at 95% (two-sided test). The numbers in parentheses beneath the estimated parameters represent the values of the t-statistics.

[b] In the corrected Box-Cox model, income is transformed into ln (income)

between the respondents' age and age 44[12], the difference being squared. age_dev2 is significant (95%) and negatively correlated with WTP : the higher the difference with the reference age, the lower the WTP[13].

Two variables correspond to the respondents' perception of health impacts. The first is seriousness, a numerical variable expressing the respondents' concern about the overall effect that air pollution would have on their own health. A highly significant variable (> 99%), seriousness has a positive effect on WTP. The second variable is incinerator, a discrete numerical variable expressing the influence which respondents attribute to the urban incinerator in inducing pollution-related health

12 This reference age maximises the likelihood function in the corrected Box-Cox model. It is kept constant in both uncorrected models. It lies between the mean and median values (respectively 46, 8 and 42 years).

13 Such an inverse U-curve has often been observed (Regens 1991, Persson *et al.* 1995, Schwab Christe and Soguel 1995). Moreover, neither the linear form of the age nor the linear form of the variable AGE_DEV emerge as influencing the WTP at any significant level of confidence. As a result, the use of the square of the deviation implies the same marginal effect, for instance, on the WTP of a 20 year-old individual as on the WTP of a 64 year-old individual.

impacts. It takes a value ranging from 1 (no influence attributed to the incinerator) to 6 (greatest attributed influence). This variable is kept in the WTP function since its significant level is close to 95%. incinerator has a positive effect on WTP.

So as to include the respondents' motivations in the econometric model, 13 dummies were introduced as motivation variables. Among these 13 motivation variables, two show a highly significant influence on expressed WTP (larger than 99%). Suffering, the first of these (item A in Table 1), takes the value 1 whenever respondents say they were motivated by their fear of suffering from potential health impacts. It has a very strong positive effect on WTP. In the exponential model, the estimated WTP of respondents who express such a fear is twice as high as that of respondents who do not. The second statistically significant motivation variable is loss_of_job (item J in Table 1). Loss_of_job takes the unitary value whenever respondents mention the fear of losing their job as one of their motivations. It also has a very strong positive effect on WTP, with estimates nearly double when loss_of_job is equal to one.

Interestingly, the motivations expressed by a majority of respondents – helping to improve air quality (77% of the sample) and solidarity with sick people (69% of the sample) – did not turn out to be significant motivation variables. A possible reason could be that while such collective concerns do motivate people to pay, they do not determine exactly *how much* they are willing to pay.

The Box-Cox model corrected for heteroscedasticity shows a parameter λ_1 that maximises the likelihood function when $\lambda_1 = 0.148$ (0.157 for the uncorrected model). This shows that the model is definitely more efficient than the exponential one, as confirmed by the value taken by the likelihood function (see Table 2). Indeed, the confidence interval, with a 95% significance, ranges from 0.073 to 0.230 and therefore excludes the value 0[14]. Hence the Box-Cox model corrected for heteroscedasticity was chosen as the best WTP function. The explanatory power of this model (Adjusted $R^2 = 0.317$) is quite high compared to the standards of contingent valuation studies. Table 3 summarises the usual statistics for the WTP. A comparison of the elicited and estimated results shows clearly the effect of the Box-Cox transformation on the average value, on the standard-error and on the maximum value; whereas the median value remains almost unchanged.

3.2. Isolating the value of pain and suffering

The WTP function enabled us to simulate four different types of situations. In all cases, the motivation variables suffering and loss_of_job could be controlled so as to ensure that all respondents consider the same motivations. *Situation A* corresponds to a situation in which no respondent, when expressing his WTP, thinks about the

14 However, the exponential model is very close to the confidence interval.

Table 3 : *Elicited and estimated yearly WTP (SFr)*

		Median	Average	Standard deviation	Maximum	Minimum
Elicited WTP		50.00	130.10	201.44	1000.00	0.00
Estimated Box-Cox models						
Uncorrected	$\lambda_1 = \mathbf{0.000}$	39.97	71.85	85.09	559.74	0.79
Uncorrected	$\lambda_1 = \mathbf{0.157}$	51.45	77.25	76.32	419.32	0.41
Corrected	$\lambda_1 = \mathbf{0.000}$	50.17	75.67	72.39	458.26	0.32

possibility of suffering or losing his job (suffering= 0 and loss_of_job= 0). *Situation B* simulates the situation in which all respondents think about suffering (suffering=1), but none of them thinks about losing his job (loss_of_job= 0). *Situation C* represents the opposite situation, in which no respondent thinks about suffering (suffering= 0), but all of them are motivated by the fear of losing their jobs (loss_of_job= 1). In *situation D*, all respondents are motivated both by the fear of suffering and by the fear of losing their jobs (suffering= 1 and loss_of_job= 1). Table 4 shows the results of such simulations.

Table 4 : *Simulated WTP values when suffering and loss_of_job are controlled for*

	Estimated situation	Simulated situations A	B	C	D
SUFFERING		0	1	0	1
LOSS_OF_JOB		0	0	1	1
Median estimated WTP (Sfr.)	50	28	67	74	158

In situation A the median estimated WTP is 28 francs. Since both significant motivation variables (suffering and loss_of_job) are kept equal to zero, this value confirms that other motivations, which are not statistically significant, have an influence on WTP. This estimate may be considered as a floor value corresponding to the collective and altruistic motivations expressed by the majority of respondents in retrospective protocols. As seen in Section 4, 77% of respondents indicated the overall improvement in air quality as a motivation for their WTP (item L in Table 1). This may be a case of *embedding effect* (Kahneman and Knetsch 1992), in which respondents consider a good (*i.e.* air quality improvement) that is more inclusive than the particular good which the researcher has in mind (health improvement). When considering air quality as a whole, individuals may express *citizens' values* (Stevens *et al.* 1993, Sagoff 1998), that is to say values reflecting collective considerations. These considerations include motivations of a moral kind such as the *warm glow* of giving (Kahneman and Knetsch 1992, Andreoni 1990) derived from showing solidarity with sick people, a motivation expressed by 69% of respondents (item M in Table 1)[15]. The median respondent would thus be willing to pay

15 There is a reason to believe that warm glow does not exclude private (egotistical) motivations. Both motivations are added up in the overall WTP.

28 francs not as a part of a trade-off between income and individual health, but because of considerations of another kind[16]. In order to avoid an overestimation of the costs specifically associated with health impacts, this floor-value was excluded. This solution is at least partially justified since a large number of respondents mentioned item L (77%) and M (69%) and that these items, together with more personal or selfish items - B to I - do not prove to influence significantly the elicited WTP in the estimated models.

With a functional form that is nearly exponential, the corrected Box-Cox model shows the strong impact which both suffering and loss_of_job have on WTP values. In Situation B the median WTP is 67 francs, in Situation C it is 74 francs and in Situation D it is 158 francs, reaching a value 5.6 times as high as in Situation A.

There are two ways of obtaining an estimate for suffering alone : either by determining the difference between situation B and situation A (B – A) or by determining the difference between situation D and situation C (D – C). The same methods can be applied to loss_of_job. An estimate can be obtained either by determining the difference between situation C and situation A (C – A) or by determining the difference between situation D and situation B (D – B). Results are indicated in Table 5.

The results are very dependent on the situations used for estimation. For example, the median estimated WTP obtained for suffering is either 39 francs (B – A) or 84 francs (D – C). Figures are higher for loss_of_job, with a median estimated WTP between 46 francs (C – A) and 91 francs (D – B). This difference results from the functional form and from the fact that the coefficient attached to the dummy variable is higher for loss_of_job.

Table 5 : *Estimates obtained for SUFFERING and LOSS_OF_JOB (in Sfr.)*

	Estimates obtained for SUFFERING			Estimates obtained for LOSS_OF_JOB		
	B – A	D – C	Mean	C – A	D – B	Mean
Median estimated WTP	39	84	62	46	91	69

4. Incorporating contingent-valuation estimates into cost-of-illness studies

We can now return to the question initially raised in this paper - to what extent can a combination of valuation techniques cover the full range of consequences

16 In fact none of the corresponding items (notably items K, L and M in Table 1) emerges as influencing significantly the elicited WTP in the estimated models (more personal or selfish items - B to I - do not prove significant as well). However, our position is at least partially justified since a large number of respondents referred to items L (77%) and M (69%).

valued in cost-of-illness studies ? – and to its corollary question – is it possible to avoid the overestimation due to the overlapping of HCM and CVM concerning the consumption of deceased persons ?

We ended up with a WTP function in which the specific dummy variable associated with medical costs was insignificant and was therefore excluded. This result might reflect the good quality of the Swiss social security system, in which individuals pay only a fraction of the restoration costs. In such a context, CVM does not seem to constitute an appropriate method for the estimation of restoration costs. This has two consequences : (a) RCM is needed for the evaluation of restoration costs; (b) there is no risk of double-counting when RCM and CVM are used jointly, provided that the WTP function does not include motivations related to these specific costs.

The risk of losing one's job was the most effective of all significant explanatory variables of the WTP function (see Section 4). The question remains, however, to what extent this motivation corresponds to the welfare counterpart of the opportunity costs of production considered in HCM. More specifically, our results do not enable us to determine whether the fear of losing one's job is caused by the fear of losing further opportunities to consume[17]. Although this may indeed be the case, other factors may be involved. Therefore, our estimates cannot provide a reliable estimate of the costs of lost production as opportunity costs, nor can it provide us with a reliable estimate of the disutility of the consumption lost due to health impacts. This gives rise to two recommendations : (a) lost production should be valued with HCM; (b) the WTP function should not include motivations related to lost production, to remove any risk of double-counting when using HCM and CVM jointly. In our case, the estimate for loss_of_job had to be excluded.

Thanks to the type of simulations we carried out, CVM can provide a reliable estimate of the intangible costs of health impacts provided that : (a) respondents are motivated by the fear of suffering from health impacts; (b) this motivation comes out as a statistically significant variable in the WTP function; (c) all observations are controlled in such a way that all respondents are made to consider this motivation, thus avoiding any risk of underestimating intangible costs; (d) other motivations are controlled in such a way that they do not affect the WTP function, thus avoiding any risk of double-counting; (e) the estimate of a floor-value – presumably corresponding to the collective aspect of individual motivation – is excluded. Obviously, these conditions can only be met in an unrestricted scenario leaving respondents free to consider the consequences of damage to health which matter to them.

17 Instinctively, one may think that the fear of losing one's job stems from the fear of losing one's primary source of income. This would obviously result in a loss of purchasing power, thus leading to a further loss of consumption. However legitimate such a viewpoint might be, it does not take into account various other factors which respondents may take into consideration. In expressing concern about losing their jobs, respondents may be expressing their fear of losing their social status, of being unemployed or, more simply, of no longer being able to fulfil themselves in a job they actually enjoy.

Conclusion

The work described in this paper constitutes the first attempt to adopt a coherent approach to the problem of double-counting while at the same time reducing the risk of hypothetical bias. It explores the possibility of limiting WTP to intangible costs by excluding from the WTP function the variables related to tangible costs. Instead of artificially restricting the contingent scenario to the valuation of intangibles, we demonstrate the advantage of using an unrestricted scenario leaving respondents free to consider whatever consequences matter to them when expressing their WTP. Such an approach can lead to more consistent estimates, provided that the scope of the elicited WTP can be controlled during the econometric analysis. Above all, it underscores the need to analyse the respondents' motivations in expressing their WTP and their attitudes towards the valuation procedure.

By carrying out simulations on and controlling for significant variables in the WTP function, we were able to distinguish three different components of WTP : (a) an estimated floor-value presumably associated with the collective and/or altruistic aspects of individual behaviour, (b) an estimate for the fear of losing one's job, and (c) an estimate for the fear of suffering from health impacts. The floor-value had to be excluded, as it did not appear to be specific to health impacts. As for any link that may exist between the fear of losing one's job and the fear of losing opportunities to consume, it was at best conjectural and the value obtained for this fear had to be excluded as well. By excluding both the floor-value and the value for the fear of losing one's job, we were able to obtain a WTP function based exclusively on pain and suffering. To overcome the underestimation problem, this function was further controlled in such a way that all respondents consider the risk of facing intangible costs.

We ended up with a WTP figure representing the value which all respondents give to intangibles. Since this figure does not include any of the consequences valued by means of restoration-cost method (RCM) and/or the human-capital method (HCM), our work shows that the contingent-valuation methods (CVM) can be used jointly with those methods without any risk of double-counting.

Consequently, a comprehensive cost-of-illness study could be carried out using the following combination of valuation methods : (a) RCM, for an estimate of the medical and administrative costs; (b) HCM, for an estimate of the opportunity costs of lost production (including lost consumption); (c) CVM, for an estimate of pain and suffering. When such an approach is taken, the methodologies of each technique remain different, but the corresponding fields of valuation do not overlap. Adding up the three estimates therefore raises less of a problem since the risk of double-counting or underestimating costs are kept to a minimum.

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