Does charity begin at home for pollution reductions?*

Olivier Chanel
GREQAM-IDEP-CNRS
Stéphane Luchini
GREQAM-IDEP-CNRS
Jason Shogren
University of Wyoming

Preliminary version 16/11/2005

Abstract

We propose a structural econometric model which explicitly introduces altruism towards household members in the willingness to pay for a public good. The model distinguishes preferences for safety improvements for oneself from preferences for other household members when income elasticity is taken into account. We test of three different types of economic behavior–'pure-self interest', 'pure altruism' and 'safety-focused paternalistic altruism'. Using data from our experimental design in France, we find positive and significant degrees of concern only for children under the age of 18.

Keywords: Mortality Risk, Air pollution, Field Experiment
Familial Altruism, Contingent Valuation.

JEL Classification: D6, C9

*We thank Charles Figuières, Xavier Joutard, Alain Trannoy, and the participants of the first workshop on Economics and Environment held in Montpellier (January 2005) and EAERE meetings in Bremen for helpful comments and suggestions. Financial support from the French Environment Ministry (Primequal grant n° 36/98) is gratefully acknowledged. Jason Shogren thanks GREQAM for hospitality and support.

1 Introduction

During the last decades altruism has become a common theme in economic theory. Experimental evidence has supported the idea that altruism is compatible with rational behaviour (e.g., Andreoni, 2002). Moreover, altruism has been demonstrated to play a significant role in how people cooperate and contribute to public goods (see Fehr and Fischbacher, 2003). With such an impact on behavior and choice, many argue that altruism should be addressed within a cost-benefit analysis for more accurate public decision making. The open question, however, is which type of altruism is driving behavior -pure altruism or paternalistic altruism. This distinction matters because accounting for the utility change of others may or may not be double counting (Bergstrom, 1982; Jones-Lee,1991, 1992). With pure altruism, the utility of others is included in one's utility function and the change in the utility of others may be zero if they pay their Hicksian compensating variation, and therefore should not be included in the benefit estimate. In contrast, with paternalistic altruism, the health or wealth of others enter one's utility function directly, and therefore any utility gains associated with greater health or wealth of others should be accounted for in benefit estimates (Mishan, 1971; Jones-Lee, 1976).

In this paper, we test for pure versus paternalistic altruism for the provision of a public good within the family. Focusing on air quality improvements in France, we find evidence of a strict form of paternalistic altruism - parents reveal significant concern towards only their own children under 18. All other forms of pure or paternalistic altruism within the family are insignificant, including for children over 18, siblings, spouses, and parents. This result implies benefit estimated that do not consider paternalistic altruism could be undervaluing the public good.

Before proceeding, we believe it is worth noting one key aspect of our experimental design. At first glance, one might think that there is an obvious way to explore altruism in cost-benefit analysis by designing a valuation survey that elicits explicitly people's altruistic preferences. This means that people state directly the amount of their altruism, i.e., the value of personal well-being they are willing to forgo to increase the well-being of someone else. But this approach is open to the criticism that if you ask someone if they are altruistic, it costs them nothing to say 'yes'. Following Viscusi *et al.* (1988), our altruism survey is designed so people do not have to state any amount of altruism but can reveal altruism by stating their preferences over certain household trade-offs. To paraphrase the French playwright Molière, our design allows people to reveal their altruism without knowing they are revealing it. If people reveal altruism in these choices, econometric tools then allow us to calculate its value.

2 A structural model of altruism within the family

We develop a structural econometric model to measure the *degrees of concern* within the family. We do so by using a random utility model which considers altruism within the family in the case of a mortality risk variation among family members. Formally, we consider a household k, $k = 1 \dots K$ which is composed of n_k individuals indexed by $l = 1 \dots, i, \dots, n_k$. Each individual i belongs to one household only, and faces a risk of death μ_i during a single forthcoming period. We characterize the individual's random utility function that is separately additive with respect to an index of the household wealth, W_k, own risk of death μ_i and the mortality risks of other members, μ_{-i}. This function is increasing in W_k and non increasing in μ_i and μ_{-i}.[1] In the initial situation with baseline risks μ_i^0 and μ_{-i}^0, the random utility function is

$$V_i(W_k, \mu_i^0, \mu_{-i}^0; \epsilon_i, \theta) = h(W_k; \alpha) + Z_i(\mu_i^0; \epsilon_i, \psi_i) + \sum_{l \neq i} Z_l(\mu_l^0; \epsilon_i, \psi_l). \tag{1}$$

In this specification, $\theta \equiv (\alpha, \psi_i, \psi_l)$, $i \neq l$ is a vector of parameters. The function $Z_i(\mu_i^0; \epsilon_i, \psi_i)$ captures the individual's (dis)taste for own risk of death, whereas $Z_l(\mu_l^0; \epsilon_i, \psi_l)$ captures the individual's (dis)taste for other household members' risk of death. The components of the utility $Z_i(\mu_i^0; \epsilon_i, \psi_i)$ and $\sum_{l \neq i} Z_l(\mu_l^0; \epsilon_i, \psi_l)$ vary in the population with a distribution induced by the ϵ-distribution.

For safety improvements for all household members, each individual i faces a scenario with lower mortality risks μ_i^1 and μ_{-i}^1 and states a willingness-to-pay w_{ik} for a decrease of mortality risks for herself and other members of her household k. The utility derived by individual i is thus

$$V_i(W_k - w_{ik}, \mu_i^1, \mu_{-i}^1; \epsilon_i, \theta) = h(W_k - w_{ik}; \alpha) + Z_i(\mu_i^1; \epsilon_i, \psi_i) + \sum_{l \neq i} Z_l(\mu_l^1; \epsilon_i, \psi_l) \tag{2}$$

where μ_i^1 and μ_l^1, $i \neq l$, represent the levels of risk of death proposed in the hypothetical scenario. The maximum amount the individual is willing to pay to reduce the risk of death, $w_{ik}^\star$, satisfies:

$$V_i(W_k, \mu_i^0, \mu_{-i}^0; \epsilon_i, \theta) = V_i(W_k - w_{ik}^\star, \mu_i^1, \mu_{-i}^1; \epsilon_i, \theta) \tag{3}$$

which leads to the following compensating variation function

$$G(W_k, w_{ik}^\star; \alpha) = \left[Z_i(\mu_i^1; \epsilon_i, \psi_i) - Z_i(\mu_i^0; \epsilon_i, \psi_i)\right] + \sum_{l \neq i} \left[Z_l(\mu_l^1; \epsilon_i, \psi_l) - Z_l(\mu_l^0; \epsilon_i, \psi_l)\right] \tag{4}$$

We consider the following functional form for the random utility derived from individual i's risk and other household members' risk and the ϵ-distribution (see Milgrom, 2004, for a similar form for pay-offs in auctions):

$$Z_l(\mu_l^r; \epsilon_i, \psi_l) = z_l(\epsilon_i, \psi_l) + \mu_l^r \xi_l(\epsilon_i, \psi_l), \text{ with } l = 1 \dots, i, \dots, n_k \text{ and } r = 0, 1 \tag{5}$$

where $\xi_l(\epsilon_i, \psi_l)$ is the marginal utility derived by i for a variation of risk of death for individual l. Consequently, equation (4) becomes

[1] This type of utility function has been first proposed by Needleman (1976). It implies that individuals are not malevolent towards household members.

$$
\begin{aligned}
G(W_k, w_{ik}^{\star}; \alpha) &= d\mu_i \xi_i(\epsilon_i, \psi_i) + \sum_{l \neq i} d\mu_l \xi_l(\epsilon_i, \psi_l) \\
&= d\mu_i \xi_i(\epsilon_i, \psi_i) \left[1 + \sum_{l \neq i} \frac{d\mu_l}{d\mu_i} \frac{\xi_l(\epsilon_i, \psi_l)}{\xi_i(\epsilon_i, \psi_i)} \right]
\end{aligned} \tag{6}
$$

where $d\mu_i(d\mu_l)$ is the change in risk of death of member i (l) and $\xi_l(\epsilon_i, \psi_l)/\xi_i(\epsilon_i, \psi_i)$ can be interpreted as the degree of concern of individual i for household member l's safety (see Hughes, 1973, and Needleman, 1976). Expression (6) includes three types of behavior:[2]

Pure self-interest corresponds to the case in which $\forall i \neq l$, $\xi_l(\epsilon_i, \psi_l) = 0$, i.e. l's risk of death does not enter i's utility function. This case leads to:

$$
G(W_k, w_{ik}^{\star}; \alpha) = d\mu_i \xi_i(\epsilon_i, \psi_i) \tag{7}
$$

The self-interest model is the null hypothesis:

$$
\mathbf{H}_0^{SI} : \xi_i(\epsilon_i, \psi_i) > 0 \text{ and } \xi_l(\epsilon_i, \psi_l) = 0, \forall i \neq l. \tag{8}
$$

Pure altruism means i's utility towards mortality risks derived from l's risk of death is similar to l's utility derived from own risk of death. The utility derived from the household wealth is assumed to be similar for each member of household k. This leads to the following specification:

$$
G(W_k, w_{ik}^{\star}; \alpha) = d\mu_i \xi_i(\epsilon_i, \psi_i) \left[1 + \sum_{l \neq i} \frac{d\mu_l}{d\mu_i} \right], \tag{9}
$$

and the corresponding alternative hypothesis is defined:

$$
\mathbf{H}_1^{PA} : \xi_i(\epsilon_i, \psi_i) = \xi_l(\epsilon_i, \psi_l) > 0, \forall i \neq l. \tag{10}
$$

which implies that the degree of concern $\xi_l(\epsilon_i, \psi_l)/\xi_i(\epsilon_i, \psi_i)$=1.

Safety-focused paternalistic altruism means that member i's utility towards mortality risks derived from l's risk of death only depends upon i's coefficient of concern for l, i.e. $\forall i \neq l$, $\exists l$ such as $\partial V_i / \partial \mu_l > 0$. This leads to equation (6). The test related to safety-focused paternalistic altruism consequently amounts to test the following alternative hypothesis:

$$
\mathbf{H}_1^{SFPA} : \xi_i(\epsilon_i, \psi_i) \neq \xi_l(\epsilon_i, \psi_l) > 0, \text{ for at least one household member } l \neq i. \tag{11}
$$

[2] We do not present pure paternalism (which is similar to pure altruism within our framework) and various degrees of wealth-focused and safety-focused altruism that would exist if individual i's utility function was a function of the wealth of each household member W_{lk} instead of the total household wealth W_k (see Jones-Lee, 1992).

3 Experimental design

The data used in this paper are derived from a state preferences experiment designed to explore theoretical and empirical issues related to the risks of air pollution exposure. Respondents were from the Bouches-du-Rhône district (1.8 million inhabitants), which includes Marseilles, the second largest city in France. In the survey, respondents were asked about their willingness to pay (WTP) to reduce the risk of morbidity and mortality owing to air pollution exposure. The first part of the survey required respondents to provide details of their socio-economic background, risk attitudes, belief and knowledge of air pollution and health status. In the second part, the scenario was described and WTP was elicited.

Following Viscusi et al. (1988), the scenario proposed a hypothetical choice of moving with her household between two cities, which are exactly the same (city size, housing, weather, public services etc.) with the exception of the cost of living and the level of air pollution.[3] By moving to a less polluted place, the respondent was randomly offered the possibility to reduce the mortality risk associated to air pollution exposure by 25%, 50% or completely for herself and other members of her household (see appendix B for the hypothetical scenario). The corresponding changes in the risks of death are computed based on epidemiologic data (see Künzli *et al.*, 2000) for the levels of risk variations presented in the hypothetical scenario (see Appendix D for detailed computations).[4]

The scenario we use is distinct from those usually used in valuation studies. The common practice is to ask for the maximum WTP ($w^{\star}_{ik}$) to move from an (existing) initial situation to a final situation in which an action (public or private) increases the quality of natural resources, health status, life duration, *etc.* or reduce negative externalities like noise, pollution, pain, *etc.* Our scenario focuses on a private action–choosing which city your household will live–not a public action. This eliminates the potential confounding factors of altruism others outside the family. Consequently, the respondent values variations of mortality risk only for herself and other household members.

4 Data

We collected WTP data using two methods.[5] First, we use an innovative survey (267 persons). The survey was self-administrated following the instructions given by the research team. Two sessions of 142 and 125 respondents have been organized in the Region Council

[3]The air quality in Marseilles, the largest city of the district, was used as a referent point for all respondents.

[4]Note that these data are not precise enough to allow for the computation of age-dependent changes in risk of death. Hence, we use an average change computed for each household's member ($d\mu_i = d\mu_l$), $\forall l, i$ which implies that $d\mu_l/d\mu_i \equiv 1$ in equation (6).

[5]A semi-directive face-to-face interviews (73 persons) provided information to pre-test and refine the survey.

congress room and lasted for one hour. WTP revelation questions were computer-assisted with an electronic vote sessions (see Chanel *et al.*, 2005). Second, we ran a telephone survey on 1006 respondents by an opinion survey company during July 2000 and July 2001 through computer-assisted telephone interviews using four stratification variables (age, gender, residence and profession). Our sample was representative of the corresponding population.

From the initial 1273 interviews, the 'WTP for a mortality reduction' question was asked to a sub-sample of 731 of 1006 telephone respondents and all the self-administrated respondents (267). The exploitable sub-sample is 923 respondents. Among these 923 respondents, 7 (0.8%) exhibited unusable responses, 12 (1.3%) exhibited protest responses[6]. In addition, 41 respondents whose WTP was surprisingly high in relation to the household income were also excluded.[7] The remainder consists of 862 respondents. The elicitation mechanism covered several questions and the analysis in the following focuses on the responses received from the open-ended question that specifically deals with WTP for mortality risk reduction. Appendix C presents the mean and standard deviation of variables characterizing the sample.[8]

Wealth is computed as the monthly income of the household, and relationship categories (parents, spouse, siblings, children) are used to construct a typology of household composition with eight categories: single, couple without child(ren), couple with child(ren), single with child(ren), single with sibling(s), couple in parent(s)'s home, single in parent(s)'s home and other cases.[9] Table 1 presents several statistics computed for these eight categories and the average $w^{\star}_{ik}$ for each category.

The average monthly WTP for the whole sample is 371.9 FRF (the median is 250 FRF), the average income is 12747 FRF (median 12500 FRF), and the average share of the income devoted to WTP is 3.26% (median 2.40%). When distinguishing whether respondent belongs to single or non-single household, we notice that the WTP is higher in the second case (277 *vs* 394 FRF), like the average household income (6984 *vs* 14042 FRF). However, the average WTP represents approximately the same share of the household income (3.15% *vs* 3.78%). Refining the analysis by distinguishing the composition of non-single

[6]Protest responses are either respondents who do not answer to the WTP questions or respondents that express null WTP and justify their answers by choosing the item "I am willing to change my behaviour in order to pollute less but I am not willing to pay for living in a less polluted place".

[7]The upper limit of the ratio WTP/household income was set at 0.15 and 4.44% of respondents interviews were thus removed (see Duffield and Patterson, 1991 or Kanninen, 1995, on the problem of thick upper tails in WTP distributions).

[8]As respondents in the Regional Council differ from the general population, the overall sample is not perfectly representative of the socio demographic characteristics of the Bouches-du-Rhône (BDR) population. In particular, 55.0% are female (52.3% in the BDR population), 18.9% are living alone (27%), 58.1% live in Marseilles (45.48%), the average number of persons in the household is 2.78 (2.56), the level of education is higher (38.3% have a tertiary education versus 32.2%) and the average individual income is 5275 FRF (1 FRF = 0.15 euro and 1 euro = \$ 1.17, November 2005) versus 7021 FRF in the BDR population. Hence, the sample population over-represents urban non-single women with a relatively low income and a higher level of education.

[9]We were unable to identify the structure of the household for six respondents and we excluded them from the data.

The respondent is ... (number of cases)	Number of persons in household	Monthly WTP $w^\star_{ik}$ (FRF)	Monthly Income W_k (FRF)
All compositions	2.78	371.93	12 747
(N=856)		*250.00*	*12 500*
Single	1	277.08	6 984
(N=162)		*162.50*	*7 900*
non-single	3.19	394.07	14 042
(N=694)		*300.00*	*12 500*
Couple without child(ren)	2	350.93	12 574
(N=204)		*200.00*	*12 500*
Couple with child(ren)	3.94	503.89	16 907
(N=198)		*400.00*	*17 500*
Single with child(ren)	2.74	246.40	10 197
(N=43)		*300.00*	*7 900*
Single with sibling(s)	2.37	302.83	11 208
(N=30)		*262.50*	*7 900*
Couple in parents' home	3.62	218.97	13 258
(N=29)		*150.00*	*12 500*
Single in parents' home	3.84	395.25	13 873
(N=182)		*300.00*	*12 500*
Other cases	4.25	520.00	13 900
(N=8)		*125.00*	*12 500*

NB: Medians are in italics.

Table 1: Statistics according to the composition of the household (n=856)

households, we see a higher average WTP for couple with children, and a lower average for couples in parents' home. Table 1 shows that the average WTP of single respondents is 30% lower than the average WTP for non-single respondents, suggesting the possible existence of altruism.

5 Results

We now use a three steps method to formally test for altruism. In **step 1**, we estimate the "Pure self interest" model used as the null hypothesis ($\mathbf{H}_0^{SI}$)[10] and show that our experimental design yields reasonable economic results. In **step 2**, we test for the presence of altruism. We do so with unconditional mean difference tests. We then introduce in the econometric model the utility derived from the decrease in risk for each type of relatives one by one and test for significance of altruism for each household member using Likelihood Ratio (LR) tests. Both analyzes lead us to reject the self-interest model hypothesis $\mathbf{H}_0^{SI}$ in favor of an altruistic model in which respondents only express concern towards children under 18. In **step 3**, we estimate a model with exogenous covariates to explain altruism over children under 18. This allows us to estimate the degree of concern ($\xi_l(\epsilon_i, \psi_l)/\xi_i(\epsilon_i, \psi_i)$) for children under 18. We show that this degree of concern is significantly less than one.

[10] See Appendix A for the parameterization of the econometric model.

	WTP ($w^\star_{ik}$)			WTP per member ($w^\star_{ik}/n$)		
	N	Mean	Std. Dev.	N	Mean	Std. Dev.
Single respondents	162	277.08	343.33	162	277.08	343.33
non-single respondents	694	394.07	453.79	694	137.29	168.53
Equality test		3.66			-5.042	
Corresponding p-value		0.0001†			<0.0001	

† Unilateral p-value

Table 2: Mean difference tests for single and non-single respondents (N=856)

We thus reject the pure altruism hypothesis $\mathbf{H}_1^{PA}$ in favor of the safety-focused paternalistic altruism hypothesis $\mathbf{H}_1^{SFPA}$. The three steps are detailed below.

Step 1

Results for the pure self-interest model are presented in the first column of Table 3.[11] To examine whether our experimental design yields reasonable economic results, we review the parameter estimates. First, note the parameter associated to the income elasticity is highly significant (p <0.001) and higher than a half. This is reassuring (see Hausman 1993 for a discussion on this issue) and supports the validity of the stated preference experiment (what Bishop and Woodward (1995) defined as *theoretical construct validity*). The income elasticity is significantly lower than one (p <0.001), which means that WTP increases less proportionally than income, which justifies the use of the Box-Cox transformation (see Appendix A). An overview of the effect of the other significant variables leads to the following coherent results. The effect of AGE is quadratic, with a maximum at 46 years. Parameter estimates associated with *smoking more than 10 cigarettes a day* (BSMOKER) and *declaring valuing health* (HEALTHIMP) have a negative and a positive impact in the WTP equation, which follows common sense.

Step 2

The presence and type of altruism in respondents' answers is first examined through standard unconditional mean difference tests (Table 2). First, we reject the hypothesis of self-interest behavior since the mean WTP $w^\star_{ik}$ difference between single respondents and non-single respondents (Column 1) is highly significant ($p < 0.001$). Second, we test for the types of altruism. Column 2 computes the WTP per member for non-single households $w^\star_{ik}/n$, and shows the value obtained for non single households is half the value obtained for single households (137 vs. 277). This indicates the pure form of altruism is unlikely to exist in our sample. Rather, data indicate that safety-focused paternalistic altruism is the

[11] Due to missing values (mainly for the income variable), the sample size reduces to N=709. Table 4 in Appendix C provides the sample characteristics and shows no significant differences with the initial sample. Computations were made using the R statistical package version 2.0.1. Models were estimated using Broyden-Fletcher-Goldfab-Shanno (BFGS) algorithm. Convergence was checked using a stochastic global optimisation algorithm (simulated annealing). Parameters associated to the standard error σ and the mixing probability δ are parameterized by an exponential and a double exponential in order to guarantee that $\sigma > 0$ and $0 < \delta < 1$.

prevailing form of altruism.[12] Of course, these findings do not take into account income elasticity and heterogeneity of preferences with respect to risk of death and they must be confirmed by econometric estimations.

Therefore, we test for the presence of altruism (either pure or safety-focused paternalistic) by introducing in the econometric model the utility derived from relationship categories: parent(s), spouse, child(ren) under 18 years, child(ren) over 18 years, sibling(s) under 18 years, sibling(s) over 18 years. When the respondent has several relatives of a same type (for instance two children under 18 years), the utility derived from the decrease in risk is proportional to the number of relatives of the same type.[13] The estimated model is used as the alternative hypothesis against the pure self interest model (hypothesis $\mathbf{H}_0^{SI}$). Only one type of family member is significant according to the LR test: the child(ren) under 18 ($p-value = 0.012$)–this rejects the hypothesis of pure self-interest ($\mathbf{H}_0^{SI}$). The five other types of relative do not have any impact on respondents' willingness to pay ($p-value \approx 1$).

In the second column of Table 3, we present the details of the altruistic model with child(ren) under 18 years. Estimates are in line with the pure self-interest model, although the parameter estimates associated with AGE and AGE^2 are less significant in the altruistic model.[14] The highest level of education enters the set of significant variables with a positive effect, albeit at a 10% threshold level.

Step 3

Finally, we examine the determinates of the altruistic effect associated with child(ren) under age of 18. Explanatory variables have been introduced successively and tested with LR tests. We find only two significant variables in the heterogeneous altruistic model

[12] These descriptive results are in the range of the few European studies that previously describe 'levels' of altruism. In the UK, Needleman (1976) observed the average person was willing to pay between 10% and 38% of her own WTP to decrease the risk of dying of relatives, depending on the degree of relation. Jones-Lee (1989) observed people were willing to pay 43% more a for a safety device if it protects all the passengers rather than herself only. Jones-Lee (1992) showed theoretically that the VPF in a representative U.K. population with plausible distribution of altruistic concern should be 10% to 40% larger than the one in a purely self interested population. In Switzerland, Schwab and Soguel (1996) found in a CV survey that the human costs to victim's relatives are systematically about 25% higher than those borne by the victim himself. In Sweden, Lindberg (2003) found that a relative's safety is valued between 33% and 72% of one's own safety, and that safety-related altruism is the predominant type of altruism (only 2.5% to 3.5% of the sample have pure altruistic preferences). In Norway, Strand (2003) found that concern for other family members represents between 56% and 70% of the value for the whole family (when the concern "other motives" is ruled out).

[13] This amounts to assume constant marginal utility of children with symmetric concern over children. We tested the assumption of constant marginal utilities of children by identifying the first, the second and the remaining children. Given their relative low statistical significance (slightly more than 10%), we maintain the assumption of constant marginal utility of children in order to gain statistical power. We also keep with symmetric concern over children as is commonly assumed (Wilhelm, 1996; Agee and Crocker 2002).

[14] As living with one's child(ren) is obviously correlated with the age of the respondent, this result is not surprising and might rather indicate a weakness of the data than a weakness of the model. If we had a larger dataset with more variations of age with respect to children, we would most likely find age significant.

	Pure self-interest model	Constant altruistic model towards child < 18	Heterogeneous altruistic model towards child < 18
		Parameter ($p-$value)	
Constant	0.1443	0.5517	0.7909
	(0.846)	(0.469)	(0.295)
SEX	0.1255	0.1414	0.1589
	(0.190)	(0.158)	(0.110)
AGE$^{(a)}$	3.8397**	2.3219	1.9249
	(0.012)	(0.166)	(0.241)
AGE$^{2\,(a)}$	-4.1688**	-2.4918	-2.1042
	(0.013)	(0.174)	(0.242)
EDUC2	0.0807	0.1010	0.0926
	(0.539)	(0.464)	(0.501)
EDUC3	0.1678	0.1938*	0.2038*
	(0.132)	(0.100)	(0.082)
HEALTHWORK	0.1396	0.1050	-0.0950
	(0.369)	(0.533)	(0.617)
AIRPERSO	-0.0344	-0.0153	-0.0188
	(0.799)	(0.914)	(0.894)
BADQUALI	-0.1692	-0.1869*	-0.2756**
	(0.113)	(0.095)	(0.018)
BSMOKER	-0.6034***	-0.7700***	-0.7068***
	(0.002)	(<0.001)	(0.002)
HEALTHIMP	0.2386**	0.2703**	0.2892***
	(0.018)	(0.014)	(0.006)
KNOWAIR	-0.00004	-0.00009	-0.00011
	(0.957)	(0.908)	(0.880)
Income elasticity $\hat{\alpha}$	0.5624***	0.5377***	0.5214***
	(<0.001)	(<0.001)	(<0.001)
Standard error: $\log(\hat{\sigma})$	0.1175***	0.1118***	0.1039***
	(<0.001)	(<0.001)	(<0.001)
Mixing probability $\hat{\delta}$	0.8378***	0.8378 ***	0.8378***
	(<0.001)	(<0.001)	(<0.001)
Altruism towards child(ren) < 18			
Constant	-	-0.4934	-0.9384
	-	(0.584)	(0.344)
HEALTHWORK	-	-	1.6391***
	-	-	(0.001)
BADQUALI	-	-	1.4298**
	-	-	(0.027)
Loglikelihood	-4570.04	-4566.95	-4562.48

*** if p-value<0.01, ** if p-value<0.05, * if p-value<0.1
$^{(a)}$ AGE = age of the respondent /100

Table 3: Econometric estimations (N=709), dependent variable is $w^{\star}_{ik}$.

(third column of Table 3): *being a health worker* and *a low air quality perception* (joint nullity test: $p - value = 0.011$). Both variables have a positive impact and suggest greater altruism towards children. Both variables can be rationalized based on common sense– health workers are better informed about health effects, and greater perceived risk induces more response.

From parameter estimates of the heterogeneous altruistic model and equation (6), it is straightforward to compute the degree of concern for the child(ren) under 18 for each respondent, that is $\xi_l(\epsilon_i, \psi_l)/\xi_i(\epsilon_i, \psi_i)$ ($l = Child(ren) < 18$). On average, the degree of concern equals 0.314 for each children under 18 years with a bootstrapped 95% confidence interval [0.280; 0.354]. This result rules out the likelihood that pure altruism ($\mathbf{H}_1^{PA}$) is the dominant type of altruism in our sample in favor of safety-focused paternalistic altruism ($\mathbf{H}_1^{SFPA}$). Our results suggest that for every franc spent by the average parent; he or she will spend another 31 cents on his or her child. On average, this translates into a mean WTP of 407.8 FRF (standard deviation 343.0) for parents with children and a mean WTP of 244.9 FRF (standard deviation 193.5) for parents without children (median WTP 338.5 FRF with children; median WTP 220.3 FRF without children).

6 Conclusion

Does charity begin at home for air pollution reduction? Our answer is 'yes and no'. 'Yes', we find paternalistic altruism for children under 18; 'no', we do not find any other forms of altruism within the family, pure or otherwise. These results suggest two things–First, for every franc spent by an average parent on air pollution improvement, his or her safety-focused paternalistic altruism leads him or her to spend another 31 cents for each child under 18 in the family. Second, this extra payment translates into a sizable increase in the value of improved air quality if it would be accounted for in cost-benefit analysis.

The delicate question we now raise but do not expand on is whether the estimated concern for children under 18 is truly paternalistic altruism or some form of selfish behavior as in the selfish gene or behavioral failure (e.g., self-control, multiple-self) argument. There is an identification question here that arises when considering paternalism within the family versus the desire to promote and protect one's genetic code for posterity. If it is paternalistic altruism in the economic sense, our results show that it can be captured and included in welfare evaluation. But if it is selfish genetics at work or some behavioral failure driving the behavior, the standard approach to welfare economics is undercut. This would lead one toward the on-coming traffic using behavioral failures as the justification of government intervention in personal decisions (see for example Sunstein and Thaler, 2003). Sorting out this identification question remains a vital topic for future research in understanding the role of altruism and behavior in nonmarket valuation.

7 References

Andreoni, J. (2002) "Giving According to GARP: An Experimental Test of the Consistency of Preferences for Altruism", *Econometrica*, **70**:2, 737-753

Bergstrom, T. (1982), "When is a man's life worth more than his human capital?" In Jones-Lee, M. (Ed.), *The value of life and safety*, North-Holland, Amsterdam.

Bergstrom, T. (1997), "A Survey of Theories of the Family", In M. Rosezweig and O. Stark (Eds.), *Handbook of population and family economics*, vol. 1A, 21-79, North-Holland, Amsterdam.

Chanel O., S. Cleary and S. Luchini (2005) "Does Public Opinion Influence Willingness-to-Pay? Evidence from the Field" , *Applied Economics Letters*, forthcoming.

Diamond, P., and J. Hausman (1993), "On contingent valuation measurement of nonuse values" In: Hausman, J.A. (Ed.) *Contingent Valuation: A Critical Assessment* 3-38, North-Holland, Amsterdam.

Duffield J.W. et Patterson D.A. (1991), "Inference and Optimal Design for A Welfare Measure in Dichotomous Choice Contingent Valuation", *Land Economics*, **67**2, 225-239.

Fehr E. and U. Fischbacher (2003), "The nature of human altruism", *Nature*, **425**, 785-791.

Fischhoff, B. (1989), "Risk: a guide to controversy", In *Improving Risk Communication, Appendix C*, National Research Council Committee, 211-319, National Academy Press, Washington DC.

Guria J, Jones W, Jones-Lee MW, Keall M, Leung J and Loomes G (1999) *The values of statistical life and prevention of injuries in New Zealand.* Report to the New Zealand Transport Safety Authority.

Hammitt, J.K., and J.D. Graham (1999), "Willingness to Pay for health protection?: inadequate sensitivity to probability ?", *Journal of Risk and Uncertainty* **8**, 33-62.

Hoffrage, U., Lindsey, S., Hertwig, R., and Gigerenzer, G. (2000). Communicating statistical information. *Science*, **290**, 2261-2262.

Hugues, M. (1973), "Our concern with others", in Selby-Bigge, L. (Ed.), *Philosophy and Personal Relations*, London.

Jones-Lee, M.W. (1976) *The value of life: An economic analysis* , Chicago: University of Chicago Press.

Jones-Lee, M. (1989), *The Economics of Safety and Physical Risk*, Basil Blackwell, Oxford.

Jones-Lee, M. (1991), "Altruism and the Value of Other People's Safety", *Journal of Risk and Uncertainty* **4**, 213-219.

Jones-Lee, M. (1992), "Paternalistic Altruism and the Value of Statistical Life", *The Economic Journal* **102**, 80-90.

Jones-Lee, M. (1994), "Safety and the saving of life : The economics of safety and physical risk", In R. Layard & S. Glaister (Eds.), *Cost-benefit Analysis*, Cambridge University Press.

Kanninen B.J. (1995), "Bias in Discrete Response Contingent Valuation", *Journal of Environmental Economics and Management*, **28**, 114-125.

Künzli, N., R. Kaiser, S. Medina, M. Studnicka, O. Chanel, M. Herry, F. Horak, V. Puybonnieux-Texier, P. Quenel, J. Schneider, R. Seethaler, J.-C. Vergnaud and H. Sommer (2000), "Public-health impact of outdoor and traffic-related air pollution: a European assessment", *Lancet* **356**, 795-801, Sept. 2nd.

Lindberg, G. (2003), "Benevolence and the value of statistical life Safety of children relatives and friends", Chapter 3, PhD dissertation, `http://www.vti.se/tek/MC-tema-filer/doc/seminarium/gli_ch3.pdf`

Manski, C. F. (2004) "Measuring Expectations", *Econometrica*, **72**(5), 1329-76.

McFadden, D. and G. K. Leonard (1993) "Issues in the contingent valuation of environmental goods: Methodologies for data collection and analysis" In: Hausman, J.A. (Ed.) *Contingent Valuation: A Critical Assessment* 165-215, North-Holland, Amsterdam.

Milgrom, P. (1993), "Is Sympathy an Economic Value? Philosophy, Economics, and the Contingent Valuation Method", In Hausman, J.A. (Ed.), *Contingent Valuation: A Critical Assessment* 417-441, North-Holland, Amsterdam.

Milgrom P. (2004) *Putting Auction Theory to Work*, Cambridge University Press.

Mishan, E.J. (1971), "Evaluation of life and limb: a theoretical approach", *Journal of Political Economy*, **79**, 687 - 705.

Needleman, L. (1976), "Valuing others people's lives", *The Manchester School Social Studies* **44**, 309-342.

Pidgeon, N. and J. Beattie (1997), "The psychology of risk and uncertainty", In Calow P. (Ed.), *Handbook of Environmental Risk Assessment and Management* 289-318, Blackwell Science, Oxford.

Schwab C. N. and N. Soguel (1996), "The Pain of Road-Accident Victims and the Bereavement of their Relative A Contingent Valuation Experiment", *Journal of Risk and Uncertainty*, **13**(3), 277-291.

Strand, J. (2003), "Interpersonal factors in the valuation of statistical lives", *Working Paper*, Department of Economics, University of Oslo, August.

Thaler R.H.; Sunstein C.R. (2003) "Libertarian Paternalism", *American Economic Review*, **93**(2), 175-179.

Viscusi, K., J., Hakes and A. Carlin (1997), "Measure of Mortality Risks", *The Journal of Risk and Uncertainty* **14**:3, 213-233.

Viscusi W.K., Magat W.A. and Forrest A. (1988), "Altruistic and private valuations of risk reduction", *Journal of Policy Analysis and Management*, **7**:2, 227-245.

A Econometric model

In order to estimate the model, we need to parameterize both sides of equation (6). First, the individual's utility $h(.)$ derived from household wealth is parametrized as a "Box-Cox" transformation of income:

$$h(W_k;\alpha) \equiv \begin{cases} \frac{W_k^{1-\alpha}}{1-\alpha} & \text{if } W_k > 0 \text{ and } \alpha \neq 1 \\ \log(W_k) & \text{if } W_k > 0 \text{ and } \alpha = 1 \end{cases} \tag{12}$$

with the parameter α interpreted as the elasticity of utility with respect to household wealth. It includes as special cases the linear ($\alpha = 0$) and logarithmic ($\alpha = 1$) forms most commonly used in the literature and thus provides sufficient flexibility (McFadden and Leonard, 1993). From equation (12), the left-hand side of equation (6) becomes:

$$G(W_k, w_{ik}^\star;\alpha) \equiv \begin{cases} \frac{W_k^{1-\alpha}-(W_k-w_{ik}^\star)^{1-\alpha}}{1-\alpha} & \text{if } \alpha \neq 1 \\ -\log(1-w_{ik}^\star/W_k) & \text{if } \alpha = 1 \end{cases} \tag{13}$$

Second, utility derived from a decrease of risk of death is assumed to be a "good" and thus must be positive. This leads to the following for the Right Hand Side of equation (6):

$$\begin{aligned} d\mu_i \xi_i(\epsilon_i, \psi_i)\left[1 + \sum_{l\neq i} \frac{d\mu_l}{d\mu_i}\frac{\xi_l(\epsilon_i,\psi_l)}{\xi_i(\epsilon_i,\psi_i)}\right] &= d\mu_i\left[e^{\epsilon_i}\gamma_i + \sum_{i\neq l}\frac{d\mu_l}{d\mu_i}e^{\epsilon_i}\gamma_l\right] \\ &= d\mu_i e^{\epsilon_i}\left[\gamma_i + \sum_{i\neq l}\frac{d\mu_l}{d\mu_i}\gamma_l\right] \end{aligned} \tag{14}$$

with γ_i and γ_l are functional forms that allow for individual heterogeneity, and that must be non-negative by assumption. A standard specification states

$$\gamma_i(X_i;\beta_i) = \exp(X_i\beta_i) \text{ and } \gamma_l(X_l;\beta_l) = \exp(X_l\beta_l), \forall l \neq i \tag{15}$$

where X_i (X_l) is a matrix of explanatory variables specific to the respondent i which captures preferences for herself (for household member $l, l \neq i$), and β_i (β_l) is a vector of parameters characterizing the respondent's utility derived from the decrease in his own risk (in household member $l, l \neq i$). The logarithm of equation (6) parameterized using (13) and (14) is:

$$\log\left[G(W_k, w_{ik}^\star;\alpha)\right] = \log(d\mu_i) + \log\left[\gamma_i + \sum_{i\neq l}\frac{d\mu_l}{d\mu_i}\gamma_l\right] + \epsilon_i \tag{16}$$

Third, we assume that $w_{ik}^\star$ is not a limiting value. From the mapping (13) and equation (16), $w_{ik}^\star$ has the density

$$f_w(w_{ik}^\star;\theta) = \frac{1}{\sigma}\frac{f_{\epsilon_i}\left[\log\left(G(W_k, w_{ik}^\star;\alpha)\right);\theta\right]}{(W_k - w_{ik}^\star)^\alpha G(W_k, w_{ik}^\star;\alpha)} \tag{17}$$

In the case ϵ_i is normally distributed, the density of $w^\star_{ik}$ is

$$\frac{\phi\left[\frac{\log\left(G(W_k,w^\star_{ik};\alpha)\right)-\log(d\mu_i)-\log\left(\gamma_i+\sum_{i\neq l}\frac{d\mu_l}{d\mu_i}\gamma_l\right)}{\sigma}\right]}{\sigma(W_k-w^\star_{ik})^\alpha G(W_k,w^\star_{ik};\alpha)} \tag{18}$$

where $\phi(.)$ is the density of the standardized normal distribution. The parameters of the model can be estimated by maximum likelihood provided that different variations of risk $d\mu_i$ are submitted to sub-samples of respondents and that the composition of the household varies across the sample.

Finally, one remaining issue comes from respondents with null willingness to pay. To provide additional flexibility needed to handle observations at zero, we assume a degenerate distribution centered at zero (see McFadden and Leonard, 1993). The density of $w^\star_{ik}$ is then defined as follows:

$$g_w(w^\star_{ik};\theta)=\begin{cases}\delta & \text{if } w^\star_{ik}{=}0\\ (1-\delta)f_w(w^\star_{ik};\theta) & \text{if } w^\star_{ik}{>}0\end{cases} \tag{19}$$

This density corresponds to the delta-lognormal distribution proposed by Aitchison and Brown (1957) when the error terms ϵ_i are normally distributed. Note that the maximum likelihood estimate of δ is easily seen to be $\hat{\delta}=N_0/N$ (where N_0 is the number of zero values and N the sample size).

B Hypothetical scenario

This scenario derived from Viscusi et al. (1998) and Guria et al. (1999) has numerous methodological advantages. First, it decreases the possibility of strategic behavior: the level of air pollution in both cities will not be changed by individual decisions and future behavior. It thus invalidates strategic biases since it becomes too difficult for a respondent to speculate about the way he could manipulate the final decision by formulating a strategic answer. Second, any biases linked to uncertainty about the existence of the good are minimized because no public action is required. Third, the familiarity with the hypothetical market is good since the proposed choice set is very close to those respondents are used to deal with in their 'real' life. Individualistic and economic dimensions dominate in localization decision processes, and this kind of choice is more related to the market sphere than in scenarios that ask for financial contributions to environmental improvements publicly financed. Moreover, even if other criteria are relevant in real localization processes, the scenario makes apparent the trade-off between two criteria only (pollution and cost of living) by constraining the choice set to two similar towns in their other characteristics. This allows for a better understanding of the exact boundaries of the environmental change, and may reduce embedding effects. Finally, the payment ($w^{\star}_{ik}$) is presented as an additional cost to the current monthly expenditure. It reduces the risk of protest responses induced by other payment vehicles such as taxes. Moreover, a household's monthly payment is *a priori* more closely related to the respondents reasoning framework: rent, bank credit, water, electricity and phone bills are generally paid every month.

A remaining issue is related to information provision. In general, people have difficulties with handling risk levels, especially small changes in risk (see Pidgeon and Beattie, 1997, Fischhoff, 1989, Hammitt and Graham 1999). Different ways to present them are available (verbal communication tool, visual aid like risk cards or risk ladders). In the case of air pollution exposure, the difficulty is to limit this cognitive inability but to keep with the epidemiologic reality. We chose to express risk changes on a time period longer than one year and on a large population (one hundred persons). The exact wording was: *x persons out of 100 randomly chosen in the street would die before 80 due to a poor health status related to air pollution exposure. This(ese) person(s) will have lost around 10 years of life.* (x varies randomly in the sample with values 0.5, 1 and 2). This wording is in line with epidemiologic data ('will lost around 10 years of life', 'before 80') and introduces the uncertainty dimension both by mentioning 'randomly chosen in the street' and 'will die before 80'. Since natural frequencies are much more easier to handle with than objective probabilities (Hoffrage *et al.*, 2000; Manski, 2004), the wording 'an annual variation of 0.0004328 in the risk of death' has been avoided (see Appendix D for the detailed computations).

A translation of the 50% reduction scenario presented to respondents and relevant to the study is reproduced below.

« *You are going to be the main actor in our scenario. You will have to take the best decision for yourself and your household.*

Let's imagine that you and your household have to move. You can choose between two towns which are exactly equivalent in terms of inhabitants, work conditions, schools, climate, public services, cultural life, transport, housing, surroundings, etc. There is only one difference between them: the level of atmospheric pollution. The first town - let's call it POL - is as polluted as Marseilles. And the second town - let's call it LESSPOL - is half as polluted as Marseilles.

The problem is that the cost of living is higher in LESSPOL (the less polluted town): housing, local taxes, public transport, etc. are more expensive. This means that if you choose to move to LESSPOL, you will have to pay more to have the same standard of living as in POL.

In fact, only a few persons actually know the impact of air pollution. There are three different types of effects: the pure polluting effects, the irritant effects, and the fatal effects.

The pure polluting effects cause a cloud of brown dust. They make the buildings dirty which have to be more frequently cleaned up and which smell badly.

The irritant effects cause additional diseases: irritated eyes, headache, sore throat, coughing fit, flue symptoms, and even hospitalizations for respiratory and cardiac problems.

Fatal effects shorten life. If you are exposed during several years to a high level of air pollution, you will be less healthy, and you will die earlier. If you take 100 persons living in LESSPOL, ONE will die before 80 because of her/his bad health due to air pollution. This person will have lost around 10 years of life. If these 100 persons live in POL, TWO of them will die. We can hence say that 1 person per 100 can live 10 years more by living in LESSPOL rather than in POL.

We would like to know how much you would be able to pay per month for you and your household to move to LESSPOL (the less polluted town) rather than to POL (the town as polluted as Marseilles). Do not forget that this money will be drawn from your household's budget! You will therefore have less money at the end of the month. »

_ _ _ _ _ _ *French Francs per month.*

C Sample characteristics

Variable	Description	Missing	N =862 Mean (sd)	N =709 Mean (sd)	$p-$value Equality test
SEXE	Gender (Male=1)	0	0.4501 (0.4978)	0.4598 (0.4987)	0.7014
NBPERS	Number of persons in the household	0	2.7941 (1.4370)	2.7320 (1.3936)	0.3865
NBMINEUR	Number of minors in the household	0	0.5783 (0.9391)	0.5839 (0.7415)	0.8942
AGE	Age of the respondent (years)	0	38.1195 (17.6501)	37.8575 (16.9889)	0.7651
INCOME	Monthly household income (FRF)	137	12740.8 (7501.5)	12926.7 (7408.1)	0.6226
EDUC1	Primary-level education (=1)	0	0.4026 (0.4907)	0.4006 (0.4904)	0.9363
EDUC2	Senior high school education level (=1)	0	0.2123 (0.4092)	0.2102 (0.4077)	0.9176
EDUC3	University-level education (=1)	0	0.3828 (0.4864)	0.3893 (0.4879)	0.7940
BSMOKER	Smoking more than 10 cig. a day (=1)	0	0.0626 (0.2425)	0.0663 (0.2490)	0.7701
HEALTHWORK	Being a health worker (=1)	3	0.1071 (0.3205)	0.0973 (0.2966)	0.5306
BADQUALI	Bad air quality perception in Marseilles (=1)	0	0.2610 (0.4394)	0.2736 (0.4461)	0.5748
AIRPERSO	Respondent has personally felt the effects of air pollution (=1)	0	0.8318 (0.3743)	0.8350 (0.3715)	0.8659
KNOWAIR	Respondent declares having a good knowledge of air pollution (=1)	2	0.3047 (0.4605)	0.3047 (0.4606)	0.9999
HEALTHIMP	Respondent declares caring about her health	0	0.6926 (0.4617)	0.6897 (0.4629)	0.9025

Table 4: Descriptive statistics

D Computation of $d\mu$

This appendix presents how the $d\mu_i$ and $d\mu_l$ have been computed, and explicit the wording used in the scenario in terms of "if you take 100 persons living in LESSPOL, ONE will die before 80 because of her/his bad health due to air pollution".

A Gompertz function is generally chosen to approximate the death probability of an individual at age j: $\mu(j) = ce^{bj}$(cf Leksell et Rabl, 2001, Johannesson et al., 1997, etc.). Estimation on French mortality data (Insee, 1999) leads to the following:

$$\mu(j) = ce^{bj} = 0.00007345e^{0.081245106\times j} \quad R^2 = 0.9959 \tag{20}$$

The corresponding conditional survivor function, i.e. the probability to be alive at age t conditional on having survived until age j, is:

$$S_{t,j} = \exp\left[\int_j^t \mu(s).ds\right] = \exp\left[\int_j^t ce^{bs}.ds\right] \tag{21}$$

The concept of Relative Risk (RR) is used to represent the effect of long term air pollution exposure on mortality. It supposes that the death rate $\mu(j)$ is affected proportionally by air pollution exposure:

$$\mu(j) = RR\underline{\mu}(j) \tag{22}$$

where $\underline{\mu}(j)$ is the death rate that would be observed without air pollution. The change in the death rate $d\mu$ that corresponds to the existence of this relative risk between the median age in the population (35 years in 1999) and the age of 80, is computed by solving:

$$\exp\left[-RR^{-1}\int_{35}^{80} ce^{bs}.ds\right] = \exp\left[\int_{35}^{80} (ce^{bs} - d\mu).ds\right] \tag{23}$$

Hence,

$$d\mu = \frac{\int_{35}^{80} ce^{bs}.ds[1 - RR^{-1}]}{45} \tag{24}$$

Particulate Matter of diameter lower than 10 μm (PM10) is used as pollution indicator. French weighted average exposure is assessed at 23.5μg/m^3 (see Filliger et al. 1999), in the range of the two local air pollution measure networks (Airmaraix for the most urban area, 28 μg/m^3 and Airfobep for the most rural and industrial part, 21μg/m^3). The level of 7.5μg/m^3 constitutes the natural level that would be observed in absence of anthropic emissions.

Künzli et al. (2000), estimated the RR of mortality due to air pollution exposure at 1.043 for a 10 μg/m^3 PM10 variation, i.e. $RR = 1 + (0.0043\Delta c)$ for a Δc variation. The level of reduction used in the survey are $\Delta c = 23.5 - 7.5 = 16$ μg/m^3 for a complete suppression, $\Delta c = 8$ μg/m^3 for a 50% reduction, and $\Delta c = 4$ μg/m^3 for a 25% reduction. Since we consider a reduction for the forthcoming-year and an age-independent effect of air pollution exposure on death rate, the corresponding changes in the survival probability are, by (24), $d\mu^{16}$=0.0008378, $d\mu^8$=0.0004328, and $d\mu^4$=0.0002200.

Finally, the right hand side in equation (23) allows us to compute the number of deaths attributable to air pollution as presented in the scenario. For instance, in the case of a 50% reduction, the conditional survivor probability $S_{80,35}$ equals 0.5568 before reduction and 0.5677 after reduction. Converted in a "per 100 persons" base, this leads to 1.09 person (rounded to one).