Does charity begin at home for air pollution reductions? Unraveling intra familial altruism

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Abstract

We propose a structural econometric model explicitly introducing altruism towards household members into willingness to pay for a household public good. The model distinguishes preferences for public good improvements for oneself from preferences for improvements for other household members. We test for three different types of economic behavior - 'pure self-interest', 'pure altruism' and public-good-focused non-pure altruism'. Using an appropriate experimental design and French contingent valuation data regarding air quality improvements, we find positive and significant degrees of concern only for children under the age of 18. They are explained by determinants related to health and subjective air quality assessment. All other forms of pure or air-quality-focused altruism within the family are insignificant, including for children over 18, siblings, spouses, and parents. This result suggests that benefit estimates that do not consider altruism could be undervaluing the public good.

Keywords: air pollution, familial altruism, field experiment, contingent valuation, willingness to pay.
JEL Classification: D6, C9

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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 behavior (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; Goeree et al., 2002) or global externalities like climate change (see Daube, 2019). Given its impact on behavior and choice, many argue that altruism should be addressed within a cost-benefit analysis for more accurate public decision making (Bergstrom, 2006; Jacobsson et al., 2007; Quiggin, 1997). The open question, however, is which type of altruism is driving behavior – pure forms of altruism[1] or specific-good-oriented altruism, e.g. wealth, health, safety, education. This distinction matters because accounting for the utility change of others may or may not affect the desirability of a public project (Bergstrom, 1982, 2006; Jones-Lee, 1991, 1992).

With pure altruism, the utility of others is built into 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 be excluded in the benefit estimate. As shown in Flores (2002) and Bergstrom (2006) for pure altruism, a sufficient condition for a change in a public good to be Pareto-improving is that it satisfies a cost-benefit test based on private values only (if the initial allocation is distributionally efficient).[2]

In contrast, with non-pure forms of altruism (i.e., health or wealth of others enter one's utility function directly), the private value criterion is insufficient to detect a potentially Pareto-improving project. The utility gains to the person from other people's increases in health or wealth could exceed the Hicksian compensation paid by the others, which would make the project Pareto-improving. Economic circumstances exist in such cases such that the greater health or wealth of others should be accounted for, at least partially, in cost-benefit analysis estimates (Mishan, 1971; Jones-Lee, 1976; Johansson-Stenman, 2005; Jacobsson et al., 2007).

In this paper, we test for pure forms versus non-pure forms of altruism for the provision of a public good within the family, using stated preference data. It could be assumed that the obvious way to explore altruism in cost-benefit analysis is to design a valuation survey explicitly eliciting altruistic preferences. This would have people directly state the extent of their altruism, i.e., the value of personal well-being they are willing to forgo to increase

[1]Terminology varies depending on authors. Some authors also referred to "pure altruism" as non-paternalistic or welfare oriented altruism (see, for instance, Bergstrom, 2006; or Flores, 2002).

[2]To get this sufficient condition, one also needs additional technical assumptions, unrelated to altruism itself, to show that the private value CBA test is a necessary condition (see Bergstrom, 2006).

the well-being of someone else.

Some studies explore altruism in this way on the basis of family relationship. Dickie and Gerking (2007, 2009) found that parents are altruistic towards their young children over reducing skin cancer risks, and Evans et al. (2011) found higher Willingness To Pay (WTP) for changes in asthma care-giving time affecting the respondent's child(ren) under 18 than for changes affecting the respondent him/herself, and no difference for other adults. Most studies assessing adults' WTP for children's health (see the review by Agee and Crocker, 2004; or Gerking and Dickie, 2013) found a degree of parental concern[3] greater than one. For the avoidance of acute illnesses, there was a degree of about two for Dickie and Messman (2004) or Liu et al. (2000), of 1.5 for Blomquist et al. (2011) and between 1.4 and 2 for Dickie and Salois (2014). For the reduction of more severe illnesses or mortality risk, Hunt and Ortiz (2006)'s review reported degrees of concern in the range 0.6 - 2.3, almost all being greater than 1; Blomquist et al. (2011) of 1.7 and Gerking et al. (2014) reported degrees of concern greater than 2.

However, the design of these studies makes altruism towards children explicit in the elicitation questions, either through WTP or changes in protective actions taken to reduce the risk of death / illness. This leaves them open to the criticism that if asked whether one is altruistic, it costs nothing to say 'yes'. We propose to fill this gap by designing a survey in such a way that, instead of directly stating the extent of their altruism, people unwittingly reveal their altruism. They state their preferences over certain household trade-offs, following Viscusi et al. (1988), and econometric tools then allow us to calculate the value of their altruism from their choices.

We make two principal contributions to the existing literature. First, our analysis contributes to the methodological literature by proposing a structural econometric model to measure degrees of altruism within the family regarding a change in the level of a household public good. Second, our analysis contributes to the empirical literature by proposing an appropriate experimental design and applying it to a contingent valuation survey related to air quality improvements.

We find evidence of a strict form of air quality focused altruism - parents reveal significant concern only towards their own children under 18. All other forms of pure or air quality focused altruism within the family are insignificant, including for children over 18, siblings, spouses, and parents. This result implies benefit estimates that do not consider altruism could be undervaluing the public good.

[3]The degree of concern of individual i for individual j's health is the ratio of the marginal utility derived by i for a variation of j's health over the marginal utility derived by i for a variation of own's health.

The paper proceeds as follows. Section 2 presents a structural model of altruism within the family. Section 3 analyses the experimental design and the data. Section 4 discusses the results and the final section provides conclusions.

2 A structural model of altruism within the family

Several studies describe 'levels' of altruism within the family for various public policies. Needleman (1976) observed in the UK that 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 kinship. Jones-Lee (1989) observed that people are willing to pay 43% more for a safety device if it protects all the passengers rather than the respondent alone. In Switzerland, Schwab Christe and Soguel (1996) found in a CV survey that the human costs to a victim's relatives are systematically about 25% higher than those borne by the victim herself. In Norway, Strand (2003) found a concern for other family members that represents between 130% and 230% of the value for oneself (when the category "other motives" is removed).

2.1 *Theoretical framework*

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 (household) public good improvement. 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 the household lives with a level of public good q_k. We characterize the individual's random utility function that is separately additive with respect to an index of the household wealth, W_k, her own utility to live with public good level q_k and utility that she derives from other members living with public good level q_k. This function is increasing in W_k and q_k. In the initial situation with baseline level of public good q_k^0, the random utility function is:[4]

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

In this specification, $\theta \equiv (\alpha, \psi_i, \psi_l)$, $i \neq l$ is a vector of parameters. The function $Z_i(q_k^0; \epsilon_i^0, \psi_i)$ captures the individual's taste for the public good, whereas $Z_l(q_k^0; \epsilon_i^0, \psi_l)$ captures the individual's taste for other household members living with public good level q_k^0. The components of the utility $Z_i(q_k^0; \epsilon_i^0, \psi_i)$ and $\sum_{l \neq i} Z_l(q_k^0; \epsilon_i^0, \psi_l)$ vary in the

[4]This type of utility function was first proposed by Needleman (1976). It implies that individuals are not malevolent towards household members. Moreover, we adopt McFadden and Leonard (1993)'s notations.

population with a distribution induced by the ϵ-distribution.

Consider a situation where an improvement in the level of the public good $q_k^1 > q_k^0$ affects all household members and costs c_{ik}. The utility derived by individual i is thus:

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

The compensating variation measure, i.e. the maximum amount the individual i is willing to pay to increase the level of public good, $wtp_{ik}^\star$, satisfies:

$$V_i(W_k, q_k^0; \epsilon_i^0, \theta) = V_i(W_k - wtp_{ik}^\star, q_k^1; \epsilon_i^1, \theta) \tag{3}$$

which leads to the following compensating variation function:

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

We consider a quasi-linear form for the random utility derived from individual i's and other household members' tastes for the public good and the ϵ-distribution (see Milgrom, 2004; for a similar form for pay-offs in auctions):

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

where $\xi_l(\epsilon_i^r, \psi_l)$ is the marginal utility derived by i for a variation of the level of public good for individual l. Consequently, equation (4) becomes

$$G(W_k, wtp_{ik}^\star; \alpha) = dq_k \xi_i(\epsilon_i^r, \psi_i) + \sum_{l \neq i} dq_k \xi_l(\epsilon_i^r, \psi_l) = dq_k \xi_i(\epsilon_i^r, \psi_i) \left[1 + \sum_{l \neq i} \frac{\xi_l(\epsilon_i^r, \psi_l)}{\xi_i(\epsilon_i^r, \psi_i)}\right] \tag{6}$$

where dq_k is the change in the level of public good for household k and $\xi_l(\epsilon_i^r, \psi_l)/\xi_i(\epsilon_i^r, \psi_i)$ can be interpreted as the degree of concern of individual i for household member l's change in the level of public good (see Hughes, 1973; Needleman, 1976; Daube and Ulph, 2016). Expression (6) includes three types of behavior:[5]

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

$$G(W_k, wtp_{ik}^\star; \alpha) = dq_k \xi_i(\epsilon_i^r, \psi_i) \tag{7}$$

[5] We do not present pure paternalism (which is similar to pure altruism within our framework) and various degrees of wealth-focused and public-good-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 and Appendix A).

The self-interest model is the null hypothesis:

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

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

$$G(W_k, wtp_{ik}^{\star}; \alpha) = n_k \times dq_k \xi_i(\epsilon_i^r, \psi_i), \tag{9}$$

and the corresponding alternative hypothesis is defined:

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

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

Public-good-focused non-pure altruism means that member i's utility towards public good derived from l's public good level only depends upon i's coefficient of concern for l with respect to a change in l's public good level, i.e. $\forall i \neq l$, $\exists l$ such as $\xi_l > 0$. This leads to equation (6). The test related to public-good-focused non-pure altruism consequently amounts to test the following alternative hypothesis:

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

2.2 *Econometric model*

The estimation of the model requires several parametrizations on both sides of equation (6). First, the individual's utility $h(.)$ derived from household wealth is parametrized as a "Box-Cox" transformation of income. The left-hand side of equation (6) becomes:

$$G(W_k, wtp_{ik}^{\star}; \alpha) \equiv \begin{cases} \left[W_k^{1-\alpha} - (W_k - wtp_{ik}^{\star})^{1-\alpha}\right]/(1-\alpha) & \text{if } \alpha \neq 1 \\ -\log(1 - wtp_{ik}^{\star}/W_k) & \text{if } \alpha = 1 \end{cases} \tag{12}$$

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.

Second, utility derived from an increase in the public good level is assumed to be a "good" and thus must be positive. This leads to the following for the right-hand side of equation (6):

$$dq_k \xi_i(\epsilon_i^r, \psi_i)\left[1 + \sum_{l \neq i} \frac{\xi_l(\epsilon_i^r, \psi_l)}{\xi_i(\epsilon_i^r, \psi_i)}\right] = dq_k\left[e^{d\epsilon_i}\gamma_i + \sum_{i \neq l} e^{d\epsilon_i}\gamma_l\right] = dq_k e^{d\epsilon_i}\left[\gamma_i + \sum_{i \neq l}\gamma_l\right] \quad (13)$$

with γ_i and γ_l are functional forms that allow for individual heterogeneity, and that must be non-negative by assumption, and $d\epsilon_i = \epsilon_i^1 - \epsilon_i^0$. A standard specification states:

$$\gamma_i(X_i; \beta_i) = \exp(X_i\beta_i) \text{ and } \gamma_l(X_l; \beta_l) = \exp(X_l\beta_l), \forall l \neq i \quad (14)$$

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 an increase in the level of public good for herself (for household member $l, l \neq i$). The logarithm of equation (6) parameterized using (12) and (2.2) is:

$$\log\left[G(W_k, wtp_{ik}^\star; \alpha)\right] = \log(dq_k) + \log\left[\gamma_i + \sum_{i \neq l}\gamma_l\right] + d\epsilon_i \quad (15)$$

Third, we assume that $wtp_{ik}^\star$ is not a limiting value. From the mapping (12) and equation (15), $wtp_{ik}^\star$ has the density:

$$f_{wtp}(wtp_{ik}^\star; \theta) = J_{wtp_{ik}^\star} . f_{d\epsilon_i}\left[\log\left(G(W_k, wtp_{ik}^\star; \alpha)\right); \theta\right] \quad (16)$$

where $J_{wtp_{ik}^\star}$ is the Jacobian term. In the case ϵ_i^r $(r = 0, 1)$ are identically and independently normally distributed $(0, 0.5\sigma^2)$, $d\epsilon_i$ is normally distributed $(0, \sigma^2)$ and the density of $wtp_{ik}^\star$ is:

$$\frac{\phi\left[\frac{\log\left(G(W_k, wtp_{ik}^\star;\alpha)\right) - \log(dq_k) - \log\left(\gamma_i + \sum_{i \neq l}\gamma_l\right)}{\sigma}\right]}{\sigma(W_k - wtp_{ik}^\star)^\alpha G(W_k, wtp_{ik}^\star; \alpha)} \quad (17)$$

where $\phi(.)$ is the density of the standardized normal distribution. The parameters of the model can be estimated by maximum likelihood provided that the composition of the household varies across the sample.

Finally, one remaining issue comes from respondents with zero WTP. To provide the additional flexibility required to handle zero WTP, we assume a degenerate distribution centered at zero (see McFadden and Leonard, 1993). The density of $wtp_{ik}^\star$ is then defined as follows:

$$g_{wtp}(wtp_{ik}^\star; \theta) = \begin{cases} \delta & \text{if } wtp_{ik}^\star = 0 \\ (1 - \delta) f_{wtp}(wtp_{ik}^\star; \theta) & \text{if } wtp_{ik}^\star > 0 \end{cases} \quad (18)$$

This density corresponds to the delta distribution when the error terms ϵ_i are normally distributed (see Aitchison and Brown, 1957). Note that the maximum likelihood estimate of δ is easily seen to be the fraction of zero WTP in the sample.

3 Experimental design and Data

3.1 *Experimental design*

The data used in this paper are derived from a 2000/2001 stated preference experiment initially designed to explore theoretical and empirical issues related to the (health) risks of air pollution exposure. Respondents were from the Bouches-du-Rhône district (1.9 million inhabitants), which includes Marseille, the second largest city in France.[6] In the survey, respondents were asked about their willingness to pay (WTP) to increase the air quality. 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.

The scenario, derived from Viscusi et al. (1988) and Guria et al. (1999), 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.[7] Similar scenarios have been applied to value health risks in the USA (Magat et al. 1996), the United Kingdom (Jones-Lee and Loomes 1999), New Zealand (Guria et al. 2005; Leung and Guria 2006) and France (Ami et al. 2011; Aprahamian et al. 2007, Chanel et Luchini, 2014). The move was mandatory, but by choosing the less polluted place, the respondent was offered the chance to increase the air quality for herself and other members of her household (see Appendix B) for the hypothetical scenario, i.e. to increase the level of a (household) public good.

It is worth noting that revealed preference methods have long used the housing market to assess the value of various spatially-related amenities, including the seminal work of Ridker and Henning (1967) on air pollution. They involve statistical treatments based on the hedonic method, and consider the level of, or distance from, various public goods or bads as a real estate characteristic. Our design makes the trade-off between air quality and wealth more obvious, and it is interesting to compare our results with those based on the hedonic method.

Respondents, aged 18 and above, were asked to take the best decision for themselves and their households, in line with the household budget. While the preferences of under-18s

[6] The air quality in this district is poor due the presence of many petrochemical complexes. This district is the prime emitter of both nitrogen and sulfur dioxide in France, has the highest average ozone concentrations, and Marseille is the French city with the highest annual particulate concentration.

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

regarding air quality also deserve study (this is allowed by the theoretical model), our choice of subjects reflects ethical and legal constraints. Here, we chose to elicit individual WTP to increase air quality on behalf of the household, thus not addressing health resource allocation within the household (see Dickie and Salois, 2014, for a review). The scenario thus explicitly asks the respondent to act as a "dictator" for the household to avoid any strategic issues within the household: "you will have to take the best decision for yourself and your household". Bateman and Munro (2009), valuing reductions in dietary health risks, found that decision-makers give significantly different answers to the same choices in a given household, but could not tell which standpoint (individual or household) provides the best estimate of household behavior. Lindhjem and Navrud (2009), in a survey dealing with forest protection in Norway, found non-significantly different WTP depending on whether respondents are asked to reply on behalf of the household or as individuals, which raises aggregation issues (using individuals' WTP doubles the household welfare change for a couple compared to household WTP).

The scenario we used is distinct from those usually used in valuation studies. The common practice is to ask for the maximum WTP ($wtp^{\star}_{ik}$) 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 focused on a private action – choosing which city your household will live – not a public action. This eliminates the potential confounding factors of altruism outside the family. Consequently, the respondent values an improvement in air quality for herself and other household members only.

Although the usual limits of any stated preference survey also apply (in particular the hypothetical nature of the valuation exercise), this scenario has numerous methodological advantages. First, it decreases the possibility of strategic behavior: the air quality 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 she 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: the lower air pollution level is already offered. Third, the familiarity with the hypothetical market is good since the proposed choice set is very close to those respondents are used to dealing with in '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 that are publicly financed. Moreover, even if other criteria are relevant in real localization processes, the scenario makes apparent the trade-off between two criteria only (air quality and cost of living) by constraining the choice set to two similar cities 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 ($wtp^{\star}_{ik}$) is presented as an additional cost to the current monthly expenditure. This 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 loans, water, electricity and phone bills are generally paid every month.

We collected WTP data using two methods.[8] First, we used an innovative survey (267 persons) self-administrated following the instructions given by the research team. Two 1-hour sessions of 142 and 125 respondents were organized in the Region Council congress room. Each respondent was paid €15.24[9] in gift vouchers. WTP revelation questions were computer-assisted with an electronic vote sessions (see Chanel et al., 2006). Second, we ran a telephone survey on 1006 respondents by an opinion survey company through computer-assisted telephone interviews using four stratification variables (age, gender, residence and profession). On average, one out of six telephone calls ended with a full questionnaire completion, and the sample was representative of the corresponding population. With both surveys, we tried to minimize the possibility of self-selection biased towards altruism- or environmental-friendly motivations. Hence respondents were unaware of the exact topic prior to the survey, described as addressing quality of life. Newspaper advertising of the innovative survey may have attracted respondents for various reasons: financial gain (gift vouchers), curiosity (visiting the Regional Council congress room, rarely open to the public) or technology (participating in an interactive survey).

For both surveys, the elicitation mechanism started with several closed-ended questions regarding an overall improvement in air quality: eight ascending bids in the Regional Council survey, a double-bounded dichotomous choice in the telephone survey (questions 1 in Appendix B). The last closed-ended question was then followed by an open-ended WTP elicitation question that asked respondents to give a precise monetary value. The analysis in the following focuses on the responses received from this final open-ended question (question 2 in Appendix B).

[8]Semi-directive face-to-face qualitative interviews (73 persons) provided information to pre-test and refine the survey.

[9]As €1=6.55957 French Francs (FRF) = \$1.12 (in July 2019), this corresponds to FRF100. Results are expressed in € in the following.

3.2 *Data*

From the initial 1273 interviews, the WTP for an air quality reduction was known for 1188 respondents. Among these 1188 respondents, 7 (0.6%) exhibited unusable responses, 15 (1.3%) exhibited protest responses.[10] In addition, 87 respondents whose WTP was surprisingly high in relation to the household income were also excluded.[11] The remainder consists of 1079 respondents. Appendix C presents the mean and standard deviation of variables characterizing the sample.[12]

[PLEASE INSERT TABLE 1 ABOUT HERE]

Wealth is computed as the monthly income of the household, and relationship categories (parents, spouse, siblings, children) are used to construct a typology of actual household composition with nine categories: single, couple without child(ren), couple with child(ren), couple with sibling(s), single with child(ren), single with sibling(s), couple in parent(s)'s home, single in parent(s)'s home and other cases.[13] Table 1 presents several statistics computed for these nine categories and the average $wtp^{\star}_{ik}$ for each category.

The average monthly WTP for the whole sample is €64.9 (the median is €45.7), the average income is €2057.3 (median €1905.6), and the average share of the income devoted to WTP is 3.55% (median 2.86%). When distinguishing whether the respondent belongs to single or non-single household, we notice that the WTP is higher in the second case (€48.3 *vs.* €68.4), like the average household income (€1118.8 *vs* €2238.3). In the end, the average WTP for a single household represents a higher share of the household income (4.51% *vs* 3.35%). Refining the analysis by distinguishing the composition of non-single households, we see a higher average WTP for couples with children, and a lower average for couples in parents' home or with sibling(s). 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.

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[10]Protest responses are respondents who express null WTP and give a reason in open comments that can be described as protests (for instance, "I do not agree with the principle of paying", "I would not pay since I will only move to live in the country"or "I do not want to pay because the factories are the major polluters").

[11]We remove the respondents (7.32%) whose WTP represents more that 15% of the household income (see Duffield and Patterson, 1991; or Kanninen, 1995; on the problem of thick upper tails in WTP distributions).

[12]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, 53.9% are female (52.3% in the BDR population), 21.8% are living alone (27%), 55.4% live in Marseille (45.48%), the average number of persons in the household is 2.83 (2.56), the level of education is higher (37.0% have a tertiary education versus 32.2%) and the average individual income is €1,027 *vs* €1,050 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.

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

Additionally, we can compute the average annual WTP for a 1-unit change in air quality and compare it with results from revealed preferences. Our scenario corresponds to an 8 $\mu g/m^3$ decrease in the level of particulate matter lower than 10 μm (PM10) (see Chanel et Luchini, 2014; supplementary material). Consequently, the annual WTP for 1 $\mu g/m^3$ is (12x €64.9)/8 = €97.3. Direct comparison with results obtained

from property value data via the hedonic method is difficult because they rely on many factors like choice of pollutant, country, year of survey and methodology used in the analysis. However, a rough comparison yields the following, assuming PM10 represents 50% of the total suspended particulates (Brook et al, 1997) and accounting for differences in currency and purchasing power parity (World Bank, 2019). Smith and Huang (1995) based on 23 studies from 1967 to 1988, found a mean of €93, Chay and Greenstone (2005) a mean of €115, and Bayer et al. (2009), values in the range €252-312. Overall, our CV based results are in the range of revealed preference results.

4 Results

We use a three-step method to formally test for altruism. First, we estimate the "Pure self-interest" model used as the null hypothesis ($\mathbf{H}_0^{SI}$). Then, we test for the presence of altruism by introducing in the econometric model the utility derived from the improvement in air quality for each type of relatives one by one and testing for significance of altruism for each household member using Likelihood Ratio (LR) tests. Finally, we estimate a model with covariates X_l to explain altruism for children under 18. This allows us to estimate the degree of concern $\xi_l(\epsilon_i^r, \psi_l)/\xi_i(\epsilon_i^r, \psi_i)$ for children under 18.

4.1 *The pure self-interest model*

Results for the pure self-interest model are presented in the first column of Table 2.[14] All the covariates were kept in the model to limit the risk of under-specification, but results are comparable with a parsimonious model restricted to significant variables only (details upon request).

Our experimental design yields reasonable economic determinants of WTP, as shown by the parameter estimates. First, note the parameter associated to the *income elasticity*

[14] Due to missing values (mainly for the income variable), the sample size reduces to $N = 973$. Appendix C provides the sample characteristics and shows no significant differences with the initial sample. Computations were made using the R statistical package and models were estimated using Broyden-Fletcher-Goldfarb-Shanno (BFGS) algorithm. Convergence was checked using a stochastic global optimization 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 $0 < \delta < 1$.

is highly significant (p <0.001) and higher than a half. This is reassuring (see Hausman, 1993; for a discussion on this issue) and provides evidence of 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. An overview of the effect of the other significant variables leads to the following results. The effect of *Age* is quadratic, with a maximum at 42 years. The parameter estimate associated with *smoking more than 20 cigarettes a day* (Heavy smoker) has a negative impact in the WTP equation. Four variables that control for self-protection behavior are also significant and self-evident: *caring about one's health* (Care about health), *going regularly to the country to breath fresh air* (Breath fresh air), *possessing an air purifier* (Possess. air purifier) as well as *an air conditioner* (Possess. air conditioner). Those respondents who care about their health and visit the countryside were willing to pay more. People who purchased an air purifier or air conditioner had a lower WTP for collective action because, in effect, they have privately invested in air quality improvements in their home (see Shogren and Crocker, 1991).

[PLEASE INSERT TABLE 2 ABOUT HERE]

4.2 *Test for the presence of altruism*

Main analysis

We test for the presence of altruism (either pure or non-pure air quality focused) in respondents' answers by introducing into the econometric model the utility derived from relationship categories through dummy variables: 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 air pollution is proportional to the number of relatives of the same type, which amounts to assuming constant marginal utility of children with symmetric concern over children.[15] Here, X_l, $l \neq i$, reduce to a dummy variable for each category and the corresponding 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 ($p - value = 0.014$)–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-values $> .3$) and the corresponding parameters are removed.

[15] We tested the assumption of constant marginal utilities of children by identifying the first, the second and the remaining children. Given their low statistical significance ($p = .308$), we maintain the assumption of constant marginal utility of children (like in Hammitt and Haninger, 2007) in order to gain statistical power. We also keep with symmetric concern over children as is commonly assumed (Wilhelm, 1996; Agee and Crocker, 2002).

Altruism does exist, but only for a specific set of people–children under 18 years. This result is in line with Agee and Crocker's (1994, 1996) studies based on revealed preferences of parents to reduce child body lead burden. In the second column of Table 2, we present the details of the constant altruistic model with child(ren) under 18 years. Estimates are in line with the pure self-interest model, although *gender* (Male) and *changing habits during highly polluted days* (Change behavior) now enter the set of significant variables with a positive effect and the parameter estimates associated with Age and Age^2 are no longer significant.[16]

Robustness checks

To determine whether the previous results were driven by the way income entered the model or by the identification strategy, we performed two types of consistency checks. First, instead of using household income among the explanatory variables, we used household income divided by the square root of the number of household members (see Atkinson, Rainwater, and Smeeding, 1995). This may help account for the positive relationship between income and number of children in the household. Second, we estimate the model on a sub-sample of N= 706 observations, restricted to relationships including child(ren) and spouse only, i.e. single with or without child(ren), couple with or without child(ren). We still distinguish minor from major child(ren) living in the household.

The results of these robustness checks are provided in Table 3 and show the findings to be robust to a change in method of household wealth measurement or identification strategy. Overall, in every model, LR tests 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 for children under 18, at a comparable level (between.16 and .20).

[PLEASE INSERT TABLE 3 ABOUT HERE]

4.3 *Looking for the determinants of altruism*

Finally, we examine the determinants of the altruistic effect associated with child(ren) under age of 18 by introducing respondent's characteristics in X_l, $l \neq i$, to explain altruism. We find three significant variables in the heterogeneous altruistic model (third column of Table 2): *being a health worker* (Health worker, $p = 0.037$), *perceiving air quality as low* (Bad air quality, $p = 0.016$) and *smoking more than 20 cigarettes a day* (Heavy smoker, $p = 0.040$) – joint nullity test: $p = 0.021$. All three variables have a positive impact

[16] As living with one's child(ren) is obviously correlated with the age of the respondent, this result is not surprising.

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 air pollution induces more response. Heavy smokers are more concerned for their children's welfare, which can be interpreted as a consequence of guilt or remorse for the highly damaging health effects on their children more than of altruism (see Dickie et al., 2013).

From parameter estimates of the heterogeneous altruistic model ($\hat{\alpha}$, $\hat{\beta}_i$, $\hat{\beta}_j$, $\hat{\sigma}$, $\hat{\delta}$) and equation (6), it is straightforward to compute the degree of concern for the child(ren) under 18 for each respondent with child(ren) under 18, that is $\xi_l(\epsilon_i^r, \psi_l)/\xi_i(\epsilon_i^r, \psi_i)$ ($l = Child(ren) < 18$). On average, the degree of concern equals 0.157 for each child under 18 years with a bootstrapped 95% confidence interval $[0.124; 0.197]$. This degree of concern is significantly less than one. We thus reject the pure altruism hypothesis $\mathbf{H}_1^{PA}$ in favor of the air-quality-focused non-pure altruism hypothesis $\mathbf{H}_1^{PGFA}$. Our results suggest that for every euro spent by the average parent; he or she will be willing to spend another 16 cents on each of his / her children.

This is in accordance with Dickie and Gerking (2007, 2009), Dickie and Messman (2004), Evans et al. (2011) or Liu et al. (2000) for the reduction of morbidity risk, and with Hunt and Ortiz (2006)'s review or Chanel and Luchini (2014) for the reduction of mortality risk. However, most of these authors found a much greater degree of parental concern, suggesting that these values might be driven by the design, which makes altruism towards children explicit in the elicitation questions. This criticism cannot be applied to our design, which allows people to reveal their altruism without knowing they are revealing it.

On average, and accounting for the mix of family types and number of children in the sample, the altruism we found translates into a mean WTP of €69 (standard deviation 54.1) for parents with child(ren) under 18 and a mean WTP of €44.1 (standard deviation 34.2) for respondents without children (median WTP €60.1 with children; median WTP €38.7 without children). This result rules out the likelihood that pure altruism ($\mathbf{H}_1^{PA}$) is the dominant type of altruism in our sample; ; it is more likely to be air-quality-focused non-pure altruism ($\mathbf{H}_1^{PGFA}$).

This confirms the results of Lindberg (2006), who found in Sweden that a relative's safety is valued at 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 the same country, Jacobsson et al. (2007) investigate whether people are paternalistic altruists with respect to strangers' health and found altruism to be predominantly paternalistic and health-focused.

5 Conclusion

Does charity begin at home for air pollution reduction? Our answer is a qualified 'yes.' 'Yes', we find air quality focused non-pure altruism for children under 18; we do not observe, however, any other forms of altruism within the family, pure or otherwise. These results suggest two conclusions: First, for every euro spent by an average parent on air pollution improvement, his or her air quality focused paternalistic altruism leads him or her to be willing to spend another 16 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 were accounted for in cost-benefit analysis.

It should be pointed out that, although the scenario we used has several interesting features, it does not make explicit the time dimension in the respondent's trade-off between higher cost of living and lower air pollution level. Actually, when setting her WTP to move to the less polluted place, the respondent expects the level of air pollution to remain at a low level long enough for her and her household to reap the (health) benefits. However, since the level of pollution depends on regulations and decisions that may be manipulable and/or more uncertain in the long run than an increase in the cost of living, and because the scenario does not link the two, respondents may have lowered their stated WTP (Ami et al., 2018). Note that this, *a priori*, does not preclude a proper estimate of the degree of concern.

In contrast, selection effects are likely to be confounders in the estimation and identification of altruism towards children if they rely on why some respondents have child(ren) and others not. Different *ex ante* preferences regarding children may imply differences regarding the decision on whether to have children and how many, and these preferences could be further reinforced by raising children in a potentially harmful environment. This may result in an endogenous degree of altruism across households with and without children.

Finally, the delicate question we now raise, but do not expand on, is whether the estimated concern for children under 18 is truly 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 undermined. This would lead one toward the on-coming traffic using behavioral failures as the justification for government intervention in personal decisions (see for example Thaler and Sunstein, 2003). This identification question could usefully be explored by future research into the role of altruism and behavior in nonmarket valuation and in determining which social values should be accounted for in cost-benefit analysis. One way would be to adapt contribution to public goods experiments (see, for instance, Palfrey and Prisbrey, 1997; and Goeree et al., 2002) to the family framework.

References

Agee MD, Crocker TD (1994) Parental and social valuations of child health information. J Pub Econ 55:89-105

Agee MD, Crocker TD (1996) Parental altruism and child lead exposure: Inferences from the demand for chelation therapy. J Hum Res 31:677-691

Agee MD, Crocker TD (2002) Parents' discount rate and the intergenerational transmission of cognitive skills. Economica 69:143-154.

Agee MD, Crocker TD (2004) Transferring measures of adult health benefits to children: A review of issues and results. Cont Econ Pol 22:468-482

Aitchison J, Brown JA (1957) The lognormal distribution. Cambridge University, Cambridge

Atkinson AB, Rainwater L, Smeeding TM (1995) Income distribution in OECD countries, Evidence from the Luxembourg Income Study. Volume 18 of OECD Social Policy Studies. Paris: Organisation for Economic Co-operation and Development.

Ami D, Aprahamian F, Chanel O, Luchini S (2011) A test of cheap talk in different hypothetical contexts: The case of air pollution. Env Res Econ 50(1):111-130

Ami D, Aprahamian F, Chanel O, Luchini S (2018) When do social cues and scientific information affect stated preferences? Insights from an experiment on air pollution. J Choice Model 29:33-46

Andreoni J (2002) Giving according to GARP: An experimental test of the consistency of preferences for altruism. Economet 70:737-753

Aprahamian F, Chanel O, Luchini S (2007) Modeling starting point bias and unobserved heterogeneity in contingent valuation surveys: An application to air pollution. Am J Agr Econ 89(2):533-547

Bateman I, Munro A (2009) Household versus individual valuation: What's the difference? Env Res Econ 43(1):119-135

Bayer P, Keohane N, Timmins, C (2009) Migration and hedonic valuation: The case of air quality, J Env Econ Man 58(1):1-14

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 (2006) Benefit-cost in a benevolent society. Am Econ Rev 96:339-351

Bishop R, Woodward R (1995) Valuation of environmental quality under certainty. In: Bromley D (ed) The handbook of environmental economics. Blackwell Publishing, Oxford, p 543.

Blomquist GC, Dickie M, O'Conor R (2011) Willingness to pay for improving fatality risks and asthma symptoms: Values for children and adults of all ages? Res Energ Econ 33 (2):410-425.

Brook J, Dann T, Burnett R (1997) The Relationship Among TSP, PM10, PM2.5, and Inorganic Constituents of Atmospheric Participate Matter at Multiple Canadian Locations. J Air Waste Manag Assoc 47(1):2-19.

Chanel O, Cleary S, Luchini S (2006) Does public opinion influence WTP? Evidence from the field. App Econ Let 13:821-824

Chanel O, Luchini S (2014) Monetary values for risk of death from air pollution exposure: a context-dependent scenario with a control for intra-familial altruism. J Env Econ Policy 3(1):67-91.

Chay K, Greenstone M (2005) Does Air Quality Matter? Evidence from the Housing Market. J Polit Econ113(2):376-424.

Daube M (2019) Altruism and Global Environmental Taxes. Env Res Econ 73:1049-1072

Daube M, Ulph D (2016) Moral behaviour, altruism and environmental policy Env Res Econ 63:505-522

Dickie M, Gerking S, Khaddaria R (2013). Do smoking parents under-invest in children's health? Working Paper. Department of Economics, University of Central Florida.

Dickie M, Gerking S (2007) Altruism and environmental risks to health of parents and their children. J Env Econ Man 53:323-341

Dickie M, Gerking S (2009) Family behavior: Implications for health benefits transfer from adults to children. Env Res Econ 43:31-43

Dickie M, Messman VL (2004) Parental altruism and the value of avoiding acute illness: are kids worth more than parents? J Env Econ Man 48:1146-1174

Dickie M, Salois MJ (2014) Altruism, efficiency, and health in the family. Preference Measurement in Health (Advances in Health Economics and Health Services Research, Volume 24). Emerald Group Publishing Limited, pp. 1-92

Duffield JW, Patterson DA (1991) Inference and optimal design for a welfare measure in dichotomous choice contingent valuation. Land Econ 67:225-239

Evans M, Poulos C, Smith VK (2011) Who counts in evaluating the effects of air pollution policies on households? Non-market valuation in the presence of dependencies. J Env Econ Man 62: 65-79

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

Flores NE (2002) Non-paternalistic altruism and welfare economics. J Pub Econ 83:293-305

Gerking S, Dickie M (2013) Valuing reductions in environmental risks to children's health. Annual Rev Res Econ, 5:245-260

Gerking S, Dickie M, Veronesi M (2014) Valuation of human health: An integrated model of willingness to pay for mortality and morbidity risk reductions. J Env Econ Man 68 (1):20-45.

Goeree JK, Holt C, Laury S (2002) Private costs and public benefits: Unraveling the effects of altruism and noisy behavior. J Pub Econ 83:255-276

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

Guria J, Leung J, Jones-Lee M Loomes G (2005) The willingness to accept value of statistical life relative to the willingness to pay value: Evidence and policy implications. Env Res Econ 32, 113-127.

Hammitt J, Haninger K (2010) Valuing fatal risks to children and adults: Effects of disease, latency, and risk aversion. J Risk Unc 40: 57-83.

Hanemann M, Loomis J, Kanninen B (1991) Statistical efficiency of double-bounded dichotomous choice contingent valuation. Am J Agr Econ 73:1255-1263

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

Hugues M (1973) Our concern with others. In: Selby-Bigge L (ed) Philosophy and personal relations. London

Hunt A, Ortiz RA (2006) Review of revealed preference studies. Paper presented at the VERHI-Children advisory group meeting. OECD, Paris, November

Jacobsson F, Johannesson M, Borgquist L (2007) Is altruism paternalistic? Econ J 117:761-781

Johansson-Stenman O (2005) Global environmental problems, efficiency and limited altruism. Econ Let 86:101-106

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

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. J Risk Unc 4:213-219

Jones-Lee M (1992) Paternalistic altruism and the value of statistical life. Econ J 102:80-90

Jones-Lee M, Loomes G (1999) The monetary valuation of safety and its role in the appraisal of proposed air pollution abatement programmes.? Paper presented at the EVE workshop on 'Health and Value of Life', Strasbourg, France, September 16-18.

Kanninen BJ (1995) Bias in discrete response contingent valuation. J Env Econ Man 28:114-125

Leung, J, Guria J (2006) Value of statistical life: Adults versus children. Accident Anal Prev 38: 1208-1217

Lindberg G (2006) Benevolence and the value of statistical life safety of children relatives and friends. Valuation and pricing of traffic safety. PhD dissertation, Örebro University

Lindhjem H, Navrud S (2009) Asking for individual or household willingness to pay for environmental goods? Env Res Econ 43 (1): 11-25

Liu J-T, Hammitt JK, Wang J-D, Liu J-L (2000) Mother's willingness to pay for own and her child's health: contingent valuation study in Taiwan. Health Econ 9:319-326

Magat W, Viscusi WK, Huber J (1996) A reference lottery metric for valuing health. Manag Science 42 (8): 1118-1130.

McFadden D, Leonard GK (1993) Issues in the contingent valuation of environmental goods: Methodologies for data collection and analysis. In: Hausman JA (ed) Contingent valuation: A critical assessment. North-Holland, Amsterdam

Milgrom P (2004) Putting auction theory to work. Cambridge University Press, Cambridge

Mishan EJ (1971) Evaluation of life and limb: A theoretical approach. J Pol Econ 79:687-705

Needleman L (1976) Valuing others people's lives. Manchester School Soc Stud 44:309-342

Palfrey TR, Prisbrey JE (1997) Anomalous behavior in public goods experiments: How much and why? Am Econ Rev 87:829-846

Quiggin J (1997) Altruism, total valuation and benefit cost analysis. Austral Econ Pap 36:144-155

Ridker R, Henning J (1967) The determinants of residential property values with special reference to air pollution. Rev Econ Stat 49(2):246-257

Schwab Christe N, Soguel N (1996) The pain of road-accident victims and the bereavement of their relative: A contingent valuation experiment. J Risk Unc 13:277-291

Shogren JF, Crocker TD (1991) Risk, self-protection, and ex ante economic value. J Env Econ Man 20:1-15

Smith K, Huang J-C (1995) Can markets value air quality? A meta-analysis of hedonic property value models. J Polit Econ 1031:209-227

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

Thaler RH, Sunstein CR (2003) Libertarian paternalism. Am Econ Rev 93:175-179

Viscusi WK, Magat WA, Forrest A (1988) Altruistic and private valuations of risk reduction. J Pol Anal Man 7:227-245

Wilhelm MO (1996) Bequest behavior and the effect of heirs' earnings: Testing the altruistic model of bequests. Am Econ Rev 86:874-892

World Bank database (World Development Indicators and Global Development Finance), http://databank.worldbank.org/ddp/home.do, access 13 September 2019.

Appendix A. Defining altruism within the family

We provide below standard definitions of other-regarding preferences and under which hypotheses these definitions apply to the econometric framework developed in the article.

Consider a society composed of individuals indexed by $i = 1, ..., n$. They face a public good level q_i during a single forthcoming period, and a wealth W_i. Each individual has a differentiable and generally well-behaved cardinal utility function denoted $V_i(.)$, strictly increasing in q_i and W_i and non-decreasing in its other arguments:

$$V_i = V_i(q_1, W_1, ..., q_n, W_n), \quad i = 1, ..., n. \tag{19}$$

Note by V_{iq_j} the partial derivative of V_i with respect to q_j and V_{iW_j} the partial derivative of V_i with respect to W_j. Consider that each individual i belongs to one and only household, so that the n individuals are partitioned into K households indexed by $k = 1, ..., K$. An household k is composed of n_k members ($n_k \geq 1$), indexed by $l = 1, ..., i, ..., n_k$. Within this framework, and following the literature, different types of other-regarding preferences within a household can then be defined:

Definition 1 *Pure self-interest corresponds to the case in which $\forall i \neq l$ within a given household k, $V_{iq_l} = V_{iW_l} = 0$.*

Definition 2 *Pure (or non-paternalistic) altruism corresponds to the case in which $\forall i \neq l$ within a given household k, $V_{iq_l}/V_{iW_l} = V_{lq_l}/V_{lW_l}$.*

When a household's member is a pure (or non-paternalistic) altruist, he thus respects member l's preferences in that he uses the same marginal rate of substitution between the public good and wealth as member l (see Jones-Lee, 1992).

Definition 3 *Paternalistic altruism corresponds to the case in which member i is not selfish, and $\forall i \neq l$ within a given household k, $V_{iq_l}/V_{iW_l} \neq V_{lq_l}/V_{lW_l}$.*

In that case, member i is said to not respect member l's preferences (see Jacobsson et al., 2007).

Definition 4 *Paternalistic altruism is pure if , $\forall i \neq l$ within a given household k, $V_{iq_l}/V_{iW_l} = V_{iq_i}/V_{iW_i}$.*

Paternalistic altruism is said to be pure when member i values member l's wealth or public good level as his own, irrespective of member l's preferences (see Jones-Lee, 1992). In other words, member i's marginal rate of substitution of l's wealth for member l's public good is the same as his marginal rate of substitution between his own wealth and own public good level.

Paternalistic and non-paternalistic altruism could deviate from the pure form in many ways, especially in the direction of the public good (air quality in our case) or wealth (see Jones-Lee, 1992):

Definition 5 *Public-good-focused non-pure altruism corresponds to the case in which $\forall i \neq l$ within a given household k, $\exists l \neq i$ such as $V_{iq_l} > V_{iW_l} \geq 0$.*

In the extreme case, member i does not care about member l's wealth and $V_{iW_l} = 0$.

Definition 6 *Wealth-focused non-pure altruism corresponds to the case in which* $\forall i \neq l$ *within a given household* k, $\exists l \neq i$ *such as* $V_{iW_l} > V_{iq_l} \geq 0$.

In the extreme case, member i does not care about member l's air public good level and $V_{iq_l} = 0$.

We now concentrate on the assumptions made in the econometric specification and show how the model relates to the previous definitions under these assumptions.

Assumption 1 *Member* i *only considers household's wealth* W_k *in his utility.*

Assumption 2 *The utility function is separable and additive in wealth and public good level:*

$$V_i(q_1, ..., q_n, W_k) = h(W_k) + Z_i(q_i) + \sum_{l \neq i} Z_l(q_l).$$

Assumption 3 *The function* $h(.)$ *is similar for all members of the household* k

Assumption 4 *The function* $Z_i(.)$ *is similar for all members of the household* k *for a same level of public good* q.

Assumption 5 $q_i = q_j = q_k$, *i.e. all household* k*'s members are exposed to the same public good level at home.*

Under these assumptions, the characterization of pure self-interested individual does not change. The different types of other-regarding preferences need however to be reconsidered.

First consider the pure (non-paternalistic) altruism case. Due to assumption (1), $V_{iq_l}/V_{iW_l} = V_{lq_l}/V_{lW_l}$ can be written $V_{iq_l}/V_{iW_k} = V_{lq_l}/V_{lW_k}$. Moreover, assumptions (2) and (3) imply that $V_{iq_l}/V_{lq_l} = 1$ and assumptions (4) and (5) imply that $V_{iq_i} = V_{lq_l} = 1$.

Second, consider pure paternalistic altruism. Due to assumption (1), $V_{iq_l}/V_{iW_l} = V_{iq_i}/V_{iW_i}$ is now: $V_{iq_l}/V_{iW_k} = V_{iq_i}/V_{iW_k}$. Moreover, assumptions (2) and (4) imply that $V_{iq_l}/V_{iq_i} = 1$. It follows that, under assumptions (1) to (5), pure paternalistic altruism is equivalent to pure (non-paternalistic) altruism in our framework.

Public-good-focused non-pure altruism is now defined such that $\exists l \neq i$ such as $V_{iq_l} > 0$. Wealth-focused non-pure altruism has no meaning in our framework, since under assumptions (1), (3) and $V_{iW_i} > 0$, it reduces to pure self-interest.

Appendix B. Hypothetical scenario

A translation of the scenario presented to respondents and relevant to the study is reproduced below (in FRF).

« *You are going to be the central character 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 cities which are exactly equivalent in terms of inhabitants, working 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 city - let's call it POL - is as polluted as Marseille. And the second city - let's call it LESSPOL - is half as polluted as Marseille.

The problem is that the cost of living is higher in LESSPOL (the less polluted city): 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.

Actually, few people realize the impact of air pollution. There are three different types of effects: pure polluting effects, irritant effects, and fatal effects.

The pure polluting effects *cause a cloud of brown dust. They make buildings dirty, so that they need to be cleaned more frequently and smell bad.*

(...)

The irritant effects *cause health problems: irritated eyes (red, watering and smarting eyes), headaches, sore throats, coughing fits, flu symptoms (with fever and tiredness), asthma attacks and even hospitalizations for pneumonia, acute asthma or respiratory and heart conditions.*

(...)

The fatal effects *There are many causes of death and they vary according to age: young people die more in transport accidents, old people die more due to cardiovascular diseases. (...) Air-pollution deaths should be added to the list. Researchers have found that deaths are more numerous and occur in younger people in polluted areas than in less polluted areas. Hence, if you take 100 people living in LESSPOL, ONE will die before 80 because of his/her poor health related to low air quality. This person will have lost around 10 years of life. If these 100 people 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. You are now better informed about the effects of air pollution. Maybe you thought they were less severe or on the contrary, you thought they were more severe.* »

The WTP for a reduction in the overall effects was elicited as follows:

« *We would like to know how much you would be willing to pay per month for you and your household to move to LESSPOL (the less polluted city) rather than to POL (the town as polluted as Marseille). 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.* »

For all the 267 respondents in the Regional Council survey, WTP was elicited using an ascending bid format as follows.

« *To help you determine a value, eight monthly amounts are going to appear on the individual screen. You are going to vote for each of them, one by one. You will press the YES button if you are willing to pay the monthly amount that appears, you will press NO if you are not willing to pay the amount, and ABSTENTION if you don't know or if you abstain. Always press one of the three buttons.* »

QUESTION 1A: First vote « *For you and your household to move to LESSPOL (the less polluted city) rather than to POL (the town as polluted as Marseille), are you willing to pay at least 10 francs per month (i.e. 120 francs per year)?* »

QUESTIONS 1B to 1H: Second vote to eighth vote « *For you and your household to move to LESSPOL (the less polluted city) rather than to POL (the town as polluted as Marseille), are you willing to pay at least 50, 100, 200, 400, 700, 1000, 1500 and more (i.e. 120, 600, 1200, 2400, 4800, 8400, 12000, 18000 francs per year).* »

For all the 1006 respondents in the telephone survey, WTP was elicited using a double-bounded, dichotomous-choice format (Hanemann et al., 1991). The set of initial bids was based on a pretest on 39 respondents. Three initial bids were proposed randomly to the respondent, then followed by a follow-up bid depending on the initial answer:

QUESTION 1A:« *For you and your household to move to LESSPOL (the less polluted city) rather than to POL (the town as polluted as Marseille), are you willing to pay at least 300 (resp. 400, 500) francs per month?* »

QUESTION 1B (if YES answer to question 1A): « *For you and your household to move to LESSPOL (the less polluted city) rather than to POL (the town as polluted as Marseille), are you willing to pay at least 300 (resp. 800, 1000, 1200) francs per month?* »

Or QUESTION 1B (if NO or ABSTENTION answer to question 1A) « *For you and your household to move to LESSPOL (the less polluted city) rather than to POL (the town as polluted as Marseille), are you willing to pay at least 50 (resp. 100, 200) francs per month?* »

For every respondent: QUESTION 2: « *For you and your household to move to LESSPOL (the less polluted city) rather than to POL (the town as polluted as Marseille), what is the maximum monthly amount you are willing to pay?* »

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

Appendix C. Sample characteristics

Variable	Description	Missing	Sample used for descriptive statistics N =1073 Mean (sd)	Sample used in Regressions N =973 Mean (sd)	$p-$value Equality test
$wtp^{\star}_{ik}$	Monthly willingness to pay (€)	0	66.9	66	0.7658
			(71.1)	(69.9)	
Male	Gender (Male=1)	0	0.4613	0.4584	0.9072
			(0.4987)	(0.4985)	
NPers	Number of persons in the household	0	2.8276	2.8993	0.3284
			(1.4433)	(1.4516)	
NMinors	Number of minors in the household	0	0.5788	0.6125	0.4941
			(0.9656)	(0.9818)	
Age	Age of the respondent (years)	0	39.1249	38.1161	0.2576
			(17.8957)	(17.3049)	
Income	Monthly household income (€)	86	2057.3	2062.6	0.9250
			(1098.6)	(1096.9)	
Primary-level educ.	Primary-level education (=1)	0	0.4194	0.4162	0.8999
			(0.4937)	(0.4932)	
Senior high school educ.	Senior high school education level (=1)	0	0.2069	0.2117	0.8154
			(0.4053)	(0.4087)	
University-level educ.	University-level education (=1)	0	0.3700	0.3720	0.9332
			(0.4830)	(0.4836)	
Heavy smoker	Respondent smokes more	0	0.0569	0.0596	0.8165
	than 20 cig. a day (=1)		(0.2317)	(0.2369)	
Health worker	Respondent is a health worker (=1)	4	0.1038	0.1059	0.8996
			(0.3143)	(0.3177)	
Bad air quality	Respondent says that the air quality where	0	0.1566	0.1624	0.7544
	they reside is lower than Marseille (=1)		(0.3636)	(0.3690)	
Affected by air pollution	Respondent has personally felt	0	0.8295	0.8314	0.9163
	the effects of air pollution (=1)		(0.3763)	(0.3745)	
Good knowledge of air poll.	Respondent declares having a good	0	0.3066	0.3042	0.9181
	knowledge of air pollution (=1)		(0.4613)	(0.4603)	
Care about health	Respondent declares caring	0	0.7018	0.7020	0.9937
	about her health (=1)		(0.4577)	(0.4576)	
Change behavior	Respondent changes habits during	0	0.2926	0.2970	0.8498
	highly polluted days (=1)		(0.4552)	(0.4572)	
Breath fresh air	Respondent declares going regularly	0	0.6642	0.6578	0.7895
	to the countryside to breath pure air (=1)		(0.4725)	(0.4747)	
Poss. air purifier	Respondent declares possessing	4	0.0196	0.0175	0.7582
	an air purifier (=1)		(0.1386)	(0.1311)	
Poss. air conditioner	Respondent declares possessing	5	0.06929	0.0678	0.9095
	an air conditioner (=1)		(0.2541)	(0.2516)	

Table 1: Statistics according to the composition of the household (N=1073)

The respondent is ... (number of cases)	Number of persons in household	Monthly WTP $wtp^{\star}_{ik}$ (€)	Monthly income W_k (€)
All compositions	2.83	64.9	2057.3
(N=1073)		*45.7*	*1905.6*
Single	1	48.3	1118.8
(N=192)		*30.5*	*1204.3*
Non-single	3.23	68.5	2238.3
(N=881)		*53.4*	*1905.6*
Couple without child(ren)	2	60.4	2038.7
(N=250)		*41.9*	*1905.6*
Couple with child(ren)	3.94	76.8	2577.5
(N=288)		*65.6*	*2667.9*
Couple with sibling(s)	3.62	34.3	2763.1
(N=8)		*22.9*	*2667.9*
Single with child(ren)	2.66	39.9	1648.4
(N=48)		*38.1*	*1204.3*
Single with sibling(s)	3.2	74.7	1692.2
(N=5)		*61.0*	*1204.3*
Couple in parents' home	3.62	38.4	1812.6
(N=21)		*30.5*	*1905.6*
Single in parents' home	3.80	70.9	2256.4
(N=234)		*61.0*	*1905.6*
Other cases	2.48	54.7	2087.3
(N=27)		*45.7*	*1905.6*

NB: Medians are in italics.

Table 2: Econometric estimations (N=973), dependent variable is $\log(G(W_k, wtp^{\star}_{ik}; \alpha))$

	Step 1 Pure self-interest model	**Step 2** Constant altruistic model towards child < 18	**Step 3** Heterogeneous altruistic model towards child < 18
X_i **variables**			
Constant	-0.331	-0.047	0.031
	(.600)	(.942)	(.961)
Male	0.128	0.150*	0.156*
	(.101)	(.064)	(.051)
(Age/100)	2.339*	1.020	0.931
	(.063)	(.465)	(.493)
$(\text{Age}/100)^2$	-2.794**	-1.324	-1.258
	(.045)	(.391)	(.403)
Senior High School educ.	0.034	0.042	0.046
	(.744)	(.699)	(.668)
University-level educ.	0.065	0.083	0.081
	(.472)	(.378)	(.383)
Health worker	0.118	0.103	0.002
	(.321)	(.413)	(.986)
Affected by air pollution	-0.003	-0.004	-0.006
	(.977)	(.972)	(.957)
Bad air quality	0.037	0.015	-0.062
	(.714)	(.885)	(.589)
Heavy smoker	-0.282*	-0.391**	-0.516***
	(.089)	(.035)	(.009)
Care about health	0.212***	0.233***	0.247***
	(.010)	(.007)	(.004)
Good knowledge of air poll.	-0.015	-0.005	-0.002
	(.853)	(.953)	(.978)
Breath fresh air	0.521***	0.522***	0.529***
	(<.0001)	(<.0001)	(<.0001)
Change behavior	0.123	0.152*	0.165*
	(.142)	(.081)	(.056)
Poss. air purifier	-0.715***	-0.753**	-0.696**
	(.009)	(.011)	(.014)
Poss. air conditioner	-0.268*	-0.267*	-0.268*
	(.063)	(.075)	(.073)
Income elasticity $\hat{\alpha}$	0.618***	0.605***	0.600***
	(<.0001)	(<.0001)	(<.0001)
Standard error $\log(\hat{\sigma})$	0.073***	0.070***	0.064***
	(.003)	(.004)	(.009)
Mixing probability $\hat{\delta}$	0.133***	0.133***	0.133***
	(<.0001)	(<.0001)	(<.0001)
X_l **variables for altruism towards child(ren) < 18**$^{(a)}$			
Constant	-	-1.314*	-2.380**
		(0.097)	(.029)
Health worker	-	-	1.706**
			(.037)
Bad air quality	-	-	1.721**
			(.016)
Heavy smoker	-	-	1.842**
			(.040)
Loglikelihood	6478.73	6475.74	6470.86

$p-$values are in brackets: *** if p-value<.01, ** if p-value<.05, * if p-value<.1

$^{(a)}$ The marginal utility derived by respondents for child(ren)<18 is obtained by an exponential transformation

Table 3: Robustness check

Altruism towards ...	Overall sample Hous. inc.	Overall sample Hous. inc./$\sqrt{NPers}$	Sub-sample Hous. inc.	Sub-sample Hous. inc./$\sqrt{NPers}$
Spouse	0.043	0.048	<0.001	0.016
	(.321)	(.282)	(.932)	(.838)
Child(ren) $<$ 18	0.157**	0.200***	0.187***	.160***
	(.014)	(.008)	(.008)	(<.001)
Child(ren) $\geq$ 18	<0.001	<0.001	<0.0010	<0.001
	(>.999)	(>.999)	(.864)	(.991)
Sibling(s) $<$ 18	<0.001	<0.001	-	-
	(>.999)	(>.999)	-	-
Sibling(s) $\geq$ 18	<0.001	<0.001	-	-
	(>.999)	(>.999)	-	-
Parent(s)	<0.001	<0.001	-	-
	(>.999)	(>.999)	-	-
X_i variables	Yes	Yes	Yes	Yes
Sample size	973	973	706	706

P-values are of LR test of nullity in brackets: *** if p-value<.01, ** if p-value<.05, * if p-value<.1