Voluntary Non-Remunerated Blood Donation under Risk Aversion: Insights from the French Context

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Abstract

The aim of this article is to develop a framework for voluntary non-remunerated blood donation that takes into account the interaction between risk-aversion and the usual explanatory factors in the agent's decision to donate blood. We use the theoretical model of pro-social behaviour by Bénabou & Tirole (2006). We introduce two differences with the original model in order to make it more realistic in the French context. First, donors are not rewarded. Second, risk-averse agents are apprehensive about blood donation. We derive several testable assumptions from our model and we use a reduced form econometric model to provide a confrontation between theory and empirical findings. The dataset at hand is a nationally representative survey of individuals aged 18+ and living in the community in 2012 France, with variables on blood donation, health, economic, and social features of more than 10,000 respondents. We estimated a Linear Probability Hurdle (two-part) model that takes into account the classification of donors defined by the French Blood Service into active donors, potential donors, and disqualified donors. Our empirical results support the main assumptions from the theoretical model. In particular, we found that risk-averse individuals are less prone to give their blood. We also found that stigma considerations (or shame) dominate honour considerations as a motive for blood donation.

Keywords: Pro-social behaviour, Organ donation, Altruism, Reputational gain, Shame, Health.

JEL Codes: I12, D91, C31.

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1 Introduction

The safety requirements for blood collection have increased considerably over the last decades in Europe, especially in France following the 1980's HIV blood contamination crisis (Hergon et al. 2005). At the time, the French authorities had postponed the use of heat-inactivation methods as an effective means of inactivating the HIV virus in certain blood products and blood plasma. The spread of the virus among infected blood transfusion recipients resulted in widespread mistrust in blood donation, not only on the part of recipients but also on the part of donors (Murray, 1990; Trebilcocket, Howse, & Daniels, 1996). Despite all the efforts to improve safety worldwide, fear of AIDS remains a major deterrent to donating blood (Steele et al. 2009). In addition, public trust in the integrity and the efficiency of the blood transfusion service is regularly challenged. Recently in France, some blood donors were repeatedly found to carry hepatitis E virus (Galian et al., 2014; Mansuy et al, 2008), and some cases of Zika virus transmission through blood transfusion have been reported (Musso et al., 2014). Although sporadic, these events may nonetheless contribute to maintain perceived risks over blood donation, and concerns over infection in the population. Even when unjustified, negative perceptions of health risks in blood donation may undermine the willingness to perform this action (Chen & Ma, 2015; Reid & Wood, 2008; Hupfer et al., 2005 ; Barkworth et al., 2002 ; Allen & Butler, 1993).

Blood donation can thus be seen as health-risk behaviour, whether the risk is real, potential, or subjective. In this respect it is relatively surprising that, to the best of our knowledge, no economic studies have yet envisaged analysing the relationship between individuals' risk aversion and individuals' propensity to donate blood. Since voluntary unpaid blood donors are rather rare (e.g. 4% to 5% of the population in France, French National Blood Service/Armed Forces Blood Transfusion Centre, 2013), a better understanding of the determinants of blood donation is of significant importance. Regulatory aspects governing blood donation prohibit the remuneration of blood donors in most European countries, like France, so that blood collection can only be achieved through the participation of voluntary, non-remunerated blood donors (Fontaine, 2002). Blood donation may thus be encouraged by health marketing campaigns promoting pro-social values, such as altruism. Taking into account risk-aversion in such campaigns may improve targeting specific donors. Intuitively, one may suspect that risk-averse individuals are less prone to donate blood.

The aim of this article is to develop a framework for voluntary non-remunerated blood donation that takes into account the interaction between risk-aversion and the usual explanatory factors such as the agent's degree of altruism (either pure or impure), his health status, the individual cost associated with blood donation, and the rate of active donors in the individual's district. We use the theoretical model of pro-social behaviour by Bénabou & Tirole (2006). We introduce two differences with the original model in order to make it more realistic in the French context. First, donors are not rewarded. Second, risk-averse agents are apprehensive about blood donation. We derive several testable assumptions from our model and we use a reduced form econometric model to provide a confrontation between theory and empirical findings. The dataset at hand is a nationally representative survey of individuals aged 18+ and living in the community in 2012 France. The Health, Health Care, and Insurance Survey (Enquête sur la santé et la protection sociale, ESPS) is carried out by the Institute for Research and Information in Health Economics (IRDES, Paris) since 1988. A unique questionnaire module on blood donation was implemented in ESPS 2012 as a result of a partnership with the French National Blood Service (Etablissement Français du Sang, EFS). The survey enables, for the first time in France, to cross factors relative to blood donation with economic, social and health variables in the general population.

The remainder of the paper is organized as follows. In Section 2, we present our theoretical model and derive a set of testable assumptions. In the next section, we explain both materials and methods to estimate the determinants of blood donation. Our main results and robustness checks are reported in Section 4. Section 5 concludes.

2 The Theoretical Model

2.1 A pro-social model of behaviour for voluntary unpaid donors with risk-aversion

We consider that blood donation requires from agents a prosocial behavior. Such a decision depends on the individuals' degree of pure altruism, but also on their concern for reputation and their risk attitude towards the subjective risk of contracting an infection by donating blood. Some individuals may think it is risky, wheras this activity is very safe under the condition that all precautions are used. To assess the interaction between these explanatory factors, we introduce two differences with the model of prosocial behaviour by Benabou & Tirole (2006). First, donors are not rewarded. Second, risk-averse agents are apprehensive about blood donation.

Each individual selects a participation level, a, that is discrete. She donates blood, $a = 1$, or not, $a = 0$. Choosing a entails a cost $C(a)$, with $C(0) = 0$ and $C(1) = C > 0$. We denote v_a the agent's intrinsic valuation for blood donation or their degree of pure altruism, thus leading to a nonmonetary benefit $v_a a$. Each individual's type, v_a is drawn from a continuous distribution. Its realization is known to each agent, but not observable by others, including family, friends and others. There does also exist impure altruism. Thus, each agent receives a reputational payoff from choosing a, that depends linearly on observers' posterior expectation of the agent's type v_a. It equals $x\gamma_a E(v_a \mid a)$. The factor γ_a reflects the idea that individuals would like to appear as altruist, and the factor x measures the visibility of action a. Both factors are common to all agents. To capture the idea that individuals are apprehensive about blood donation, we assume that agents (wrongly) anticipate a multiplicative health risk, $\widetilde{y}H$, when they choose to donate blood, or $a = 1$. The factor H denotes the individual health status, and $\widetilde{y}$ is a continuous random variable defined on the interval $(0, 1)$. If the individual does not donate blood, or $a = 0$, then her health status equals H. Finally, we assume a VNM utility, denoted as a function $U(.)$, to characterize the decision-making of our rationale individuals. If the individual does not donate blood, or $a = 0$, the individual utility level is

$$U(H + x\gamma_a E(v_a \mid a = 0)).$$

If the individual donates blood, or $a = 1$, then the expected utility level equals

$$EU(\widetilde{y}H + v_a + x\gamma_a E(v_a \mid a = 1) - C).$$

We show in appendix that a type v_a individual donates blood if and only if:

$$\begin{aligned} & v_a + x\gamma_a \left(E(v_a \mid a = 1) - E(v_a \mid a = 0)\right) - C - (1 - E(\widetilde{y}))H \\ \geq \; & \frac{1}{2} r_A(H) \left(H^2\sigma^2 + (v_a + x\gamma_a E(v_a \mid a = 1) - C - (1 - E(\widetilde{y}))H)^2\right). \end{aligned} \tag{1}$$

In the left hand side of Equation (1), we have the intrinsic benefit for donating blood, v_a, plus the marginal reputational benefit associated to blood donation, $x\gamma_a \left(E(v_a \mid a = 1) - E(v_a \mid a = 0)\right)$, minus two other terms, the individual's cost of blood donation, C, and the expected health loss in case of blood donation, $(1 - E(\widetilde{y}))H$. The right hand side of Equation (1) is the product between the Arrow-Pratt measure of absolute risk aversion, $r_A(H)$, and the term in brackets, $\frac{1}{2}\left(H^2\sigma^2 + (v_a + x\gamma_a E(v_a \mid a = 1) - C - (1 - E(\widetilde{y}))H)^2\right)$. This term combines a measure of the subjective health risk, the variance of $\widetilde{y}$ denoted as σ^2, and the square expression of both the intrinsic benefit, v_a, and the reputational benefit associated with blood donation, $x\gamma_a E(v_a \mid a = 1)$, minus costs C and $(1 - E(\widetilde{y}))H$ as explained above.

2.2 Testable Assumptions

We can derive from Equation (1) several testable hypotheses. First of all, as the Arrow-Pratt measure of absolute risk aversion, $r_A(H)$, or the variance of the health risk associated to blood donation, σ^2, increases, then the individual has a lower incentive to donate blood. Risk averse agents tend to reduce their participation to blood donation as they (wrongly) anticipate a negative effect on their health. Notice that the right hand side of Equation (1) equals zero when the individual is risk neutral.

The effect of altruism, v_a, the measure of the desire to appear as altruist to observers, γ_a, or the visibility of blood donation by other agents, x, can be decomposed into two effects. The first effect, as depicted in the left hand side of (1), indicates that as these factors increase, the individual has a greater incentive to donate blood because the marginal intrinsic benefit and the reputational benefit associated to this action become higher.

The second effect, as depicted in the right hand side of (1), indicates that as these factors increase, the individual expected wealth in case of blood donation increases. Thus, the individual takes risk on a larger amount of wealth, thereby decreasing her incentive to donate blood. And the lower is the Arrow-Pratt measure of absolute risk aversion, the lower is this second effect. We will assume that this second effect is smaller or equal to the first effect.

The effect of the individual cost, C, and the expected health loss $(1 - E(\widetilde{y}))H$, associated to blood donation can also be decomposed into the same two effects. As these factors increase, the benefit associated to this action becomes higher. But, the individual expected wealth in case of donation decreases. As a consequence, the individual takes risk on a lower amount of wealth, thereby increasing her incentive to donate blood. Anew, we assume that the second effect is smaller or equal to the first one.

Agents' choice also depends on their net reputation gain, $E(v_a \mid a = 1) - E(v_a \mid a = 0)$, as depicted in the left hand side of Equation (1). This nonmonetary benefit depends on the overall participation to blood donation. Indeed, let rewrite

$$E(v_a \mid a = 1) = E(v_a \mid v_a \geq \widehat{v_a}) = M^+(\widehat{v_a})$$
$$E(v_a \mid a = 0) = E(v_a \mid v_a \leq \widehat{v_a}) = M^-(\widehat{v_a})$$

where $\widehat{v_a}$ stands for the candidate cutoff value that equals the both sides of Equation (1). This value $\widehat{v_a}$ determines the overall participation to blood donation as agents whose altruism, v_a, is superior or equal to the cut off, $\widehat{v_a}$, donate blood. Thus, we have

$$E(v_a \mid a = 1) - E(v_a \mid a = 0) = M^+(\widehat{v_a}) - M^-(\widehat{v_a})$$

where the honor conferred by blood donation is $M^+(\widehat{v_a}) - \overline{v_a}$, with $\overline{v_a}$ is the unconditional mean of altruism. When participation increases, $(d\widehat{v_a} < 0)$, the honor confered by blood donation diminishes because more and more people participate, especially the least altruistic of agents. The stigma from abstention is $\overline{v_a} - M^-(\widehat{v_a})$. When participation increases, stigma rises because the least altruistic of agents who initially abstained now donate blood. Since $M^+(\widehat{v_a})$ and $M^-(\widehat{v_a})$ are nondecreasing functions of cutoff value $\widehat{v_a}$ (or participation level), the net reputation gain, $M^+(\widehat{v_a}) - M^-(\widehat{v_a})$, may then increase or decrease with the overall participation value. Put differently, the net reputation gain may increase or decrease according to whether it is honor or stigma (as defined above) that is most responsive to the extent of participation.

By definition, we know that agents' decisions are strategic *complements* if $x\gamma_a(M^+(\widehat{v_a}) - M^-(\widehat{v_a}))$ is decreasing with $\widehat{v_a}$ (see definition 1 p. 1667 in Benabou & Tirole, 2006). If the overall participation increases (or $d\widehat{v_a} < 0$), then the net marginal reputation gain increases because stigma from abstention rises faster than the honor conferred by blood donation decreases. As stigma considerations dominate honor considerations, the overall participation will increase the individual's incentive to donate blood[1]. At the opposite, assume that participation decreases, or $d\widehat{v_a} > 0$. The net marginal reputation gain will decrease if stigma from abstention decreases faster than the honor conferred by participation increases. Thus, any decrease in overall participation will lower the individidual's incentive to donate blood.

Now, assume that agents' decisions are strategic *substitutes*, that is $x\gamma_a(M^+(\widehat{v_a}) - M^-(\widehat{v_a}))$ is increasing with $\widehat{v_a}$. If the overall participation increases (or $d\widehat{v_a} < 0$), then the net marginal reputation gain decreases because honor conferred by blood donation decreases faster than stigma from abstention rises. Here, honor considerations dominate stigma considerations. And the overall participation will decrease the individual's incentive to donate blood. When participation decreases, or $d\widehat{v_a} > 0$, the net marginal reputation gain will increase if honor conferred by blood donation rises faster than stigma from abstention decreases. Thus, any decrease in overall participation will increase the individidual's incentive to donate blood[2].

Further, remark that previous considerations may also be linked to the distribution density of altruism, v_a, as explained in Benabou & Tirole (2006). If the density of the distribution of v_a is decreasing then the net reputation gain $M^+(v_a) - M^-(v_a)$ is increasing with v_a. Formally, a rise in $\widehat{v_a}$ substantially increases $M^+(\widehat{v_a})$, but hardly increases $M^-(\widehat{v_a})$, thereby increasing the difference $M^+(\widehat{v_a}) - M^-(\widehat{v_a})$. When the density of altruism is a decreasing function, this population tends to include few altruistic agents. And honor considerations are more likely to dominate stigma considerations as long as there are very few altruistic people. At the opposite, it is more likely that shame considerations will dominate when there does exist a great proportion of altruistic agents, or when the density of the distribution of v_a is increasing. In summary, an increase of the overall participation will create an incentive to donate blood if shame considerations dominate, or when there is a larger mass of altruistic types to be compared with. At the opposite, an increase of the overall participation may deter agents to donate blood if honor considerations dominate, or when there is fewer altruistic types to be identified with.

Finally, the overall effect of the individual health status, H, is decomposed into two effects. First, an increase in the health status will increase the subjective expected health

[1] As a wider participation creates an higher incentive to donate blood, then some agents who initially abstained, now participate. Thus, the overall participation increases. This further increases the marginal reputational gain, and so on. It may lead to a corner solution with full participation, as the only stable equilibrium. We can show that a partial participation to blood donation is a stable equilibrium if the left hand side of Equation (1), defined for the $\widehat{v_a}$ cutoff value, is increasing with the overall participation, $\widehat{v_a}$ (see Proposition 5 of Benabou & Tirole, 2006, for a formal proof of this result).

[2] We notice that agent's participation also depends on the overall participation via the reputation benefit, $M^+(\widehat{v_a})$, in the right hand side of Equation (1). If overall participation increases, then the right hand side of Equation (1) decreases. Thus, agents have an higher incentive to participate because they may take risk on a lower amount of wealth, as explained above.

loss, $(1 - E(\widetilde{y}))H$. Although this term appears in both sides of Equation (1), we consider that an increase of the subjective health loss associated to blood donation will reduce their incentive to participate. Second, the health status also influences the Arrow-Pratt measure of absolute risk aversion. If we assume that absolute risk aversion is decreasing (increasing) with the health status, H, then healthier individuals would have a higher (respectively lower) incentive to donate blood.

3 Materials and Methods

3.1 Source and sample

We use cross-sectional data from a unique dataset: the 2012 French health, health care, and insurance survey (ESPS). The survey, coordinated by the Institute for Research and Information in Health Economics (IRDES, Paris) since 1988, is designed to be representative of the French population (1/2231) and contains data on blood donation, health status, access to health care services, health insurance, and the economic and social status. The initial sample consists of 599,544 individuals in 2012 drawn from the EGB (Echantillon Généraliste des Bénéficiaires), a permanent representative sample of the population covered by the French public health insurance, whether they have received healthcare reimbursements or not. The main sampling frame is representative of 95 % of the French population in 2012. A random subsample of community-dwellers is drawn from the EGB; these reference individuals together with members of their household are eligible for the survey. A total of 8,413 households representing 23,048 French residents took part in the 2012 survey. The survey combines two interview methods by telephone or face-to face. Details of the survey methodology have been discussed elsewhere (Célant et al., 2014).

Since individuals must be aged 18-70 years old to be allowed to donate blood in France, the sample was reduced to 15,640 respondents. Within this population, 10,894 respondents answered the health questionnaire among which 10,492 provided information relative to blood donation. Individuals with missing values on the retained explanatory variables in this study (described below) were excluded from the regression analysis, resulting in a final sample of 10,132 respondents.

3.2 Classification of donors

Figure 1 displays the decision tree used to divide individuals having completed the 'blood donation' module into three categories: 'active/current' donors, 'potential' donors and 'disqualified' donors. Active/current donors correspond to individuals having donated blood within the last twelve months. Potential donors are those individuals who have not donated blood but fall within the regulatory age bracket and are free of chronic health problems, meaning they could actually be donors. On the contrary, disqualified donors correspond to individuals that do not donate blood (either never, or because they have stopped doing so) for one of the health-related reasons explained below. Past blood donation behaviour was assessed by: "Have you ever successfully donated blood?" which is a commonly used and reliable measure of blood donor status (Bertalli, Allen & McLaren, 2011).

– Figure 1 about here –

The identification of donor groups was based on blood donation eligibility criteria applied by the French National Blood Service (specified by the Order of 12 January 2009). Based on these criteria, the disqualified donor group includes individuals: (1) who have never donated blood due to permanent health problems; in other words, chronic health problems (serious illnesses, blood-borne pathogens that can be transmitted by blood, leukaemia etc.), (2) who have donated blood at some point in their lives but not over the last twelve months due to health problems, a blood transfusion or because they are over the 70 year old age limit, or (3) who report being registered as long-term illness sufferers, or who have suffered from one of the following illnesses over the last twelve months: bronchitis, myocardial infarction, coronary artery disease, high blood pressure, stroke, diabetes and cirrhosis of the liver.

3.3 Explanative variables

Following our theoretical model, the explanative variables of blood donation should measure pure altruism, reputational payoff associated with blood donation (or impure altruism), costs of blood donation, subjective health loss, net reputational gain, and health. Proxy measures for such complex concepts are required. The reduced-form econometric model should control for some usual confounders and survey specific features: age, sex, education level, the logarithm of income per consumption units, and whether the survey questionnaire was taken face-to-face or by telephone.

Risk-aversion is measured on a 10 points scale where the respondent is asked to say whether she is rather "adventurous" (lower values) or "unadventurous" (higher values) in life. Arrondel, Masson & Verger (2004) studied the properties of various measures of risk-aversion in the French context and concluded that this question provides a good single index to be applied in nationally representative surveys.

Altruism is a multifaceted phenomenon. Previous studies focused on the various forms of altruism associated with blood donation. They concluded that pure altruism is not the only motive and that impure altruism, whereby individuals donate to both benefit others and gain emotional warm glow, was a predictor of blood donation intentions (Andreoni, 1990; Ferguson et al., 2008, 2011, 2012; Evans & Ferguson, 2015). Much in line with this literature, our theoretical model considers these two forms of altruism. Unfortunately, our data do not incorporate any measure of altruism. We shall argue that respondents' preparedness to donate body organs after death is a good proxy for pure and impure altruism. The reason being that this variable depicts a pro-social behaviour while it is not associated with costs of giving or any potential health damage (as organ donation occurs after death). Among the individuals prepared to donate organs after death, the ESPS questionnaire provides the means to distinguish between individuals who have already taken steps in this direction (organ donors' card holders, or intentions transmitted to family members).

The "net reputational gain" in the theoretical model is a function of the overall participation to blood donation. As ESPS is a nationally representative sample of the French population, we used the dataset to derive measures of the share of donors among potential donors in 14 the administrative districts defined by the French National Blood Service. Such an indicator makes sense since the local authorities of the French National Blood Service define their strategy for blood collection at this level, such as recruitment campaign. Notice that the ratio is given as $\frac{d-1}{d+b}$, where d is the number of active donors and b is the number of potential donors (non-active donors) in the population, so that the denominator $(d + b)$ represents the number of non-disqualified donors. The numerator includes an individual deflator (-1) to take into account the fact that it is the share of other individuals giving blood in the area, which influences the agent.

The cost associated with blood donation is approximated using variables describing four types of spatial environment: outer suburbs, multipolar town, urban centre, and rural areas. The idea is that the opportunities to give blood depend from where the agents live, giving rise to higher transports costs in rural areas less provided with medical facilities to donate blood. Lacetera, Macis & Slonim (2012) presented evidence from a field experiment in the US context where financial compensation for blood donors in a given area created a spatial effect displacing the supply of donors towards places where blood donation is compensated. One interpretation of the displacement effect is that the financial compensation reduces blood donors' transportation costs, so that such costs could hinder blood donation. However, in the French context, we expect that the influence of cost to be rather small since the French National Blood Service carried out a policy of reaching out blood donors with blood collection mobile units making easy blood donation all over the French territory, including in rural areas.

Subjective health loss is approximated using a question about the reasons why non-donors in the potential donors population did not give their blood. One item is "the fear of health consequences". Although this question is only asked to potential donors (i.e. non-donors), it may be a good proxy for subjective health loss if we retain the assumption that the latent variable takes the value 0 for all donors and some non-donors for whom it may say that fear is not a significant determinant, and 1 for the other share of the non-donors for whom fear plays a significant role. Intuitively, it means that blood donors have no fear of the health consequences of blood donation.

Health status is measured as a combination of several self-reported physical and mental health variables: three health variables from the European mini-module (self-perceived health on a five points scale, (severely) limited, long-term illness), the number of chronic diseases, whether the individual reported any limitation in (instrumental) activities of daily living (ADL or IADL), a binary variable indicating whether the individual reported a score of depression from the short SF-36 module (5 items) higher than the median score, and a measure of cognitive impairments (whether the respondents can figure out the date of the day). Using factor analysis (Multiple correspondence analysis – MCA) of these variables as a technique of data reduction, we derived a single, continuous measure of health, made out of the respondents' coordinates on the first axis (factor loading). This synthetic health measure reduces the risks of multicolinearity between several health measures and helps provide a measure of health for respondents who had partial missing values for some health measures considered. It has been found a valid tool in the French context (Sirven & Rapp, 2017). Table A1 in the appendix displays the results of the MCA.

3.4 Estimation strategy

The estimation of the parameters of the determinants of blood donation is not straightforward. The dependant variable takes the value 1 for active donors, and 0 for others; so that this latter category pieces together individuals with different decisions-making processes: those who are disqualified because of permanent health problems can only be non-donors, while the others can decide to become active donors or not. Put differently, the existence of significant probability mass at a single point (here, 0) may violate the assumption that a single parametrically specified probability distribution adequately describes the population underlying the observed data. The econometric model is required to account for this two-step decision process. However, as it is often the case in the health economics literature, the choice between a Heckman selection model and a Hurdle (or two-part) model is not obvious: "The choice between a sample selection and a two-part model revolves around whether we wish to model potential or actual outcomes." (Madden, 2008).

Two main arguments in favour of the Hurdle model are supported in our case. First, our theoretical model focuses on agents who are in position to consider donating blood, i.e. the "actual" non-disqualified individuals. Quite the opposite, the Heckman model would consider the influence of explanative variables on "potential" non-disqualified individuals, for instance in a scenario where the legal age to give blood in France is extended beyond 70 years old, or in a case where the general health of the population would improve. Although these questions are important, they are beyond the scope of our analysis. Second, as health is the only reason for disqualification, and since health status is endogenous in our theoretical model, no plausible exclusion restriction can be found for the selection model to perform well.

In the two-part model both dependant variables are binary outcomes, active (1) vs. potential donor (0), and non-disqualified (1) vs. disqualified for blood donation (0), so that a simultaneous bivariate-Probit model was first considered. However, because the variable of "fear of health consequences" predicts perfectly being non-blood donor, it is not a valid covariate in a Probit setting. Although some Maximum Likelihood (ML) algorithms make it possible to estimate the Probit equation without dropping the variable, the coefficient is usually set to a very large value for the likelihood not to change, making its interpretation rather difficult. Another alternative is to estimate simultaneous equations for linear probability models; in that case, the Feasible Generalized Least Squares (FGLS) estimator would not treat the dummy for "fear of health consequences" as a perfect predictor. One downside of linear probability models is that they are prone to heteroskedasticity (the use of a Probit in the first place was intended to provide unbiased standard-errors). We use simultaneous (co)variance matrix of the Huber/White/sandwich type to provide robust estimates. Notice that the same explanative variables are retained in the two equations, a first estimation is made without controls, and another one is carried out with the full list of covariates. The two-part model is well supported empirically when explanatory variables play different roles in the two parts of the model.

4 Results

4.1 Descriptive statistics

Table 1 displays descriptive statistics for dependant variables (blood donor category), main explanative variables, and controls. The share of active donors in 2012 is 6.8% in the sample (notice that this figure sets at 6.5% using survey sampling weights, with 95%IC: 6.02-6.98); this is similar to the national rate of active donors in the French population established about 5% (French National Blood Service/Armed Forces Blood Transfusion Centre, 2013). Notice that a share of 38.9% of the sample population is disqualified from blood donation because of safety rules regarding their health characteristics. The rate of active donors among potential donors (non-disqualified) reaches 10,9% and ranges from 8.6% to 16.2% in the administrative districts defined by the French National Blood Service. The share of organ donors in the sample is more substantial and reaches 55.9% of the respondents. Our main explanative variable, the risk-aversion scale, indicates that the average individual is rather risk-averse (5.85/10).

– Table 1 & 2 about here –

Table 2 displays the average value of the explanative variables broken by active or potential donor classification. On average, active donors are less risk-averse, more altruistic (as they are more often organ donors), in better health than non-donors, and they are less afraid of the health consequences of blood donation than potential donors. Looking at the proxy for the "net reputational gain", the table indicates that the act of blood donation is more frequent in administrative districts where the rate of active donors is higher. Notice that proxies for cost of donation seem to play a less significant role: while active donors are more often located in multipolar towns, and less often in urban centres, the difference is less than 2 percentage points, and is only statistically different from zero at 10% risk. All things considered, these descriptive statistics support the choice of the variables as potential determinants of blood donation.

4.2 Models estimates

Multivariate results from the reduced-form econometric model in Table 3 provide two types of elements. First, the main variables of interest display the expected signs, suggesting that the empirical model supports the theoretical model. Second, these results remain robust even when a set of control covariates is included in the regressions or when the functional form is modified.

- *Main results*

Two innovative results are supported here, based on model estimates for the Active donor equation (equation of interest) in Table 3. First, higher values on the risk aversion scale are associated with a lower propensity to give blood, all other things being equal. This result, although quite intuitive, supports the main theoretical assumption from our model suggesting that risk-averse agents are apprehensive about blood donation, i.e. blood donation is a health-risk behaviour, whether the perception of risk is real, potential, or subjective. A second unusual result deals with the "net reputation gain". The increase in the rate of active donors in the administrative district is significantly associated with the agent's propensity to donate blood. According to the interpretations derived from the theoretical model, this result means that agents' decisions are strategic complements. Put differently, this suggest that blood donation among non-disqualified people is motivated by aversion to shame, since stigma considerations dominate honour considerations in our theoretical model.

Much in line with previous literature, we found that altruism, whether pure or impure altruism as approximated by organ donation, is another significant determinant of blood donation. The health index is positively and significantly associated with the propensity to give blood, and subjective health loss ("fear of health consequences of blood donation") is, by construction, associated with a lower propensity to give blood. Although this last result is not surprising, the significance of the effect (<5%) is probably more realistic using FGLS than what would be obtained using ML algorithms. Another expected result is the lack of significance of the costs of blood donation in the decision to donate. We already developed the following interpretation: the French National Blood Service reduced transportation costs for blood donors by means of a fleet of trucks equipped with blood collection facilities and trained personnel. These mobile units go reach out the blood donors near their homes or workplaces, in rural areas and other urban settings. Rewards to compensate blood donors' travel expenses may thus not be an adequate motive in the French context.

- *Robustness checks and ancillary results*

The previous results for the Active donor equation (equation of interest) in Table 3 remain very stable even when control covariates are added in the model. The value of the coefficients is not sensibly modified, and the t-stats approximate their initial values in models without controls. The most noticeable change, if may be, is the p-value for the risk-aversion variable that drops down to the 5% level. This is a negligible change. Stability of the results may arise from the fact that the additional covariates do not play a significant role in the decision to donate blood. The influence of age is rather small and could be interpreted as a proxy for health, as health deteriorates with age. More interestingly, the mode of interview reveals that respondents who answered the questionnaire face-to-face are less prone to declare being active blood donors than those who answered by phone. It could be that respondents physically facing an interviewer are less prone to lie about the fact they are active blood donors, while those interviewed by telephone could lie more easily in order to benefit from some "warm-glow" effect associated with declaring being an active blood donor. Control for this variable is thus a way to reduce a potential, though small, over-representation of active blood donors in the analysis.

Results from the Disqualified donor equation (which role is to model the excess of zeros in order to provide unbiased estimates in the equation of interest) also provide some interesting findings. First, as expected, health is the main driver of disqualification. The rules set by the French National Blood Service are to disqualify anyone from the list of donors if the individual has some chronic health problems. The influence of our main variables explaining blood donation appear non-significant in the case of disqualification. One exception is the case where the share of organ donors is higher among disqualified (or symmetrically, the share of organ donors is lower among the non-disqualified). One reason could be that altruistic people who cannot give their blood may want to express their pro-social behaviour (driven by pure or impure altruism) through another form of donation. This substitution effect reinforces the interpretation of organ donor as an adequate measure of (pure or impure) altruism.

Additional results come from the inclusion of control variables in the Disqualified equation. Age and being a woman are associated with a higher propensity to be disqualified, as these variables are proxies for health (health deteriorates with age, and women become pregnant so they are disqualified). More difficult to interpret is the effect of education: respondents with higher levels of education report more often being able to give their blood. Could this be because highly educated respondents understand the questions in the survey in a better way? We are agnostic about this. Finally, risk-aversion and subjective health loss become significant in the disqualified equation when the inclusion of control variables helped improve the model fit. One interpretation could be that respondents' preferences are modified with health shocks; for instance, those who do not suffer from a chronic health issue (non-disqualified) are more risk-averse because their anticipation of how a health shock would be unpleasant to them is not adequately assessed. This issue provides some avenues for further research.

Eventually, we tested the robustness of our results by means of an alternative heterosckedasticity correction and a different functional form of the regression. First, our results are similar if we used a robust variance/covariance matrix to account for some potential multiplicative heterosckedasticity due to clustering at the administrative district level. Second, we used Sartori's (2011) estimator for binary-outcome selection models without exclusion restrictions. The aim is to compare the statistical properties of our favoured model with a "feasible" Heckman selection model when, like in our case, no plausible exclusion variables are available. The results were no different to the one obtained previously with our Hurdle model.

5 Conclusion

The aim of this research was to better understand the motives for voluntary non-remunerated blood donation in a specific context where donors are not rewarded, and where the act of giving blood can be seen as health-risk behaviour. We developed a theoretical model of pro-social behaviour from which we derived several testable assumptions. The interaction between the Arrow-Pratt measure of risk aversion and other individual aggregated attributes helped unveiled some unusual reasons for blood donation, like shame or honor considerations. We estimated a reduced-form econometric model based on a unique dataset of a nationally representative survey on blood donation, with health, economic, and social features of more than 10,000 respondents.

Our empirical results support the main assumptions from the theoretical model. In particular, we found that risk-averse individuals are less prone to give their blood. Besides the fact that altruism (pure or impure) is found to be a strong determinant of blood donation, we provide new motives to blood donation. We also found that stigma considerations (or shame) dominate honour considerations as a motive for blood donation, in the French context. These two motives for blood donation are rather innovative in the literature, and they are important drivers of blood donation from both a theoretical and empirical perspective in this study. It has been argued elsewhere that "increasing the correspondence between the motive advocated by recruitment campaigns and the primary motive of the target audience is important to increase the effectiveness of recruitment campaigns" (Evans & Fergusson, 2015:125). As a consequence, taking into account-risk aversion and stigma considerations in agents' decision-making processes could potentially improve the efficiency of blood donation campaigns.

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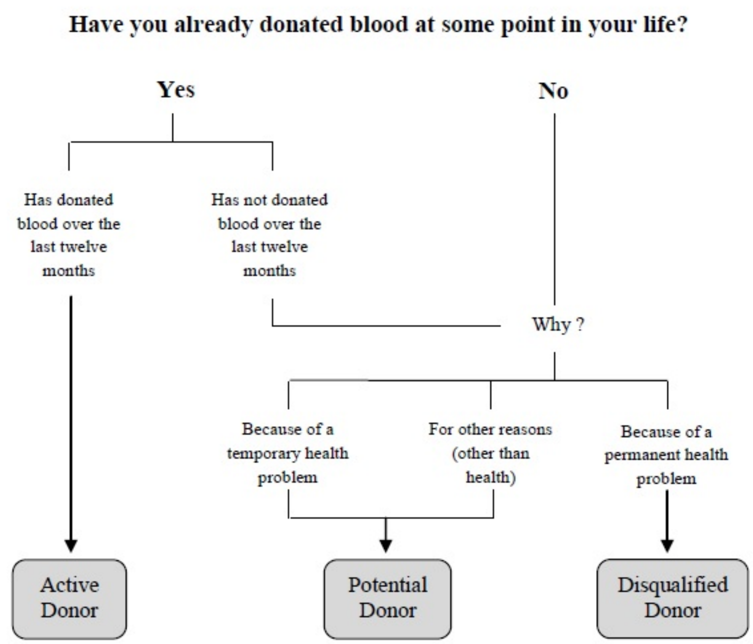
Figures

Fig 1. Donor Classification based on the 2012 ESPS Blood Donation Questionnaire Module



Source: ESPS 2012

Tables

Table. 1: Sample Descriptive Statistics

Variables	Mean	Std. Dev.	Min	Max
Blood donor category				
Active	0.068		0	1
Potential	0.543		0	1
Disqualified	0.389		0	1
Main variables				
Risk-aversion scale	5.846	2.425	0	10
Organ donor	0.562		0	1
Donors participation rate	0.109	0.021	0.084	0.162
Living area				
Outer suburbs	0.203		0	1
Multipolar town	0.057		0	1
Urban center	0.534		0	1
Rural area	0.206		0	1
Health index (MCA)	0.713	0.155	0	0.914
Fear of health consequences	0.008		0	1
Controls				
Age	44.299	14.844	18	70
Female	0.517		0	1
Education				
High school	0.588		0	1
University	0.152		0	1
Other	0.099		0	1
Income				
Log(income/cons. unit)	6.282	2.541	0	10.139
Missing value	0.136		0	1
Interview face-to-face	0.53		0	1

Note: N = 10,132 obs.

Table 2. Mean-Tests of Explanative Variables (Active vs Potential Donors)

	Active donor		Difference	S.E. of diff.	t-stat	p-value
	Yes	No				
Main variables						
Risk-aversion scale	5.282	5.747	-0.465	0.097	-4.804	0.000
Organ donor	0.737	0.547	0.190	0.018	10.483	0.000
Donors participation rate	0.113	0.109	0.004	0.001	4.809	0.000
Living area						
Outer suburbs	0.227	0.208	0.019	0.017	1.125	0.261
Multipolar town	0.075	0.056	0.019	0.011	1.784	0.075
Urban center	0.501	0.540	-0.039	0.020	-1.918	0.055
Rural area	0.197	0.196	0.001	0.016	0.067	0.947
Health index (MCA)	0.787	0.772	0.015	0.004	3.881	0.000
Fear of health consequences	0.000	0.010	-0.010	0.001	-7.453	0.000
Controls						
Age	40.249	40.699	-0.450	0.546	-0.825	0.409
Female	0.484	0.487	-0.003	0.020	-0.157	0.876
Education						
High school	0.566	0.599	-0.033	0.020	-1.638	0.102
University	0.200	0.166	0.035	0.016	2.143	0.032
Other	0.159	0.110	0.049	0.015	3.377	0.001
Income						
Log(income/cons. unit)	6.426	6.272	0.155	0.101	1.536	0.125
Missing value	0.124	0.138	-0.014	0.013	-1.030	0.303
Interview face-to-face	0.395	0.518	-0.123	0.020	-6.182	0.000

Note: N=6,186. Disqualified donors excluded.

Table 3. Model estimates - Linear Probability Hurdle Models (FGLS)

Equation	Active donor (a)				Disqualifed (b)			
Controls	Without		With		Without		With	
Estimates	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat
Main variables								
Risk-aversion scale	-0.004***	-3.869	-0.003**	-3.133	-0.002	-1.287	0.004**	2.410
Organ donor	0.041***	8.263	0.040***	7.883	-0.020**	-2.315	-0.019**	-2.146
Donors participation rate	0.516***	4.350	0.489***	4.117	-0.184	-0.906	-0.197	-0.984
Living area								
Outer suburbs	0.005	0.629	0.004	0.534	0.025*	1.874	0.020	1.571
Multipolar town	0.015	1.315	0.016	1.328	0.015	0.752	0.007	0.344
Urban centre	0.000	-0.055	-0.001	-0.222	0.021*	1.907	0.008	0.783
Rural area	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Health index (MCA)	0.189***	11.770	0.169***	9.763	1.545***	56.261	1.365***	46.943
Fear of health consequences	-0.057**	-2.048	-0.055**	-2.005	0.086*	1.808	0.108**	2.327
Controls								
Age			-0.000**	-2.478			-0.006***	-18.303
Female			-0.006	-1.147			-0.053***	-6.247
Education								
High school			-0.008	-1.310			0.034***	3.395
University			0.002	0.204			0.045**	3.165
Other			Ref.	Ref.			Ref.	Ref.
Income								
Log(income/cons. unit)			-0.003	-0.633			-0.010	-1.145
Missing value			-0.028	-0.721			-0.064	-0.970
Interview face-to-face			-0.026***	-5.149			-0.011	-1.293
Intercept	-0.124***	-6.345	-0.044	-1.066	-0.464***	-13.807	-0.037	-0.532
N	10132		10132		10132		10132	

Note : (a) Dep. Var. is active donor (1) vs non-active-donor (0). (b) Dep. Var. is potential donor (1) vs disqualified donor (0).
Legend: * p<.1, ** p<.05, *** p<.01. Robust standard-errors used to compute t-stats.

Appendix

Appendix 1: demonstration of inequality (1)

If $a = 0$ then the agent's utility level is $U(H + x\gamma_a E(v_a \mid a = 0))$. Let U be two times derivable at H. Then, according to the Taylor-Young formula, on a small neighborhood V of H, we have $\forall (H + x\gamma_a E(v_a \mid a = 0)) \in V$,

$$U(H + x\gamma_a E(v_a \mid a = 0)) = U(H) + U'(H)(x\gamma_a E(v_a \mid a = 0)) + o(x\gamma_a E(v_a \mid a = 0)).$$

We then keep the linear approximation by dropping the remainder $o(x\gamma_a E(v_a \mid a = 0))$. Thus

$$U(H + x\gamma_a E(v_a \mid a = 0)) \cong U(H) + U'(H)(x\gamma_a E(v_a \mid a = 0)). \tag{2}$$

If the individual donates blood, $a = 1$, then the *expected* utility level equals

$$EU(\tilde{y}H + v_a + x\gamma_a E(v_a \mid a = 1) - C).$$

According to the Taylor-Young formula, on a small neighborhood V of H, we have $\forall (yH + v_a + x\gamma_a E(v_a \mid a = 1) - C) \in V$,

$$\begin{aligned} U(yH + v_a + x\gamma_a E(v_a &\mid a = 1) - C) = \\ U(H) + U'(H)(yH + v_a + x\gamma_a E(v_a &\mid a = 1) - C - H) + \\ \frac{1}{2}U''(H)(yH + v_a + x\gamma_a E(v_a &\mid a = 1) - C - H)^2 + o(yH + v_a + x\gamma_a E(v_a \mid a = 1) - C - H). \end{aligned}$$

We keep the linear approximation by dropping the remainder $o(yH + v_a + x\gamma_a E(v_a \mid a = 1) - C - H)$, and we calculate the expected value of this linear approximation, according to the random continuous variable $\tilde{y}$. Further, we replace $H^2 E(\tilde{y}^2)$ by $H^2(\sigma^2 + E(\tilde{y})^2)$ where σ^2 is the variance of the health risk associated to blood donation. Thus, we have:

$$\begin{aligned} EU(\tilde{y}H + v_a + x\gamma_a E(v_a &\mid a = 1) - C) \cong U(H) + \\ U'(H)(v_a + x\gamma_a E(v_a &\mid a = 1) - C - (1 - E(\tilde{y}))H) + \\ \frac{1}{2}U''(H)(H^2\sigma^2 + (v_a + x\gamma_a E(v_a &\mid a = 1) - C - (1 - E(\tilde{y}))H)^2). \end{aligned} \tag{3}$$

By comparing Equations (2) and (3), we obtain Equation (1) if we replace $r_A(H) = -\frac{U''(H)}{U'(H)}$.

Table A1: Multiple Correspondance Analysis of Health Variables

Dimension	Principal inertia (a)	Percent	Cumul. Percent
1	0.094	84.87	84.87
2	0.006	5.43	90.30
3	0.000	0.35	90.66
4	0.000	0.12	90.78
5	0.000	0.02	90.80
Total	0.111	100	
N. obs.	8936		
N. var. (b)	7		
Chronach's alpha	0.705		

Note: (a) Burt/adjusted inertias. (b) European Mini-module (self-preceived health, limitations, long-term illness), Limitation in ADL or IADL, Nbr. of chronic diseases, Depression symptoms, Self-perceived cognition troubles.