The Market for Egg Donation

Stephanie A. Karol
Duke University

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Abstract

The egg donation industry abides by a set of guidelines limiting the compensation donors can receive for oocytes. This paper examines how donor behavior and well-being would respond to lifting this effective cap. By allowing donors to receive utility through both pecuniary and non-pecuniary aspects of egg donation, I show that a risk-averse, experienced donor who places sufficiently high weight on the non-pecuniary aspects of donation may have a negative reservation compensation level, while an otherwise identical donor who places sufficiently high weight on financial incentives for donation will always have a positive reservation level of compensation. Furthermore, I show that risk-averse, highly altruistic donors stand to garner the greatest surplus from engaging in a Nash bargaining process with the firm over compensation for a subsequent donation, relative to donors with other motivations and degrees of risk aversion. Finally, I discuss the implications of this model with respect to the arguments in favor of a price cap on donor compensation.

1 Introduction

Over the past several decades, the evolution of reproductive technology has opened the door to the creation of markets for genetic material, in the form of oocyte donation. Oocytes present a unique theoretical challenge for three reasons. First, they straddle the line between "tradable good" and "gift." Second, the institutions which govern their transfer from donor to recipient exhibit an ethically-based aversion to operating as a market, and yet facilitate an exchange of money for an end product, which has all of the traditional trappings of a market mechanism. Finally, donors often accept a price vector which would likely be too low to clear the market for a good whose provision entails a risk of considerable magnitude, and yet this exchange is not subject to government regulation. In essence, the organizations which match prospective donors with prospective parents argue that offering donors greater compensation for their genetic material will lead to unacceptable risk-seeking behavior on donors' part, and perhaps incentivize donors to deceive fertility agencies as to their true health history. This paper seeks to discern whether or not these fears are realistic. By modeling the donor's decision problem as a function of her consumption, health, and non-financial motivations, I ask two questions: How would lifting the price cap affect donor welfare and firm strategy? Are there any merits to the arguments in favor of a price cap for donor compensation – namely, that higher prices would create a coercive situation in which donors may lie to firms about their own health histories, while dismissing the physical risks of donation?

2 Background and Related Literature

The market for donor oocytes, or eggs, has gained steam in recent years, as reproductive technology has improved. As of 2010, 18,306 donor oocyte cycles took place annually in the US, representing a significant uptick in adoption of this technology over the pace seen in the year 2000[16]. This paper focuses on two out of the three categories of actors in this market: donors and fertility agencies.[1] I examine these groups' response to raising the price of donated oocytes, leaving the study of the impact on the final set of actors, prospective parents, for further research.

Fertility agencies facilitate the match between donors and prospective parents, improving the efficiency of the market and charging the end user a premium for the service. These firms frame their payments to donors not as payment for a good, but rather as reimbursement for the inconvenience of donating[2]. These entities receive applications from potential donors, apply a rejection rule to screen out unsuitable donors, and enter the approved donor into their database. When a prospective parent accesses the firm's database and selects a donor, the donor is compensated, and the firm arranges her donation cycle.

Egg donors incur both time costs and health costs from donation. The time cost is non-negligible: before the extraction itself, donors must give themselves injections to stimulate oocyte production, undergo regular sonograms, and sometimes travel to another location to have the eggs extracted. Health costs arise from the regime of follicle stimulants required to enable oocyte retrieval. These costs vary greatly in severity: for example, moderate ovarian hyperstimulation syndrome may occur in as many as 6% of cases[18], and has the potential to cause serious complications, such as ovarian torsion and consequent loss of ovary, or stroke. The presence of follicle-stimulating hormones in the body also results in an elevated rate of unintended pregnancy between donation cycles; one study found that this was the experience of as many as 7% of donors.[17] Further health risks are possible, but to date, little research has been conducted in order to quantify these risks, especially those which play out in the long term. As a result, donors take on a great deal of exposure to uncertain risks. Rosen (1988) points out that, from an insurance perspective, "such risks are not diversifiable," and thus participants in this genre of risky activity must self-insure at higher rates, leading to "larger valuations compared to known risks."

The case of the market for egg donation runs counter to this theory, given the modest level of donor compensation deemed acceptable by the American Society of Reproductive Medicine (ASRM). The vast majority of fertility agencies follow the recommendations of the ASRM, namely, that "total payments to donors in excess of $5,000 require justification and sums above $10,000 are not appropriate," and that "compensation should not vary according to the planned use of the oocytes, the number or quality of oocytes retrieved, the number or outcome of prior donation cycles, or the donor's ethnic or other personal characteristics[1]." While these guidelines do not carry the force of law, individual fertility agencies looking to maximize profits can point to the ASRM's guidelines in order to justify what some say is a relatively low level of compensation. In effect, the ASRM has placed a rather arbitrary price cap on donor compensation, which may not reflect the risks involved – yet women continue to donate. This apparent paradox prompts the following analysis of potential donors' valuation of the risks and rewards of donation. Below, I illustrate how risk-aversion and altruism combine to produce a market in which certain experienced donors will accept any level of compensation in exchange for their services.

Proponents of the price cap argue that unconstrained compensation would promote the idea that human ova are commercializable goods, and possibly lead to unsavory eugenic consequences[1]. However, the market for eggs does not cease to function as a market simply because the ASRM disapproves. Fertility agencies already recognize that they can exploit end users' elevated willingness-to-pay for donors with higher SAT scores or GPAs, or who are considered conventionally attractive, by bowing to societal norms in a manner which could be viewed as eugenically-oriented[2]. Indeed, many fertility agencies' websites cite the ASRM as the source of their guidelines for donor selection and compensation, while simultaneously violating these recommended guidelines by offering a

[1] In this paper, the market for eggs refers only to those agreements reached between two parties who were previously unknown to one another. In this case (unlike, for example, a case where someone might donate eggs to a friend or relative), prospective donors and parents match with one another through fertility agencies. Some firms provide medical services, such as pre-screening for genetic diseases; some do not. For computational simplicity, this paper assumes firms do not provide such services.

premium to donors with desirable physical attributes[3].

In summary, when it comes to donor recruitment and compensation, the match-facilitating institutions of the egg donation market appear to be working against the grain of the market forces which facilitate the industry's growth. The following paper asks how adopting motivation-based rejection rules affects donors' application strategy, and assesses the potential for the existence of a price vector which could facilitate a welfare improvement for both donors and firms.

The field of economics has paid scant attention to the markets for human gametes. Kidney donation, on the other hand, is a fairly popular subject, but it is clearly distinct from egg donation. A market for organs, such as kidneys, could be considered a special case of the market presented in this work. In both cases, donors receive non-pecuniary utility from their gift, and may stand to suffer health consequences; should organs be permitted to be sold, both would also confer benefits to consumption. However, the market for eggs remains distinct, if only because a woman has many more eggs than kidneys. Kidney donation may occur no more than once; egg donation could, theoretically, be repeated indefinitely.[2] Quantity distinctions aside, there is a portion of the market for eggs in which patients undergoing in vitro fertilization (IVF) receive a discount on the procedure if they agree to donate eggs; this corner of the market may be a good analogy to the kidney exchange mechanism described by Roth, Sonmez, and Unver (2003); however, it is out of the scope of this paper. On the other hand, Becker and Elias (2007) address a fundamentally similar problem:

> In considering the arguments against payment for organ donors, it's illuminating to compare them with the arguments about paying market wages to attract a voluntary army. For example, a first argument against monetary payment for organs is that such payment is undesirable because it involves commodifications of body parts. But the voluntary army used by the United States and many other nations allows the commodification of the whole body. ...
>
> The sale of organs has also been opposed because poor individuals probably would be the main ones who would sell their organs. The argument was also made that a voluntary army would become an army of the poor. This argument is debatable on ethical grounds: Should poor individuals be deprived of revenue that could be highly useful to them?

However, Becker and Elias go on to make a fundamentally different economic argument, addressing the public gains to be achieved through allowing the sale of organs; the present paper is concerned with individuals' motivations in a market largely enabled by profit-seeking intermediaries.

These intermediaries create a fundamental distinction between the problem at hand and that of induced demand. In the vast majority of the literature, the problem of induced demand refers to the situation in which physicians convince their patients to demand more healthcare services than is strictly optimal for the patient's health. Hadley et. al (1979) note that "the ability to create demand is based on the fact that patients generally lack the medical knowledge required to assess the quality, efficacy, and need for medical care. Consequently, the patient's physician takes on the dual role of medical care adviser and provider." There is no such conflation of interests in this market; donors have no reason to believe that the fertility agency's professional purpose is to look out for the donor's best interests.

To address the questions outlined above, I begin by modeling the prospective donor's decision problem, allowing her to have a mixture of pecuniary and non-pecuniary motivations for donation. I proceed to model the firm's problem and the interaction of donors and firms under the price cap, and finish with a discussion of the model's implications for firms' profit and donors' choices should the price cap be lifted. I find that the source of the donor's motivations and her degree of risk aversion

[2] Infinite donation is discouraged by the ASRM in order to avoid creating a situation in which children born from donor eggs have a very large number of genetic half-siblings roaming about without any way to keep track of them. In this situation, placing a quantity restriction on production by a single vendor is validated by the nature of the good in question. It is entirely plausible that career egg donation could create an unsavory genetic situation for the donor's descendants.

has a large impact on her donation decisions and surplus, and describes the sufficient conditions under which donors will choose to return to the market to make a second donation. This model confirms the existence of the potential for coercive behavior on the part of the fertility agencies, and sets forth some of the conditions under which it may occur. Finally, I show that donors who underreport their degree of financial motivation may successfully mislead firms in an initial donation period and so expand their budget set in that period; however, doing so will grant the firm additional bargaining power in subsequent donation periods.

3 The Donor's Problem

The donor's side of this model consists of a single representative donor who lives for three periods of time: $t = 0, 1, 2$. This simplification abstracts away from the N-period case for mathematical simplicity. This section aims to specify the factors which influence the donor's reservation wage, and the conditions under which an individual will choose to donate her eggs.

The act of donation could cause the donor to incur health costs, but will certainly cause her to incur the opportunity cost of her time; donors divide their endowment of time between donating (an activity which consumes share d of her unitary time endowment) and working for wage w. A donor receives p as compensation for the donation, and will only consider donating if $p \geq wd$ holds – individuals will be averse to incurring health risks at a financial loss, even though the act of donation may bring the donor non-pecuniary benefits.

There are a variety of benefits to donating an egg: primary motivations tend to be financial, altruistic, or biological. People who donate for altruistic reasons get utility out of the act of helping someone else have a child; people who donate for biological reasons get utility simply out of the act of passing down their own genes. Most donors cannot be placed neatly into one of these discrete categories. Thus, the binary donation choice Z_t yields non-pecuniary utility $1 - \alpha$ for the donor in the donation period, and an additional $f(1 - \alpha)$ of non-pecuniary utility in the subsequent period. Donors feel the pecuniary benefits of donation through expansion of the budget constraint. They place the weight α on these financial benefits, where $\alpha \in [0, 1]$. While in practice these weights may shift over time, in this model they are assumed to remain constant. However, these weights are heterogeneous across individuals.

The donor discounts future utility with $\delta \in (0, 1)$, where higher levels of δ are associated with more patient individuals and lower levels with more myopic people. I assume that d is time-invariant but heterogeneous across donors, and if the time burden of donation is too great, choosing to donate will result in zero utility. Furthermore, I assume that d is correlated with the wealth distribution; transportation costs and other time costs are easier to bear if one owns a car, or lives near convenient public transportation. The time costs of donation are easier to bear for those with white-collar jobs.

H_t is a continuous variable on the unit interval, measuring health status. It is best understood as a measure of the permanent health status of the individual, as she perceives it at the time; transitory health consequences, like inflammation, cramps, dizziness, or mild cases of ovarian hyperstimulation syndrome, will not affect this variable. However, permanent health consequences – pregnancy, infertility, ovarian torsion – will cause H_t to fall between periods[3]. The mild consequences do not enter into H_t, but rather affect q_t, the prospective donor's subjective assessment of the risk of donation, based on her beliefs at time t. The possiblity of long-term health risks is beyond the scope of this paper; it is left as an avenue for future research.

Donors are endowed with a combination of time-varying and time-invariant parameters, which affect their donation decisions in periods 0 and 1. The population of potential donors may display heterogeneity in the time-invariant parameters, enumerated as follows:

[3]For purposes of this paper, a period begins when a donor applies to a firm, and ends with egg retrieval or with rejection of the donor's application. One period may last for several months. In particular, pregnancy risk is elevated far above normal levels after the donor begins hormonal injections but before the oocytes have been removed[14].

1. Savings rate η
2. Interest rate λ
3. Wage w
4. Relative weight on the financial benefit of donation $\alpha \in [0, 1]$
5. Time spent on donation and donation-related activities d
6. Total allotment of time, normalized to 1[4]

Period 0. The prospective donor is endowed with:

1. q_0, a subjective probability of suffering negative health consequences from donation
2. ψ_0, her expectation of the magnitude of those consequences
3. Health $H_0 = 1$, a continuous variable constrained to lie on the unit interval
4. Wealth W_0
5. Initial offer of donation compensation p_0, available to all prospective donors homogeneously

By assumption, the prospective donor begins to consider donation when she is in perfect health.

In period 0, the donor decides whether or not to donate in period 1 (and only in period 1; she plans no more than one donation at a time). She chooses Z_1 to maximize the discounted present value of her expected utility in subsequent periods:

$$\max_{Z_1} \sum_{t=1}^{2} \delta^t [q_0 u(Z_1(c_t + (1-\eta)(p_0 - wd)(\lambda\eta)^{t-1}), (1-\psi_0)Z_1 H_{t-1}, Z_1(1-\alpha))+ \\ (1-q_0)u(Z_1(c_t + (1-\eta)(p_0 - wd)(\lambda\eta)^{t-1}), Z_1 H_{t-1}, Z_1(1-\alpha)) + (1-Z_1)u(c_t, H_{t-1}, 0)] \quad (1)$$

subject to the following restrictions:

$$c_t \leq (1-\eta)W_t \quad (2)$$

$$W_t = \lambda\eta W_{t-1} + w \quad (3)$$

Period 1. The consequences of the first donation decision are realized in this period. If the prospective donor chose to set $Z_1 = 1$, the time-varying parameters evolve according to the following rules:

1. $q_1 = q_0 + \rho Z_1$[5]
2. $H_1 = (1 - \Psi_1 Z_1)H_0$
3. $\psi_1 = \tau\Psi_1 + (1-\tau)\psi_0$

[4] While donors' endowment of time is normalized to 1 in this model, it should be noted that donation cycles often take more than one month to complete. This is important because donors contrast p with w, which is not a unitless comparison. In all calculations, I assume that cycles take two months to complete, and so the donor's opportunity cost is proportionate to two months' worth of her wages.

[5] Donors do not update q_0 using Bayesian conjugate priors, although it may seem natural to do so. This would involve describing q_0 as a random draw from some beta distribution, and updating q_0 using binomially-distributed observations gathered via donation. However, since donors' impressions may influence their subjective perceptions despite an unchanging health status, the data donors gather from the donation process do not follow a binomial distribution.

Note that Ψ_1 in period 1 is the actualized value of the donor's subjective estimate of the magnitude of the health damage she might suffer, represented by ψ_0 in period 0. The expectation of future health consequences, ψ_1, is a convex combination of past expectations and past realized health consequences.

The donor updates q_0 with new information gathered from her personal experience. The reasoning behind this is best understood as a consequence of cognitive dissonance; Akerlof and Dickens (1982) describe a range of situations in which individuals' need to think well of themselves causes them to disregard information which contradicts this narrative. Taking this view of the egg-donation decision, it is natural to suggest that in the absence of hard facts about the risks posed by the procedure, a donor will weight her own experiences more heavily than the reports of others. q_0 may still rise even if the donor does not realize any health consequences in this period; this variable may be affected by anything from the aforementioned transitory health consequences mentioned earlier to the impression the donor formed of the physician who performed the procedure. The parameter which facilitates this increase, ρ, is a random variable with distribution $F(\rho;\Psi)$. Higher values of Ψ necessitate higher values of ρ: if $\Psi' > \Psi$, then $F(\rho;\Psi')$ first-order stochastically dominates $F(\rho;\Psi)$. The theory of cognitive dissonance suggests that $\rho \in (-q_0, 1-q_0]$; realizations of $\rho < 0$ only occur if $H_t = 1$, which is to say, if the donor remains in perfect health despite having experience donating.

As the donor considers a donation in period 2, she anticipates receiving a non-pecuniary utility flow from her period-1 donation of $f(1-\alpha)$, an increasing and concave function defined on $[0,1]$. The concavity of $f(\cdot)$ is implied by the theory of cognitive dissonance. While in the long run, she may eventually come to pay the psychic cost of regretting her donation, she reassures herself in the short run that she made the right choice. Utility from past donation choices is additively separable from utility arising from the donation choices she currently contemplates. Both $f(1-\alpha)$ and $1-\alpha$ enter the utility function in a linear fashion.

In this period, the donor uses all of the information at her disposal to come up with a reservation level of compensation, p_r.

The donor then chooses whether or not to make a second donation in period 2. She chooses Z_2 to maximize the discounted present value of her expected utility in the subsequent period:

$$\begin{aligned}\max_{Z_2} \delta[&q_1 u(Z_2(c_2 + (1-\eta)(p - wd)(\lambda\eta)^2), (1-\psi_1)Z_2 H_1, Z_2(1-\alpha)) \\ &+ (1-q_1)u(Z_2(c_2 + (1-\eta)(p-wd)(\lambda\eta)^2), Z_2 H_1, Z_2(1-\alpha)) + (1-Z_2)u(c_2, H_1, 0)] \\ &\text{s.t. } c_2 \leq (1-\eta)W_2,\, W_2 = \lambda\eta W_1 + w \qquad (4)\end{aligned}$$

In the case where she set $Z_1 = 0$, she will not set $Z_2 = 1$ under any circumstances. She has no new information as to the dangerousness of the procedure; her health variable remains unchanged, so even if ρ or were to exogenously change, it would not affect her subjective probability; $q_1 = q_0$.

Period 2 The consequences of the second donation decision are realized in this period. If the prospective donor chose to set $Z_2 = 1$, the time-varying parameters evolve according to the following rules:

1. $q_2 = q_1 + \rho Z_2$
2. $H_2 = (1 - \Psi_2 Z_2)H_1$

As before, Ψ_2 in period 2 is the actualized value of the donor's subjective estimate of the magnitude of the health damage she might suffer, represented by ψ_1 in period 1.

The utility function is assumed to be strictly increasing and weakly concave in both of its arguments. By imposing the usual assumptions regarding strictly monotonic preferences, (2) will bind at optimal values of c_t.

I now turn to the determination of p_r, the donor's reservation level of compensation.

If she donated in period 1 and suffered a permanent health consequence, her expected utility of donating a second time must exceed the certain utility of stopping after a single donation. Then, the necessary condition for a second donation is:

$$q_1[u(c_2+(1-\eta)(p-wd), 1-\Psi_1-\psi_1, f(1-\alpha)+1-\alpha)]+(1-q_1)[u(c_2+(1-\eta)(p-wd), 1-\Psi_1, f(1-\alpha)+1-\alpha)] \geq u(c_2, 1-\Psi_1, f(1-\alpha)) \quad (5)$$

Multiplying through and rearranging, this implies:

$$\begin{aligned} q_1[u(c_2+(1-\eta)(p-wd), 1-\Psi_1, f(1-\alpha)+1-\alpha)-u(c_2+(1-\eta)(p-wd), 1-\Psi_1-\psi_1, f(1-\alpha)+1-\alpha)] \\ \leq u(c_2+(1-\eta)(p-wd), 1-\Psi_1, f(1-\alpha)+1-\alpha) - u(c_2, 1-\Psi_1, f(1-\alpha)) \\ \Rightarrow q_1 \leq \frac{u(c_2+(1-\eta)(p-wd), 1-\Psi_1, f(1-\alpha)+1-\alpha) - u(c_2, 1-\Psi_1, f(1-\alpha))}{u(c_2+(1-\eta)(p-wd), 1-\Psi_1, f(1-\alpha)+1-\alpha) - u(c_2+(1-\eta)(p-wd), 1-\Psi_1-\psi_1, f(1-\alpha)+1-\alpha)} \end{aligned} \quad (6)$$

The denominator reflects a change in utility from changes in health status, with consumption held constant; the numerator includes a change in utility from changes in consumption, with health held constant. Intuitively, a donor will choose to donate a second time if her updated subjective probability of suffering health consequences, $q_1 \equiv q_0 + \rho$, is weakly less than the ratio of the non-health (both pecuniary and non-pecuniary) benefits of donation to the potential health costs of donation. If the anticipated non-health gain is large and the expected health loss is small, a second donation is virtually guaranteed. If the expected health loss is large, it is more likely that the donor will stop after a single cycle.

Since the utility function is strictly increasing and weakly concave, we can solve (6) to obtain p_r, a lower bound for p. The solution, naturally, depends on the exact form of the utility function. In the special case where utility is linear:

$$\begin{aligned} q_1 \leq \frac{u(c_2+(1-\eta)(p-wd), 1-\Psi_1, f(1-\alpha)+1-\alpha) - u(c_2, 1-\Psi_1, f(1-\alpha))}{u(c_2+(1-\eta)(p-wd), 1-\Psi_1, f(1-\alpha)+1-\alpha) - u(c_2+(1-\eta)(p-wd), 1-\Psi_1-\psi_1, f(1-\alpha)+1-\alpha)} \\ \Rightarrow q_1 \leq \frac{(1-\eta)(p-wd)+1-\alpha}{\psi_1} \\ \Rightarrow \frac{\psi_1 q_1 + \alpha - 1}{1-\eta} + wd \leq p \end{aligned} \quad (7)$$

In other cases, solving (6) for the reservation wage will be more involved. Generally, we can say that so long as (6) is not violated, the risk-neutral donor will continue to donate. An example of the reservation wage in the risk-averse case is presented in Proposition 3.

Equation (7) is inversely related to $1-\eta$, the donor's marginal propensity to consume additional income. A higher marginal propensity to consume is generally associated with people on the lower end of the wealth distribution; wealthier people are more likely to save than spend an additional dollar. Equation (7) illustrates that as the donor's marginal propensity to consume rises, the reservation wage falls. (7) also tells us that raising the wage, the time input involved in donation, the severity of the potential health risk, and the donor's subjective assessment of the risks would each require an increase in minimum p. Then, donors' location in the wealth distribution is a key determinant of the choice to donate a second time, with wealthier donors less likely to seek a second donation.

In period 0, p is fixed at p_0; but in period 1, both donors and firms may reasonably expect to renegotiate the contract[15]. With only a single data point with regard to the prices which this donor will accept, the firm has no hope of recovering the donor's utility function or preferences at this point in time. Meanwhile, the donor's assessment of the dangers of donation, and the relative benefit given her own finances, may be subject to change between periods 0 and 1. This opens the door for a donor to be able to misrepresent her motivations in period 0, when she initially applies to a firm to become a donor.[6] I save discussion of the consequences of misrepresenting α for section 5.

The motivation term, $1-\alpha$, plays an interesting role in equation (7). The reservation wage falls as a particular woman places less weight on the pecuniary motive. This result holds even if her relative importance weights do not remain constant across time; because she considers her expected utility in period t given $Z_t = 1$ against the certain utility she would receive in the same period if $Z_t = 0$, flows of $1-\alpha$ from past time periods do not figure into her calculation at all.

Proposition 1. *If a risk-neutral agent does not suffer health consequences in her first donation cycle, the experience may permanently alter her preferences and improve her willingness to donate in subsequent rounds.*

Intuitively, if a donor emerges from the process as healthy as she was before, cognitive dissonance will kick in. She throws caution to the wind because her personal experience has shown her that the benefits of donation far outweigh the costs, and she requires less of an incentive to undergo a subsequent donation cycle.

Similar to the case in which $Z_1 = 0$, if a period-1 donor did not suffer any negative consequences from donation, her new subjective probability of coming to harm is weakly higher than in the previous period, but her health constraint is no different than before. As it turns out, (7) is an appropriate reservation wage in this case as well; however, the weakly lower level of ρ in this case will lead to a reservation wage which is weakly lower than that described in (7). Recall that ρ may take negative values if the donor is still in perfect health. If ρ falls into negative territory, then (7) suggests that the reservation wage could fall between $t = 0$ and $t = 1$.

In the linear case, it is very difficult to find a situation in which, having donated once already, a donor will prefer to stop donating. This becomes obvious by rearranging (7) to find a lower bound for $p - wd$; this lower bound necessarily lies in the unit interval when it is positive, and so regardless of a risk-neutral donor's experiences or beliefs, the only way she decides to stop donating is if p is very close to wd.

It is perhaps more realistic to consider that our representative donor is risk-averse, rather than risk-neutral. When the utility function is concave, donors change their minds more often.

Proposition 2. *A risk-averse, experienced donor with a sufficiently high $1-\alpha$ may have a negative p_r; an otherwise identical donor with high enough α will have a positive p_r.*

Consider an individual with the concave utility function $u(c, H, 1-\alpha) = ln(cH) + (1-\alpha)$. Plugging this utility function into (6):

[6]Firms often employ motivation-based rejection rules, rejecting those donors perceived to be too financially-oriented. If a donor misrepresents her motivations, pretending to be more altruistically-oriented than she actually is, she may stand a better chance of becoming a donor.

$$
\begin{aligned}
q_1 &\le \frac{ln([c_2+(1-\eta)(p-wd)](1-\Psi_1)) - ln(c_2(1-\Psi_1)) + 1 - \alpha}{ln([c_2+(1-\eta)(p-wd)](1-\Psi_1)) - ln([c_2+(1-\eta)(p-wd)](1-\Psi_1-\psi_1))} \\
&\le \frac{ln\big(\frac{[c_2+(1-\eta)(p-wd)](1-\Psi_1)}{c_2(1-\Psi_1)}\big) + 1 - \alpha}{ln\big(\frac{[c_2+(1-\eta)(p-wd)](1-\Psi_1)}{[c_2+(1-\eta)(p-wd)](1-\Psi_1-\psi_1)}\big)} \\
&\le \frac{ln\big(\frac{c_2+(1-\eta)(p-wd)}{c_2}\big) + 1 - \alpha}{ln\big(\frac{1-\Psi_1}{1-\Psi_1-\psi_1}\big)} \\
q_1 ln\Big(\frac{1-\Psi_1}{1-\Psi_1-\psi_1}\Big) + \alpha - 1 &\le ln\Big(1 + \frac{(1-\eta)(p-wd)}{c_2}\Big) \\
e^{(\alpha-1)}\Big(\frac{1-\Psi_1}{1-\Psi_1-\psi_1}\Big)^{q_1} &\le 1 + \frac{(1-\eta)(p-wd)}{c_2} \\
[e^{(\alpha-1)}\Big(\frac{1-\Psi_1}{1-\Psi_1-\psi_1}\Big)^{q_1} - 1]\frac{c_2}{1-\eta} + wd &\le p \qquad (8)
\end{aligned}
$$

Note that the term $\frac{1-\Psi_1}{1-\Psi_1-\psi_1}$ always exceeds 1, as ψ_1 is restricted to exceed zero to keep the expressions defined throughout.[7] (A strictly positive ψ_1 is also consistent with the behavior of a risk-averse individual, who believes that she is risking some physical harm by donating in period 2, regardless of what happened to her in period 1.) However, q_1 and $e^{\alpha-1}$ are both constrained to lie in $(0, 1)$. The reservation wage will be positive if:

$$
e^{\alpha-1}\Big(\frac{1-\Psi_1}{1-\Psi_1-\psi_1}\Big)^{q_1} > 1 \qquad (9)
$$

For large enough values of ψ_1, the fraction on the left-hand side will be sufficient to make this inequality hold, even for a very financially-motivated person who attaches a small subjective probability to the possibility of suffering further harm. However, unlike the case of the risk-neutral individual, it is possible for a risk-averse person to have a negative reservation wage. This is a highly counterintuitive result, as it implies that risk-averse donors who receive $\bar{p}$ for their eggs will finish the transaction with a greater welfare gain than otherwise identical, risk-neutral donors who receive $\bar{p}$. (Note that in the special case of $q_1 = 0$, in which cognitive dissonance takes hold and the risk-averse donor feels completely certain that nothing bad will happen to her, the reservation wage will always be negative.) This implies that risk-averse, altruistic donors may actually be more susceptible to coercion than risk-neutral donors, because they can receive the same amount of surplus as risk-neutral donors do while earning less compensation for taking on the same physical risk.

The graphs below illustrate the reservation wages for experienced donors. Risk-neutral donors will always demand to be offered a positive amount in order to donate again; the same is only true for risk-averse donors for whom the pecuniary motive provides a sufficiently large share of the total utility from donation. The threshold level of α depends heavily on the donor's health status after the first round of donation, and depends less heavily on her perception of the risks of the process after the first round. For risk-averse, experienced, highly altruistic donors who suffered very little negative health consequences in the previous round, any positive price will be more than enough to make a second donation worthwhile. All else held constant, the same is not true for highly financially-motivated donors.

[7] If $\Psi_1 + \psi_1 = 1$, two things occur. First, the donor expects her health to be permanently destroyed by another donation; if her utility from health and consumption are not additively separable, then her expected utility from donation is 0 and she chooses not to donate. Even if her utility function featured additive separability in health and consumption, $H_t = 0$ is associated with an individual whom the fertility agencies deem insufficiently healthy to be a donor.

Figure 1: Lower bounds for p from risk-neutral donors

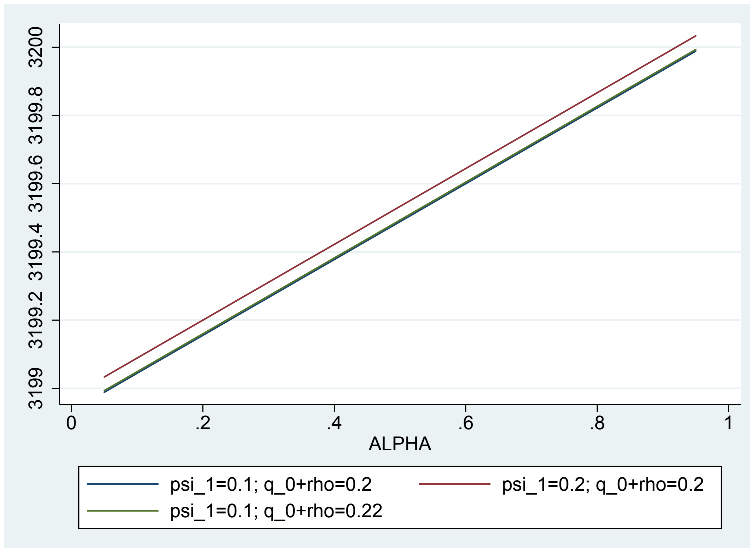
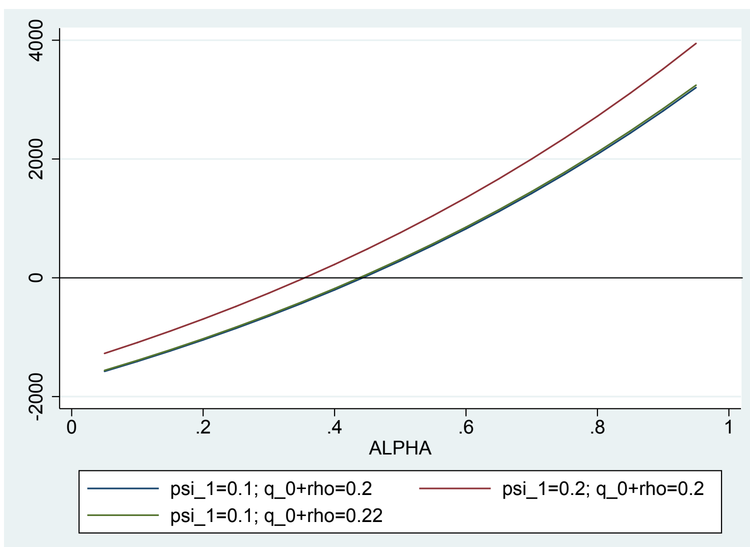


Figure 2: Lower bounds for p from risk-averse donors



Proposition 3 is highly counterintuitive, which begs the question: where does this negative reservation wage come from? The counterintuitive change from a positive reservation wage in the linear case to a possibly negative reservation wage in the nonlinear case arises from the additive separability of health and consumption present in the linear case, as well as the value attached to non-pecuniary motives.

To investigate the source of the negative reservation wage, I consider a utility function which weights health and consumption in unequal amounts: $u(c, H, 1-\alpha) = c^{\gamma}H^{\beta} + (1-\alpha)$, where $\gamma \neq \beta$. The associated reservation wage is as follows:

$$
\begin{aligned}
q_1(c_2(1-\eta)(p-wd))^{\gamma}[(1-\Psi_1)^{\beta}-(1-\Psi_1-\psi_1)^{\beta}] &\leq (c_2(1-\eta)(p-wd))^{\gamma}(1-\Psi_1)^{\beta}+(1-\alpha)-c_2^{\gamma}(1-\Psi_1)^{\beta} \\
q_1(c_2(1-\eta)(p-wd))^{\gamma}[(1-\Psi_1)^{\beta}-(1-\Psi_1-\psi_1)^{\beta}]+c_2^{\gamma}(1-\Psi_1)^{\beta}+\alpha-1 &\leq (c_2(1-\eta)(p-wd))^{\gamma}(1-\Psi_1)^{\beta} \\
c_2^{\gamma}(1-\Psi_1)^{\beta}+\alpha-1 &\leq (c_2+(1-\eta)(p-wd))^{\gamma}[(1-\Psi_1)^{\beta}-q_1[(1-\Psi_1)^{\beta}-(1-\Psi_1-\psi_1)^{\beta}]] \\
([\frac{c_2^{\gamma}(1-\Psi_1)^{\beta}+\alpha-1}{(1-\Psi_1)^{\beta}-q_1[(1-\Psi_1)^{\beta}-(1-\Psi_1-\psi_1)^{\beta}]}]^{\frac{1}{\gamma}}-c_2)\frac{1}{1-\eta}+wd &\leq p \qquad (10)
\end{aligned}
$$

This reservation wage can be either negative or positive. Its sign depends on the relative weights on consumption and health, as well as on $1-\alpha$. The minimum acceptable compensation will be weakly negative under the following conditions:

$$
\begin{aligned}
([\frac{c_2^{\gamma}(1-\Psi_1)^{\beta}+\alpha-1}{(1-\Psi_1)^{\beta}-q_1[(1-\Psi_1)^{\beta}-(1-\Psi_1-\psi_1)^{\beta}]}]^{\frac{1}{\gamma}}-c_2)\frac{1}{1-\eta}+wd &\leq 0 \\
[\frac{c_2^{\gamma}(1-\Psi_1)^{\beta}+\alpha-1}{(1-\Psi_1)^{\beta}-q_1[(1-\Psi_1)^{\beta}-(1-\Psi_1-\psi_1)^{\beta}]}]^{\frac{1}{\gamma}}-c_2+(1-\eta)wd &\leq 0 \\
\frac{c_2^{\gamma}(1-\Psi_1)^{\beta}+\alpha-1}{(1-\Psi_1)^{\beta}-q_1[(1-\Psi_1)^{\beta}-(1-\Psi_1-\psi_1)^{\beta}]} &\leq [c_2-(1-\eta)wd]^{\gamma} \\
c_2^{\gamma}(1-\Psi_1)^{\beta}+\alpha-1 &\leq [c_2-(1-\eta)wd]^{\gamma}(1-\Psi_1)^{\beta}-[c_2-(1-\eta)wd]^{\gamma}q_1[(1-\Psi_1)^{\beta}-(1-\Psi_1-\psi_1)^{\beta}] \\
(1-\Psi_1)^{\beta}(c_2^{\gamma}-[c_2-(1-\eta)wd]^{\gamma})+\alpha-1 &\leq -[c_2-(1-\eta)wd]^{\gamma}q_1[(1-\Psi_1)^{\beta}-(1-\Psi_1-\psi_1)^{\beta}] \\
\frac{c_2^{\gamma}-[c_2-(1-\eta)wd]^{\gamma}}{[c_2-(1-\eta)wd]^{\gamma}}-\frac{1-\alpha}{[c_2-(1-\eta)wd]^{\gamma}(1-\Psi_1)^{\beta}} &\leq q_1[\frac{(1-\Psi_1-\psi_1)^{\beta}-(1-\Psi_1)^{\beta}}{(1-\Psi_1)^{\beta}}] \\
\frac{c_2^{\gamma}-[c_2-(1-\eta)wd]^{\gamma}}{[c_2-(1-\eta)wd]^{\gamma}}-q_1[\frac{(1-\Psi_1-\psi_1)^{\beta}-(1-\Psi_1)^{\beta}}{(1-\Psi_1)^{\beta}}] &\leq \frac{1-\alpha}{[c_2-(1-\eta)wd]^{\gamma}(1-\Psi_1)^{\beta}} \qquad (11)
\end{aligned}
$$

If the donor's scaled utility from altruism exceeds the sum of the percentage potential loss of utility from forgoing additional consumption, and the subjective-probability-scaled percentage potential loss from health, she will accept negative compensation. Individuals who place greater weight on health relative to consumption are more likely to accept negative reservation wages, especially if they place a low subjective probability on suffering loss of health.

This suggests that the counterintuitive change from a positive reservation wage in the linear case to a possibly negative reservation wage in the nonlinear cases arises not from the fall in marginal utility of wealth between the linear and nonlinear cases, but from the following three sources: the relative weights on health and consumption, the additive separability of health and consumption present in the linear case, and the value attached to non-pecuniary motives.

The possibility of a negative reservation wage confirms that, no matter the sum of money offered, some donors will still prefer to donate– even though the process involves considerable risk to risk-averse donors. Firms which consider raising compensation will see no marginal benefit from donors with negative reservation wages. A firm with only low-α, risk-averse donors could maximize profits simply by setting $p = p_0$. Equation (11) illustrates that, all else equal, more financially-motivated donors are more likely to have positive reservation wages. Far from making these donors more susceptible to coercion, this fact arguably implies that high-α donors value the risks of egg donation more accurately than their low-α counterparts. However, Proposition 2 implies that a high-α donor who manages to avoid bad health outcomes in the first donation round will behave almost as though she were a low-α donor, requiring substantially lower levels of compensation to continue donating than her counterparts who did suffer health complications.

4 The Firm's Problem

The demand side of the market for eggs is populated by a great number of small firms. For purposes of this paper, I will abstract away from firms' potential for specialization and assume that firms do comply with the ASRM's guidelines regarding equal compensation for egg donors regardless of physical features or indicators of intellectual prowess. This assumption is non-trivial. However, addressing firm specialization conditional on, for example, race or ethnicity is beyond the scope of this paper.

In period 0, donors decide whether or not to donate based on the price, p, offered by the firm; this price is homogeneous across all individuals. The game changes in period 1, when so-called "experienced donors" have the option of bargaining with the firm.

I assume that a single firm must charge the same price to all intended parents (E), and that the overhead cost function, $C(O)$, is homogeneous of degree one in its argument. Then a firm with D donors listed in its database has profit function:

$$\pi = DE - \sum_{i=1}^{D} p_i - DC(O) \tag{12}$$

In this function, $p_i \neq p_j$ in general.

Firms are able to perfectly observe Ψ_1 and the initial p accepted by the donor. Firms observe many parameters imperfectly; based on observables, they generate expected values of $1-\alpha$, w, d, W_1, η, ψ_1, and q_1. In the below analysis, the expected values of these parameters will be represented with tildes. Firms assume the donor is risk-averse, but cannot infer the degree of her risk-aversion. In the long run, a firm may develop a conditional probability distribution of utility functions, conditional on the expected-value parameters; firms are aware that these functions are several steps removed from the donor's true utility function, but in the world of second-best, using such an approximation will do. Armed with these approximated utility functions, expected-value parameters, as well as Ψ_1 and p, the firm applies equation (6) to come up with an initial offer price.

The marginal profit to the firm of acquiring the experienced donor's egg is:

$$\begin{aligned}(\pi|{+1}\text{ egg}) - (\pi|{+0}\text{ eggs}) &= (D+1)E - \sum_{i=1}^{D} p_i - p - (D+1)C(O) - DE - \sum_{i=1}^{D} p_i - DC(O) \\ &= E - p - C(O) \geq 0 \end{aligned} \tag{13}$$

Thus, this initial offer price is subject to the restriction $p \leq E - C(O)$.

5 The Model

5.1 Initial Case: Price Cap Intact

Initially, I consider the case in which the ASRM's price cap remains intact. The model proceeds in five steps:

1. Agents decide if donation is worth the risk by plugging in the first-time donor price into equation (11); if this does not represent an expected-utility improvement over the agent's reservation utility, $u(c_t, H_t, 1-\alpha)$, then she decides not to donate.
2. Agents apply to one of the firms, reporting a level of α. Period 0 ends.[8]

[8]For the present discussion, I assume that none of these applicants are rejected.

3. Donation occurs; agents suffer health consequences, get paid, and update their subjective probabilities. Firms observe Ψ_1 for each donor, generate expected values of the other parameters, and use these to calculate an offer price.

4. Donors and firms engage in an asymmetrical Nash-bargaining process to determine the donor-specific "experienced donor" price. In this case, the set of possible agreements is limited by the ASRM's price cap; firms will not agree to compensate above that amount. Period 1 ends.

5. Repeat step 3.

In the Nash bargaining process, the donor's threat point is represented by the price p for which her utility from a second donation with this firm equals the maximum of the utility she receives from not donating and the utility she receives from donating to another firm as a first-time applicant:

$$u(c_2+(1-\eta)(p-wd), H_1-\psi_1, f(1-\alpha)+1-\alpha) = max\{u(c_2, H_1, f(1-\alpha)), u(c_2+(1-\eta)(p_0-wd), H_1-\psi_1, f(1-\alpha)+1-\alpha)\} \tag{14}$$

Note that the maximization on the left-hand side of this equation is not the same problem as the one she faces in period 0, because $c_2 \geq c_1$ and her $H_1 \leq H_0$. If her $q_1 > q_0$ and her $\psi_1 > \psi_0$, then she will prefer not to donate over donation to another firm.

The firm's threat point is represented by the restriction implied by (13): $p = E - C(O)$.

Agents and firms have asymmetric bargaining power in this negotiation: the donor believes negotiations will break down with probability $1 - e^{\omega(q_1, \psi_1, RA)\cdot\Delta}$, while the firm believes the breakdown will occur with probability $1 - e^{\tilde{\omega}(\tilde{q_1}, \tilde{\psi_1}, \tilde{RA})\cdot\Delta}$, where RA represents the donor's degree of risk aversion and Δ represents the time elapsed between offers. Let $\aleph = \frac{\tilde{\omega}}{\omega+\tilde{\omega}}$.[20] Note that $\omega(\cdot)$ is increasing in all of its arguments: if the firm believes the donor places a high likelihood on suffering physical harm with another donation, or if it believes the donor thinks the health risks are large when they do occur, or if it believes the donor is highly risk-averse in general, then it will place a high likelihood on breakdown. If any of those statements are true, then the donor will place a high likelihood on breakdown as well; if the firm manages to gauge any of these three parameters correctly, then the problem becomes symmetric.

The Nash bargaining process resolves when the players reach the solution, p^*, which satisfies:

$$\max_p (u(p^*) - u(p_r))^{\aleph}(E - p^* - C(O))^{1-\aleph} \tag{15}$$

Since the donor has outside options, the set of possible solutions is lower-bounded by the solution to (14). The set is upper-bounded by the minimum of (13) and P, the industry-imposed price cap:

$$min\{E - C(O), P\} \tag{16}$$

Proposition 3. *Experienced donors with negative reservation wages will always choose to donate again with the same firm.*

No donation will be made if the set is empty; this will only occur if, for all $p \in [p_0, min\{E - C(O), P\}]$:

$$u(c_2+(1-\eta)(p-wd), H_1-\psi_1, f(1-\alpha)+1-\alpha) < max\{u(c_2, H_1, f(1-\alpha)), u(c_2+(1-\eta)(p_0-wd), H_1-\psi_1, f(1-\alpha)+1-\alpha)\} \tag{17}$$

Since E, $C(O)$, and P are all restricted to be positive, and since $p_0 \leq E - C(O)$ in order to ensure that firms profit from first-time donors, donors with negative reservation utilities will never walk away from this negotiation. In particular, firms know that for any $p \geq p_0$, the following holds:

$$q_1u(c_2{+}(1{-}\eta)(p_0{-}wd), H_1{-}\psi_1, f(1{-}\alpha){+}1{-}\alpha){+}(1{-}q_1)u(c_2{+}(1{-}\eta)(p_0{-}wd), H_1, f(1{-}\alpha){+}1{-}\alpha)$$
$$\leq q_1u(c_2{+}(1{-}\eta)(p{-}wd), H_1{-}\psi_1, f(1{-}\alpha){+}1{-}\alpha){+}(1{-}q_1)u(c_2{+}(1{-}\eta)(p{-}wd), H_1, f(1{-}\alpha){+}1{-}\alpha) \quad (18)$$

Firms will therefore take p_0 as a lower bound for their offer. Donors with negative reservation wages will accept such an offer immediately. Essentially, they become passive participants in the "bargaining" process, as this offer is Pareto optimal.

For some donors with positive reservation wages, $max\{u(c_2, H_1, f(1-\alpha)), u(c_2 + (1-\eta)(p_0 - wd), H_1 - \psi_1, f(1-\alpha) + 1 - \alpha)\} = u(c_2, H_1, f(1-\alpha))$. Such a donor will not accept the offer of p_0 at face value; she will push back.

Using $DonorEU$ to denote $q_1u(c_2 + (1-\eta)(p - wd), H_1 - \psi_1, f(1-\alpha) + 1 - \alpha) + (1-q_1)u(c_2 + (1-\eta)(p-wd), H_1, f(1-\alpha)+1-\alpha)$ for notational convenience, the solution to the Nash bargaining problem will be:

$$\begin{aligned}
&\aleph[DonorEU]^{\aleph-1}[q_1\frac{\partial U}{\partial c}(1-\eta) + (1-q_1)\frac{\partial U}{\partial c}(1-\eta)][E-p-C(O)]^{1-\aleph} \\
&\qquad + [DonorEU]^{\aleph}[(1-\aleph)[E-p-C(O)]^{-\aleph}](-1) = 0 \\
&\Rightarrow \aleph[DonorEU]^{\aleph-1}[\frac{\partial U}{\partial c}(1-\eta)][E-p-C(O)]^{1-\aleph} = [DonorEU]^{\aleph}(1-\aleph)[E-p-C(O)]^{-\aleph} \\
&\Rightarrow [E-p-C(O)] = \frac{DonorEU}{(1-\eta)}\frac{(1-\aleph)}{\aleph}[\frac{\partial U}{\partial c}]^{-1} \\
&\Rightarrow p = E - C(O) - \frac{DonorEU}{(1-\eta)}\frac{(1-\aleph)}{\aleph}[\frac{\partial U}{\partial c}]^{-1} \quad (19)
\end{aligned}$$

As $DonorEU$ depends on p, (19) must then be simplified further on a case-by-case basis in order to isolate the endogenous variable.

In the case of linear utility, the price is:

$$\begin{aligned}
p^* &= \frac{1}{1+\frac{1-\aleph}{\aleph}}[E - C(O) - [\frac{c_2 + H_1 - \psi_1 + 1 - \alpha + f(1-\alpha)}{1-\eta} - wd]\frac{1-\aleph}{\aleph}] \\
&= \aleph[E - C(O)] + (\aleph - 1)[\frac{c_2 + H_1 - \psi_1 + 1 - \alpha + f(1-\alpha)}{1-\eta} - wd] \quad (20)
\end{aligned}$$

In general, the firm's profit from this transaction is:

$$E - p - C(O) = E - \{E - C(O) - \frac{DonorEU}{(1-\eta)}\frac{(1-\aleph)}{\aleph}[\frac{\partial U}{\partial c}]^{-1}\} - C(O) = \frac{DonorEU}{(1-\eta)}\frac{(1-\aleph)}{\aleph}[\frac{\partial U}{\partial c}]^{-1} \quad (21)$$

For a given value of p^*, the donor's expected utility falls as she becomes more risk-averse. Then, all else equal, firms profit most when they deal with risk-neutral donors. However, risk-averse donors gain the most surplus.

The donor's surplus is:

$$
\begin{aligned}
q_1[u(c_2 + (1-\eta)(E - C(O) - \frac{DonorEU}{(1-\eta)}\frac{(1-\aleph)}{\aleph}[\frac{\partial U}{\partial c}]^{-1} - wd), H_1 - \psi_1, 1-\alpha) \\
- u(c_2 + (1-\eta)(p_r - wd), H_1 - \psi_1, 1-\alpha)] \\
+ (1-q_1)[u(c_2 + (1-\eta)(E - C(O) - \frac{DonorEU}{(1-\eta)}\frac{(1-\aleph)}{\aleph}[\frac{\partial U}{\partial c}]^{-1} - wd), H_1, f(1-\alpha) + 1 - \alpha) \\
- u(c_2 + (1-\eta)(p_r - wd), H_1, f(1-\alpha) + 1 - \alpha)] \quad (22)
\end{aligned}
$$

Equations (7), (8), and (10) all present examples of reservation wage p_r.

Proposition 4. *Altruistically-motivated donors benefit more than financially-motivated donors if and only if they have negative reservation wages.*

$DonorEU$ enters (22) negatively. All else equal, for a given p^*, a donor who reports a greater degree of risk aversion will receive a greater surplus. Since utility functions exhibit additive separability in $f(1-\alpha) + 1 - \alpha$, motivations enter into donor surplus only through $DonorEU$; more altruistically-motivated donors achieve a smaller surplus than financially-motivated donors, unless they have negative reservation wages. In this case, the negative terms in (22) make positive contributions to surplus.

5.1.1 Misrepresentation of Motives

An argument used to justify the existence of the price cap claims that, if offered sufficiently high compensation, donors who are too financially-motivated will lie to fertility agencies about their family's medical history. As thorough genetic testing may be infeasible or prohibitively expensive, some firms prefer to limit the possibility of acquiring defective eggs by screening out donors who report too high an α. However, this signal could be rendered meaningless if potential donors choose to search for information online prior to submitting an application, discover the existence of this practice, and take steps to misreport their α. Proponents of the price cap may argue that the popularity of sites which disseminate information to potential donors, such as `weareeggdonors.com`, may eat away at the effectiveness of this tool, thus necessitating the use of a price cap to shield against unscrupulous donors.

In essence, nothing can be done to prevent underreporting. This practice may enable a donor to earn an extra p_0 in period 1; if she chooses to donate again, she could earn at least p_0 again in period 2. However, if $p_0 < P < E - C(O)$, removing the price cap P will only increase her incentive to misrepresent her motivations if her bargaining power is sufficient to snare her compensation in the interval $(P, E - C(O))$. This begs the question: when is underreporting α a good strategy for an applicant?

Proposition 5. *Underreporting α negatively impacts donors' bargaining power.*

A straightforward application of Crawford and Varian (1979) suggests that it is always in donors' interest to misrepresent the concavity of their utility functions – namely, that it is advantageous to pretend to be risk-neutral while actually being risk-averse. However, in this application, $\aleph$ rises with the donor's degree of risk aversion, and (20) demonstrates that the price arising from the Nash bargaining process is increasing in $\aleph$. Furthermore, (22) illustrates that lower expected utility is associated with a higher price and greater donor surplus, contrary to the result from Crawford and Varian.

A firm which believes that more financially-motivated donors are more likely to misreport their degree of risk aversion would logically condition its assumption about the concavity of a donor's utility function, $\tilde{RA}$, on that donor's reported level of α. However, $\tilde{\alpha} < \alpha \Rightarrow \tilde{RA} < RA \Rightarrow \tilde{\omega} < \omega \Rightarrow$

$\aleph < 1 - \aleph$. Therefore, donors do not benefit from misrepresenting α unless firms employ rejection rules based on some maximum level of α. Firms could improve profits simply by dropping such arbitrary rejection rules.

5.2 Alternative Case: Price Cap Lifted

Lifting the price cap will only alter the solution through (16) and (19). In other words, nothing changes unless the following two conditions hold:

$$E - C(O) > P \tag{23}$$

$$E - C(O) - \frac{DonorEU}{(1-\eta)} \frac{(1-\aleph)}{\aleph} [\frac{\partial U}{\partial c}]^{-1} > P \tag{24}$$

This has the effect of turning a potentially empty set of feasible amounts of donor compensation into a nonempty set. Bargaining processes which formerly ended with both parties consuming their disagreement levels of utility and profit can now end with a contract for a second donation.[9]

Proposition 6. *All else equal, donors with higher expected utility, lower marginal utility of consumption, lower marginal propensity to consume, or lower market power are more likely to see no change in the offered price due to changes in the price cap. The converse also holds.*

Higher marginal utility of consumption $(1 - \eta)$ and higher marginal propensity to consume $(\frac{\partial U}{\partial c})$ are phenomena commonly associated with women of lower socioeconomic status (SES). Proposition 5 implies that lower-SES donors are disproportionately impacted by the price cap. Furthermore, if firms do utilize rejection rules based on α, which is the necessary and sufficient condition under which some donors will choose to underreport α, then underreporters stand to benefit more than an otherwise identical person who reports their true, strictly lower, value of α.

As the upper bound for p^* weakly rises from P to $E - C(O)$, expanding the set of possible contract prices, donor surplus weakly rises, while firm profit weakly falls, relative to the price-cap case.

By concavity of the utility function, the greater the level of P, the smaller the change in surplus to donors and profit to firms induced by raising the price cap. Naturally, the most extreme case is the case of linear utility. The donor's increase in surplus then amounts to:

$$c_2(1-\eta)([\aleph[E - C(O)] - (1-\aleph)[\frac{c_2 + H_1 - \psi_1 + f(1-\alpha) + 1 - \alpha}{1-\eta} - wd] - wd] - P) \tag{25}$$

In this case, the firm's profit loss is:

$$\aleph[E - C(O)] - (1-\aleph)[\frac{c_2 + H_1 - \psi_1 + f(1-\alpha) + 1 - \alpha}{1-\eta} - wd] - P \tag{26}$$

As (21) illustrates, firms profit most from risk-neutral donors; then (26) represents the upper bound for profit loss due to raising the price cap. Naturally, the lower bound for profit loss is zero; donors with negative reservation wages will still accept p_0, and firms will still offer this level of compensation.

[9] If donors could choose Z_1 and Z_2 simultaneously, and if firms charged differential E to the intended parents– for example, by pricing eggs hedonically– this would imply a shift away from perfect competition on the part of the firms. In period 0, donors would prefer to apply to firms with higher E, as this would expand the set of possible agreement prices in period 1. If high-E firms did not adjust their rejection strategies to account for the influx of applicants, and if there were no response on the part of intended parents, this could put low-E firms out of business entirely. However, thorough treatment of these consequences is out of the scope of the present work.

6 Conclusion

To the best of my knowledge, this paper presents the first economic model of the donor's side of the egg donation industry. This model exploits the fact that the payoffs of the donation process take both financial and values-based forms. I have derived the conditions under which an experienced donor will have a negative reservation wage, and shown that such a donor will always choose to donate again with the same firm. Highly altruistic donors can only surpass financially-motivated donors in terms of surplus through possession of a negative reservation wage.

This paper provides an economic perspective on two arguments used by both the ASRM and firms in the market for egg donation in order to justify a maximum level of donor compensation. The primary justification for such a price cap is simply that raising the price could create a situation in which women are effectively coerced into becoming donors. Taking the view that women are rational actors, while allowing both for heterogeneity in their beliefs about the potential harm of the procedure and for the possibility that cognitive dissonance may make some feel more secure after an initial donation, I find that risk-averse, highly altruistic donors are in a sense more susceptible to coercion than risk-neutral donors. However, through a Nash-bargaining process, firms maximize profit by dealing with risk-neutral women.

A secondary, related justification for a price cap is that as the financial incentive to donate rises, highly financially-motivated but less-than-scrupulous women will lie about their health and family history in order to become donors. If this were borne out, firms would be placed in a legally vulnerable position, as there is precedent for firms to pay damages to parents of donor-egg children born with genetic abnormalities[6]. To that end, there is some evidence that firms employ motivation-based rejection rules, preventing women who display too great a degree of financial motivation from becoming donors. I show that if firms use donors' reported level of α as an indicator of the concavity of their utility functions, then overreporting α will always bring the donor greater surplus in period 2 relative to underreporting. However, since donors in this model only consider making one donation at a time, a donor who seeks to avoid disqualification via an α-contingent rejection rule will likely underreport in period 0. In doing so, she signs away some of her period-1 bargaining power. If she is masking adverse health markers in her medical history, then both donor and firm arrive at suboptimal outcomes; if not, the firm achieves its best possible outcome.

All in all, I find mixed evidence to support the argument that raising the price cap would create a coercive environment for egg donors. In the end, what we call "coercion" is more a question for the philosopher than the economist. However, I do show that since the second-round price is declining in the donor's expected utility, risk-averse donors stand to command higher prices than risk-neutral donors. Raising the price cap may cause p^* to rise for risk-neutral donors, but if it does so, it will raise p^* for risk-averse donors by at least as much. In a sense, this is highly intuitive: risk-averse donors are most likely to walk away, and require the greatest amount of compensation in order to offset the risk of donation. Therefore, one would expect an increase in the price cap to induce more risk-averse donors to stay in the market for egg donation, impacting them more than the set of risk-neutral donors. If these risk-averse donors remain completely healthy in period 1, cognitive dissonance – operating through q_1 – pushes their reservation wage towards negative territory, chipping away at the possibility that they will turn down a subsequent donation. On the one hand, they receive a sizable surplus for their donation, larger than what a comparable risk-neutral donor would be able to command. On the other, they become a captive audience, increasingly unwilling to walk away at any price. If firms became cognizant of these donors' true reservation wage, the situation could easily turn coercive.

Finally, this model confirms that if the anticipated increase in utility from consumption and non-pecuniary motives is large relative to the expected health loss, donors will return to the market to pursue a second donation. Furthermore, it predicts that donors of lower socioeconomic status are disproportionately affected by the presence of the price cap.

The present model is not without limitations, and there are many ways in which future work can build upon it. First and foremost, this work treats one half of the market for egg donation; a more complete treatment of this market should consider the interface between firms and intended parents as well. If possible, this should include the possibility of hedonic pricing by firms seeking to recruit donors with "elite" characteristics, as prompted by end-user demand for such eggs. Finally, future research should encompass risks realizable in the long run, as well as the short run.

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A Table of Parameters

Parameter	Description
t	Time period; 0, 1, or 2
H_t	Health at time period t; $H_0 = 1$
c_t	Consumption, excluding from donation, at time period t
p	Financial compensation for donation
w	Donor's wage
d	Share of a donor's working time diverted to donation and donation-related activities
Z_t	Binary donation choice, made at $t-1$ and taking effect at t
α	Utility from financial aspect of donation
δ	Donor's discount factor
ψ_t	Magnitude of potential physical damage in period $t+1$, as assessed in period t
Ψ_t	Realized physical damage in period t
q_t	Subjectively-determined probability of physical damage in period $t+1$, as assessed in period t
ρ	$q_{t+1} - q_t$
W_t	Donor's cumulative lifetime wealth at time t
λ	Interest rate faced by the donor
η	Donor's savings rate
π	Firm's profit
D	Total number of donors in firm's database
E	Price firm receives for an egg
$C(O)$	Operating costs incurred per-donor by firm
P	price cap
p_0	Initial level of donor compensation
p_r	Donor's reservation wage
ω	Parameter raising donor's probability that negotiations break down
$\tilde{\omega}$	Parameter raising firm's probability that negotiations break down
$\aleph$	Donor's market power
$f(1-\alpha)$	Stock of non-financial utility from previous donation as donor considers a subsequent donation