Redesigning the Market for Volunteers: A Donor Registry*

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Abstract: This paper addresses volunteer labor markets where the lack of price signals, non-pecuniary motivations to supply labor, and limited fungibility of supply lead to market failure. To address the causes of the market failure, we conduct a natural field experiment with volunteer whole blood donors where we introduce a market-clearing mechanism (henceforth: the Registry). Our *intention-to-treat* estimates suggest that subjects assigned to the Registry condition are more likely to volunteer and are more responsive to critical shortage appeals than control subjects. Thus, the Registry significantly improves coordination between volunteer donors and collection centers, thereby improving market outcomes. We find evidence that the Registry's effectiveness stems from crowding-in volunteers with purely altruistic motives and volunteers with a preference for commitment.

Keywords: Voluntary labor, coordination, market failure, altruism, commitment, ask avoidance, market design.

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1 Introduction

Markets are the primary institution by which economies organize and allocate goods and services among individuals. The power and appeal of market institutions is that under certain assumptions, market equilibria are also socially optimal. However, in markets that lack a price signal, it can be difficult to achieve equilibrium. This difficulty is exacerbated in labor markets that rely on volunteers who are altruistically motivated, rather than motivated by money, to efficiently supply goods or services. For example, the markets for kidney and bone marrow must rely on the altruism of unpaid donors,[1] since few, if any, countries allow for the sale of organs as this is often deemed repugnant (Becker and Elias, 2007; Roth, 2007; Sandel, 2012; Elias et al., 2015). Mechanisms have also been proposed to facilitate directed and undirected donations to reduce excess demand in the organ market (see Roth et al. (2007); Kessler and Roth (2012); Ashlagi et al. (2012); Ergin et al. (2017)).[2]

Markets that rely on the non-pecuniary motives of suppliers not only result in shortages, but can also experience excess supply. In this paper, we consider the market for whole blood, which relies on altruistically motivated volunteers and is characterized by both periods of excess demand and excess excess supply, resulting in a direct loss of nearly $1.1 billion USD ($570 per unit of blood (Slonim et al., 2014)). The lack of price signals and the altruistic motivations of blood donors makes it difficult for collection centers and donors to coordinate to meet demand.[3]

Clearinghouse mechanisms have proven to effectively increase thickness in many "thin" markets, such as the market for kidneys or bone marrow,[4] by bringing together a larger number of "buyers" and "sellers" to facilitate a transaction.[5] Registries (or clearinghouses) have also been used to reduce congestion as markets become thick, for example, in entry-level labor markets (Roth, 1984; Roth and Peranson, 1999) and school choice (Abdulkadiroglu and Sönmez, 2003; Abdulkadiroğlu et al., 2005, 2009). However, the whole blood market is thick and does not suffer from congestion since the "buyers" and "sellers" are generic (i.e., they

[1] Becker and Elias (2007, 2014) estimate that paying donors approximately $15,000 per kidney would clear the market.

[2] Elias et al. (2015) report that only 29,000 organ transplants occur every year in the U.S., while 10,000 individuals die waiting for an organ transplant.

[3] Exceptions include the use of "blood barometers" in many Scandinavian countries, where blood collection agencies post the current level of supply for each blood type on agency web sites to communicate the current need to interested donors.

[4] Roth et al. (2004, 2007) reports on the efficient exchange of kidneys using the Clearinghouse. Bergstrom et al. (2009) conduct a cost-benefit analysis of recruitment into and expansion of the U.S. Bone Marrow Registry.

[5] Roth (2008) provides a thorough outline and examples of providing thickness and overcoming congestion in various markets.

are only differentiated by a small number of blood types).

Instead, the problem in the whole blood market is one of coordination of supply to meet demand. Demand for whole blood is relatively stable with the vast majority of donated blood used for treating cancer and blood disease and only 2% used for trauma. However, supply fluctuates, resulting in periods of excess supply and periods of excess demand. The fluctuation in supply is best illustrated through the pattern of solicitations issued by the Blood Service throughout the year. In August and September (winter months in Australia), the Blood Service increases the number of donation solicitations by 200-300% relative to other months (see Figure S1. This costly surge in solicitations is due to a lower supply, rather than an increase in demand. Moreover, due to the short shelf-life of whole blood, approximately 21-42 days,[6] blood collected during periods of excess supply cannot be reliably stored to cover periods of excess demand.[7] We designed the Registry to directly address the coordination problem by leveraging individual preferences to create a more flexible and responsive supply to the temporal imbalances.[8]

In partnership with the Australian Red Cross Blood Service (henceforth: the Blood Service), we conduct a natural field experiment that implements a mechanism, the Registry, to improve market coordination.[9] We randomly assigned 15,388 long-lapsed donors (donors who have donated before, but have not made a donation in at least the past 24 months) to several treatment arms of the experiment, which unfolded over 14 months and two rounds that is described in detail in Section 2. In Round 1, the main treatment manipulation was whether subjects were informed of and invited to join the Registry (henceforth: Registry conditions). Subjects assigned to the Registry conditions were truthfully told that the Blood Service was creating a donor Registry where Registry members would only be asked to donate when there was a need for their blood type and that the Blood Service would only contact Registry members once or twice per year.[10] By contrast, subjects in the non-Registry

[6] Anecdotal evidence suggests that hospitals prefer blood that is no more than 7 days old.

[7] Additionally, blood donors are required to wait 8-12 weeks between whole blood donations to allow the body to regenerate red blood cells.This eligibility requirement varies by country. In Australia, the setting of this study, blood donors are required to wait 12 weeks, while in the U.S., blood donors are required to wait 8 weeks between whole blood donations. Thus, collection centers cannot continually cultivate the most willing donors during shortages.

[8] Alternative approaches, such as offering or increasing extrinsic incentives (Goette and Stutzer, 2008; Lacetera et al., 2012, 2013, 2014), reducing time costs (Craig et al., 2016) or providing unconditional gifts (Garbarino et al., 2013) may increase supply, but they are not designed to encourage supply-side flexibility. Conversely, the Registry is effective because it targets supply increases only when there is excess market demand conditional on the normal supply, thereby improving market efficiency.

[9] Slonim et al. (2014) provides an early and brief discussion of the Registry on pages 191-193. Slonim and Wang (2017) tested three variations of registry designs against current market setups for volunteers in a controlled lab experiment and found significant improvements in market efficiency in all registry conditions.

[10] Since the completion of the Registry study period, the Blood Service has continued to use the Registry.

conditions were never informed of the existence of the Registry. Round 2 calls began three to five months later (when anticipated winter shortages occurred) and the main treatment manipulation was whether or not subjects received a Standard Shortage Appeal or a Critical Shortage Appeal, which occurs when there is less than a few weeks of blood supply remaining.

We find that the introduction of the Registry significantly improves the coordination of supply. Based on our *intention-to-treat* analyses, subjects assigned to the Registry Conditions are more likely to donate and are more responsive to donation solicitations than subjects in the control conditions. Further, we find that the Registry invitation serves as an effective selection or screening mechanism. Individuals who would otherwise not donate are motivated to donate through the Registry. Based on our *treatment-on-the-treated* analyses, soliciting Registry members during a shortage campaign results in increased responsiveness and a lower probability of both excess supply and excess demand.

The Registry was designed to motivate long-lapsed donors to resume donating rather than to recruit new donors to make a first donation or to encourage active donors to increase donation rates. We chose long-lapsed donors as our sample, rather than active donors or new donors, because long-lapsed donors are most likely to be the most marginal donors; they have donated blood in the past, but have not donated for at least 24 months.[11] This suggests that for long-lapsed donors the marginal utility of donating at some time in the past had been greater than the marginal utility of "not donating", but had fallen below the "donation threshold" for at least the past 24 months. To increase the marginal utility of donating compared to the marginal utility of not donating, the Registry is designed to appeal to volunteers who (1) have some purely altruistic motives, rather than only warm glow motives; (2) are in need of a commitment device; and (3) experience dis-utility from being solicited for a donation. We briefly provide the intuition for how the Registry can work through each of these behavioral channels, and provide the formal development in Section 4 and in Supplementary Material B.[12]

To understand how the Registry can increase the utility of donors motivated by pure altruism, recall the main distinction between pure and impure altruism motives. Pure altruism motives stem from a compassion to help others with no ulterior personal benefits while impure motives stem from a "taste for giving," such as status seeking and self- and social-image, and this distinction has crucial implications for policy (Becker, 1974; Andreoni, 1989). This distinction is important since the Registry provides information to volunteers

[11] In contrast, individuals who have never donated before are likely to be substantially further from the donation margin, thus requiring much larger sample sizes, whereas more regular donors are likely to donate anyway and may thus disrupt the normal flow of blood supply.

[12] The Supplementary Material can be found here Supplemental Materials.

about the need for their blood donation, which affects the utility pure altruists obtain from making a donation. On the other hand, exclusively warm glow givers would not be influenced by this information since their utility from giving is independent of the need. Laboratory evidence suggests that there is heterogeneity in donor motivations (Lilley and Slonim, 2014; Gangadharan et al., 2014), thus the population of long-lapsed donors is likely to include pure altruists and warm glow givers.

In Section 4.2, we present a model of Registry demand driven by individuals with pure motives, which predicts that Registry members will be more responsive to critical shortage calls, relative to standard calls, than non-Registry members. Empirically, our data support this hypothesis as Registry members are 11 percentage points more responsive to critical calls than standard calls, while non-Registry members are not significantly more responsive.

To understand how the Registry can increase the utility of donors with a preference for commitment, the Registry provides a non-binding commitment device that increases the psychological costs of not donating when asked in the future.[13] Commitment devices have successfully modified behavior in several contexts, including savings (Thaler and Benartzi, 2004; Ashraf et al., 2006), health (Giné et al., 2010; Royer et al., 2015) and monetary donations (Breman, 2011).

In Section 4.3, we test for Registry demand driven by a preference for commitment. We model the demand for the Registry as a preference for a restricted choice set (Gul and Pesendorfer, 2001), where joining the Registry removes the option to "not donate" from future choice sets (i.e., joining the Registry restricts subsequent choices, such as in Round 2 in our study). This model predicts that Registry members will increase their donation rates more than non-Registry members between Round 1 and Round 2. Empirically, our data support this hypothesis, as Registry members are significantly more likely to donate in Round 2, relative to Round 1, than non-Registry members.

The Registry can also increase utility among donors who experience dis-utility from being solicited for a donation (Exley and Petrie, 2016). Since the Registry invitation promises to contact donors only once or twice per year (which is much less often than the Blood Service solicits active donors), the Registry may reduce the expected costs of donating due to solicitation dis-utility, and thus encourage lapsed donors to return to donate. The hypothesis is that there are a portion of long-lapsed donors who would donate if only they did not expect that the donation would lead to an increase in Blood Service solicitations. In other words,

[13]Preference for commitment originated in a literature on dynamic inconsistencies in preferences (Strotz, 1955; Phelps and Pollak, 1968), and later modeled with quasi-hyperbolic discounting (Laibson, 1997). The temptation-self control preferences (Gul and Pesendorfer, 2001), and dual-self models (Fudenberg and Levine, 2006) capture a preference for commitment by imposing dynamic inconsistencies in preferences.

these long-lapsed donors are engaging in ask avoidance (Andreoni et al., 2017; DellaVigna et al., 2012), whereby they had stopped donating in order to reduce future solicitations.

In Section 4.4, we propose a model of volunteer behavior where long-lapsed donors are, in part, motivated to avoid donation due its impact on the expectation of future solicitations. The Registry alleviates this dis-utility by promising to reduce the number of future "asks". Thus, if Registry demand is driven by solicitation dis-utility, then the Registry will crowd-in donors who are choosing to stay long-lapsed in order to avoid future solicitations. However, we do not find evidence consistent with the Registry crowding-in donors who experience solicitation dis-utility.

2 Experimental Design and Data

2.1 Experimental Design

In partnership with the Australian Red Cross Blood Service, we introduced a Blood Donor Registry throughout Australia using a large-scale natural field experiment that unfolded over two rounds. We drew the sample for our experiment from the population of long-lapsed donors. Long-lapsed donors are donors who have given at least one successful whole blood donation, but have not donated in at least the past 24 months.[14] Long-lapsed donors have two major advantages as a population to study. First, they are likely to be the most "marginal" donors; donors who have donated more recently are more likely to donate regardless of treatment conditions, and people who have never donated before may more likely be unresponsive to any manipulation. Second, once a donor has been designated as long lapsed, the Blood Service ceases to have any form of normal marketing communications with these donors; thus, we can minimize the likelihood that these donors are having any other form of (unobserved) solicitations that might interfere or add noise to the measurement of treatment effects.

We identified 44,223 eligible long-lapsed donors in Australia from which we randomly drew 15,388 for the Registry project.[15] Of the 15,388 donors assigned to the Registry project,

[14]We also restricted our sample to donors whose last donation occurred within the past 4 years in order to increase the likelihood of reaching these donors. Our concern was that donors who last donated more than 4 years ago may be more likely to have changed their contact details and thus be harder to reach.

[15]The criteria for the population we identified required (a) donated whole blood at least once in the past four years, (b) maximum age (since some older donors may have permanently retired from donating) and (c) blood types O and A (since these are the most commonly needed during shortages) and constitute approximately 87% of the Australian population and (d) excluded donors who donated for medical reasons, since the Registry would presumably not motivate them. While the age, blood type and non-medical requirements restricted this population somewhat, the major restriction was having donated at least once in

we identified 1,827 donors who were subsequently (during our study) contacted by Blood Service staff for campaigns unrelated to the Registry project and outside of the parameters of the project. Since these donors have been contacted for other purposes including to make donations, we have discarded them from the main analysis, resulting in 13,561 eligible long-lapsed donors that are randomly assigned to a treatment arm.[16] We then conducted two rounds of calls. Table 1 gives an outline of the basic design, indicating that there were two control groups. No calls were made to either control group during the Round 1 calls, but Control Group 1 receives a solicitation call in Round 2. Table 2 presents the sample sizes in each treatment condition.

The Round 1 calls occurred from April to June 2012. The design in Round 1 was a 2×2 between-subjects design, where the two treatments were a donation solicitation and Registry invitation, resulting in four distinct treatment groups: Registry + Donation, Registry Only, Donation Only, and the Control condition who were not called in Round 1 (the Control condition was split into Control 1 and Control 2 in Round 2).[17] Supplementary Material C contains the script the call agents used for each call condition. When a subject was solicited for a donation, we used the standard Blood Service solicitation script. Subjects who were not invited to join the Registry were not aware of the existence of the Registry.

When donors were invited to join the Registry in Round 1, they were told that they would only be called when there was a need for their blood type and would be called only once or twice a year. If donors joined the Registry with this invitation, they were placed into what we will refer to in this paper as the General Registry. If donors declined this invitation, they were then asked whether they would consider joining a Critical Registry that would only solicit donations if the Blood Service had less than a three day supply of blood. If they

the past 4 years. The Blood Service provided us with the universe of donors meeting our criteria which is this 44,223 sample.

[16]In Figure S2 we show the proportion of subjects from each of the treatments that were dropped from our analysis due to this outside contact.

[17]The Registry+Donation condition consisted of two closely related sub-treatments, both of which involved donors being asked to both make a donation and to join the registry. In the Simultaneous condition, donors were first informed of the registry and then simultaneously asked to make a donation and join the registry, whereas in the Sequential condition, donors were first asked to make a donation, and then informed and asked to join the registry.The initial purpose of including the Simultaneous and the Sequential treatments was to identify whether knowledge of the Registry crowded-out donations. This also raises an important distinction between making an appointment during the solicitation call and donating because appointments are not binding and not making an appointment does not prevent an individual from donating. Thus, the Simultaneous and Sequential treatments differed when making an appointment, but in both treatments subjects would have been aware of the registry when deciding to donate. However, we find that there are no significant differences in relative treatment effects if our outcome variable is made-an-appointment than if we use donation. We present these results in Table S1 and S2. However, we never found any significant differences between the two conditions in any of our analyses, so we combined these two conditions for increased power and to simplify the presentation of the results.

Table 1: Experimental Design

Round 1 Assignment March & April 2012	Answer Call	Join Registry	Round 2 Assignment July & Sept 2012	March 2013
All Registry Conditions	$\xrightarrow{yes}$	$\xrightarrow{yes}$	Standard Appeal Critical Appeal	
	$\xrightarrow{yes}$	or $\xrightarrow{no}$		Standard Appeal
Donation Only	$\xrightarrow{yes}$		Standard Appeal Critical Appeal	
No Donation & No Registry:				
Control 1	$\longrightarrow$		Standard Appeal Critical Appeal	
Control 2	$\longrightarrow$	or		Standard Appeal

declined both of these invitations, then they were not placed in either Registry.

The second round of calls occurred either during July and September 2012 when shortages (and, specifically, critical shortages) of whole blood usually occur every year and in March 2013 (when the next shortage occurred). During this second round of calls, we only called subjects who had answered the phone during the Round 1 calls.[18] Moreover, treatment calls were restricted to subjects who were eligible to make a donation during this shortage period. This means there are subjects who answered the phone in Round 1, but were ineligible to make a donation at the time of Round 2 for reasons such as medical ineligibility or having recently donated. Since this ineligibility was not random, we *include* the "Not Assigned" group in our Intention-to-Treat Analysis in Section 3.1.

In Round 2, the treatment manipulation was whether donors received a critical appeal solicitation or a standard solicitation. The critical appeal treatment informed donors that there was a critical shortage and that donations were needed within the next few weeks. The standard donation appeal consisted of the standard donation solicitation and did not inform the donors of any critical shortages or time frames. The differences between the critical and standard appeal conditions will be discussed in more detail in Section 4, where

[18]The Blood Service did not want to call donors who had not answered calls in Round 1 since their view was that these donors would also be unlikely to answer in Round 2 and would thus be costly to attempt to call.

Table 2: Treatment Assignment

	Round 1 Treatment Assignments			
	Donation Solicitation	Registry Invitation	N	Effective N
Registry + Donation	Yes	Yes	5,999	5,249
Registry Only	No	Yes	3,000	2,610
Donation Only	Yes	No	1,799	1,556
Control 1	No	No	2,838	2,324
Control 2	No	No	1,752	1,752
Total			15,388	13,561

	Round 2 Treatment Assignments Donation Appeal Type		
	Standard	Critical	Not Assigned
Registry + Donation	817	142	814
Registry Only	516	116	238
Donation Only	276	55	165
Control 1	1,770	554	
Control 2	No	No	
Total	3,379	867	1,217

The difference between N and Effective N reflects those donors who were treated, but subsequently excluded from analysis due to receiving solicitations from other units of the Blood Service that were not part of the experimental treatments.

we use these conditions to help identify whether the Registry crowded-in donations from pure altruists. Note that the number of subjects assigned to the critical appeal is much smaller than the subjects in the standard appeal since the Blood Service must actually be experiencing a critical shortage in order to truthfully make a critical appeal. During critical shortage periods, calls were randomly assigned to standard and critical appeals.

Unfortunately, the timing of the Round 2 calls could not be completely randomized; that is, the Blood Service did not want to make calls to subjects in the Registry condition who selected out of the Registry until March 2013. However, since there turned out to be no critical shortages during March 2013, all of the subjects who chose not to join the Registry did not receive a Critical Appeal. While it would have been desirable to have had some subjects who chose not to join the registry be randomly assigned to receive a Critical Appeal, we argue that this feature means that we are likely underestimating the causal impact of the Registry. We return to this in Section 3.1.

Table 3: Summary Statistics, by Assigned Round 1 Treatment

	All	Registry + Donation	Registry Only	Donation Only	Control
Female	.50	.50	.50	.50	.48
	(.50)	(.50)	(.50)	(.50)	(.50)
Past Donations	4.57	4.49	4.50	4.38	4.78
	(6.45)	(6.38)	(6.5)	(5.99)	(6.97)
Days Since Last Donation	1082	1088	1085	1084	1084
	(129)	(125)	(126)	(125)	(140)
Current Age	36.45	36.33	36.25	36.06	36.60
	(10.39)	(10.36)	(10.22)	(10.21)	(10.61)
State					
ACT	.03	.03	.02	.03	.02
NSW	.27	.28	.28	.25	.29
QLD	.12	.13	.12	.13	.12
SA	.09	.09	.10	.09	.08
TAS	.04	.04	.04	.04	.04
VIC	.33	.33	.32	.33	.33
WA	.12	.11	.11	.12	.12
Urban Donor Center	.72	.71	.73	.72	.73
Observations	13,561	5,249	2,610	1,556	4,146

Standard deviations in parentheses.

2.2 Intention to Treat & Treatment on the Treated

Before Round 1, long-lapsed donors are randomly assigned to one of four treatment groups. Table 3 shows that donor characteristics and treatment assignment are orthogonal.[19] During Round 1 (i.e., the Registry invitation round), we intended to treat subjects assigned to the Registry + Donation, the Registry Only and the Donation Only conditions. From this group, whether a subject was treated in Round 1 depends on whether he answered the phone call. Table S3 shows that males and older donors were more likely to answer the phone in Round 1, but importantly, there were no significant differences in covariates across treatments (i.e., males and older donors were equally more likely to answer the phone across treatments in Round 1).

During Round 2 (i.e., the Registry call rounds), we intended to treat all subjects who answered the phone in Round 1 plus a random subset of the Control group (henceforth: Control Group 1), where the treatment manipulation was the Critical Appeal or Standard Appeal.[20] However, recall during Round 1, subjects in the Registry conditions who answered

[19]In randomly assigning subjects to conditions, we balanced on gender, age, past donation categories (1 donation, 2-3 donations, 4+ donations), telephone call dates and call agents. The benefit of a natural field experiment is that participants do not select into treatment and are unaware that they are taking part in an experiment (Harrison and List, 2004).

[20]For completeness we also include Supplemental Table S5, which shows that there are no treatment

the call either selected into or out of the Registry. Table 4 shows that (1) 22 percent of subjects subjects joined the General Registry, while 66 percent joined conditional on answering the phone in Round 1; (2) the likelihood of joining the General Registry is similar across the Registry conditions; and (3) subjects' characteristics are not significant predictors of joining the Registry.

Those subjects who selected out of the Registry in Round 1 were not treated in July or September 2012, but instead were called in March 2013, along with a random subset from Control Group 1, during a non-critical shortage and therefore they all received a Standard Appeal. Including those subjects who selected out of the Registry allows us to conduct an intention-to-treat analysis to establish whether there are causal effects of introducing the Registry, which we turn to in Panel A of Table 5 in Section 3.1. Conversely, in Panel B of Table 5 we only use data from July and September 2012, which represents the treatment-on-the-treated effects and thus combines the causal and the selection effects of the Registry.

Table 4: Registry Take-Up

	Join General Registry	Join General Registry Answered R1	Join Critical Registry	Join Critical Registry Answered R1	Join Either Registry	Join Either Registry Answered R1
Reg + Don	-0.008	-0.03	-0.003	-0.02*	-0.01	-0.05***
	(0.01)	(0.02)	(0.003)	(0.009)	(0.01)	(0.02)
Female	0.005	0.02	-0.008***	-0.02***	-0.007	-0.01
	(0.009)	(0.02)	(0.003)	(0.008)	(0.01)	(0.02)
Age	0.0008**	0.0001	-9.64e-06	-0.0003	0.0009*	-0.0002
	(0.0004)	(0.0009)	(0.0001)	(0.0004)	(0.0005)	(0.0009)
Yearly Donation Rate	0.17	1.02	0.003	0.05	0.18	1.08
	(0.19)	(0.8)	(0.04)	(0.23)	(0.21)	(0.82)
Days Since Last Donation	0.24	0.47	-0.06	-0.24	0.18	0.28
	(0.36)	(0.75)	(0.09)	(0.32)	(0.39)	(0.72)
Observations	7858	2697	7858	2697	7858	2697
Pseudo R^2	0.32	0.02	0.11	0.06	0.34	0.03
State and Site FE	Y	Y	Y	Y	Y	Y
Call Day FE	Y	Y	Y	Y	Y	Y
Call Agent FE	N	Y	N	Y	N	Y
Omitted Group	Reg Only	Reg Only	Reg Only	Reg Only		
Baseline	.22	.66	.03	.20	.24	.73

Marginal coefficients from a probit regression reported. Columns (3) and (4) are conditional on not joining the General Registry. Robust Standard Errors in parentheses and *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

differences in the propensity to answer the phone call in Round 2, except that Control Group 1 is less likely to answer. This is not surprising since donors in the Registry and Donation Only treatments have already answered the phone in Round 1, thus, as a group, they are more likely to answer the phone than donors assigned to Control Group 1.

2.3 Registry Hypotheses

Our data allow us to assess whether the introduction of the Registry in the whole blood market improves market outcomes. Our analysis not only considers the causal effects of the introduction of the Registry on donation behavior, but also the selection effects of the Registry. In this section, we outline two main hypotheses that highlight the Registry's effectiveness to provide a more coordinated supply of whole blood. We also state the three main hypotheses about the types of individuals that select into the Registry, although we leave the formal discussion of these hypotheses until Section 4.

The first hypothesis concerns whether the introduction of the Registry in Round 1 increases supply and improves coordination of supply during the subsequent Round 2 shortages. We hypothesize that subjects assigned to the Registry conditions will donate at higher rates in Round 2 than subjects in the Donation Only, Control 1 and Control 2 conditions. Further, we hypothesize that subjects assigned to the Registry conditions will be more likely to donate within three weeks of a solicitation than Donation Only, Control 1 and Control 2 subjects, but will not donate more beyond the period of critical need.

Hypothesis 1. *The invitation to join the Registry in Round 1 will*
(i) increase supply; and
(ii) improve coordination in Round 2.

The second hypothesis addresses the role of the Registry as a screening mechanism. Using data from the Round 1 calls, we hypothesize that the Registry serves as a screening mechanism. Part of the effectiveness of the Registry as a screening mechanism is to select for individuals who will be more responsive to a solicitation; that is, they are (1) more likely to donate when solicited and (2) *less* likely to donate when not solicited. Thus we hypothesize that subjects who select into (select out) the Registry from the Registry + Donation condition will be more (less) likely to donate in Round 1 than subjects in the Donation Only condition. To test the second part, we hypothesize that subjects who select-in to the Registry from the Registry Only condition will be *less* likely to donate than subjects who select-in from the Registry + Donation condition, but subjects who select-out of the Registry from the Registry Only condition will be no less likely to donate than subjects who select-out from the Registry + Donation condition.

Hypothesis 2. *The invitation to join the Registry serves as a selection or screening mechanism.*

Finally, Section 4 more formally explores the previously discussed behavioral mechanisms. We present three models from the literature, adapted to the current context, to examine

whether the Registry is effective due to the crowding-in of (1) pure altruists, (2) donors who need a commitment device or (3) donors who have been engaging in ask avoidance behavior. We save the formal derivation and discussion of these mechanisms for Section 4, but state the hypotheses that are derived from these models here.

Hypothesis 3. *The Registry crowds-in donations from long-lapsed donors with pure motives.*

Hypothesis 4. *The Registry crowds-in donations from long-lapsed donors who have a preference for commitment.*

Hypothesis 5. *The Registry crowds-in donations from long-lapsed donors who experience dis-utility from being asked to donate.*

3 Registry Effects

We first report the main results from the experiment, and in Section 4 we examine the hypothesized behavioral channels that can explain the effectiveness of the Registry. In this section, our outcome of interest is the donation behavior of donors assigned to the various treatments. Throughout our analysis we control for gender, age, yearly donation rate prior to becoming long-lapsed and days since last donation. We also include state fixed effects and a dummy for whether the donor donated through a metropolitan site. Additionally, where appropriate, we also use day of week fixed effects and call agent fixed effects in order to control for any differences in solicitation styles across agents.[21]

3.1 Registry Calls: Round 2

In this section, we examine donation behavior in Round 2 when the Blood Service conducted its shortage calls. Recall, Round 2 occurred in July and September 2012 during the typical winter shortages and in March 2013 when the next shortage occurred. At the Blood Service's request, in July and September 2012, we only called individuals from the Registry conditions who selected into the Registry, subjects from the Donation Only treatment who answered the phone in Round 1 and subjects assigned to Control Group 1 (who are being contacted for the first time by the Blood Service in conjunction with this experiment). We contacted subjects assigned to the Registry conditions, but selected out of the Registry, in March 2013. We include Control Group 2 in the analysis for comparison when relevant. Control Group 2 was not contacted in Rounds 1 or 2 of the experiment.

[21] Agents were instructed to read the scripts, but if donors need additional information or clarification, then individual differences across call agents can emerge.

The main additional treatment manipulation in Round 2 is whether a subject received a "Standard Appeal" or a "Critical Appeal" for a donation. The Standard Appeal is the Blood Service's standard donation solicitation that reminds donors of the importance of blood donations and asks the donor to make a donation, while the Critical Appeal is the typical solicitation used when there is a critical shortage, which tells the donor that the Blood Service is experiencing a critical shortage and that there is less than a few weeks of blood supply remaining.[22]

In Panel A of Table 5 we present our intention to treat analysis, where we compare the behavior of all subjects assigned to the Registry Conditions (i.e., regardless of whether they *joined* one of the Registries) with those assigned to the Donation Only, Control 1 and Control 2. In columns (1)-(4), we report marginal effects from a probit regression where the outcome variable takes a value of 1 if the subject donated and 0 otherwise. Column (1) shows that the subjects in the Registry Conditions were 3 percentage points more likely to donate than subjects in Donation Only, and Control Groups 1 and 2. Control Group 2 subjects, who were never called during the experiment, are removed in columns (2)-(4). These columns show that among all subjects that the Blood Service attempted to call that the subjects in the Registry conditions were 2 percentage points more likely to donate than subjects in Donation Only and Control Group 1. Note also that the Critical Appeal has a positive and significant effect on Round 2 donations. We discuss the Critical Appeal in more detail below when we examine the behavioral motivation underpinning the Registry's effectiveness.

In column (5), we consider a different outcome variable that takes into account the nature of the Registry. Recall, the invitation to join the Registry informed individuals that they would only be invited to donate "when the community has a critical need for blood," so subjects in the Registry conditions should be more likely to donate in a shorter time frame than subjects not in the Registry condition. We find, in support of Hypothesis 1, that subjects assigned to the Registry conditions are more responsive to a solicitation; they are two percentage points more likely to donate within 3 weeks than individuals in the Donation Only condition. Moreover, and in further support of Hypothesis 1, this greater responsiveness only occurs during the time of greater need. Column (6) shows that subjects assigned to the Registry Conditions do not donate significantly more (pvalue=.89) than Donation Only subjects during the following nine weeks after the critical need has passed. The greater immediate responsiveness of Registry members (when shortages occur), but not later (when the shortages have passed) provides the first evidence of the effectiveness of the Registry to improve market efficiency. We discuss efficiency in much greater detail in Section 3.2. We also find that the Critical Appeal treatment manipulation is effective; Column (5) shows that

[22]The call scripts for these calls are presented in Supplementary Material C.

individuals who receive the Critical Appeal are 9 percentage points more likely to donate within 3 weeks, while Column (6) shows that the critical appeal has a significantly weaker effect after the first three weeks.

Table 5: Introduction of Registry: Causal & Selection Effects on Donation Behavior

	Likelihood to Donate				Donate within 3 weeks	Donate in weeks 4-12
	(1)	(2)	(3)	(4)	(5)	(6)
	Panel A: Intention-to-Treat Effects of Registry					
Registry Conditions	0.03***	0.02**	0.02**	0.01	0.02**	0.0009
	(0.008)	(0.009)	(0.009)	(0.02)	(0.008)	(0.007)
Critical Appeal, Round 2	0.06***	0.05***	0.05***	0.1***	0.09***	0.02*
	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.01)
Female	.	.	-0.02*	-0.02*	-0.02**	-0.006
			(0.009)	(0.01)	(0.007)	(0.005)
Age	.	.	0.002***	0.001**	0.0007**	-0.0002
			(0.0004)	(0.0006)	(0.0003)	(0.0002)
Yearly Donation Rate	.	.	0.08	0.39	-0.04	-0.49
			(0.22)	(0.49)	(0.35)	(0.43)
Days Since Last Donation	.	.	-0.004	0.002	0.004	0.002
			(0.004)	(0.005)	(0.003)	(0.002)
Observations	7285	5463	5463	3139	3139	3139
Pseudo R^2	0.009	0.005	0.01	0.02	0.06	0.02
Omitted Group	Control 1,2 & Don Only	Control 1 & Don Only	Control 1 & Don Only	Don Only	Don Only	Don Only
Baseline Probability	.09	.11	.11	.11	.04	.03
	Panel B: Treatment-on-the-Treated Effects of Registry					
General Registry Member	0.09***	0.07***	0.07***	0.07***	0.06***	0.01
	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.01)
Critical Registry Member	-0.008	-0.01	-0.01	-0.06	-0.02	-0.02
	(0.03)	(0.03)	(0.03)	(0.04)	(0.03)	(0.02)
Critical Appeal, Round 2	0.06***	0.05***	0.05***	0.12***	0.09***	0.01
	(0.01)	(0.01)	(0.01)	(0.03)	(0.03)	(0.02)
Female	.	.	-0.02**	-0.04**	-0.03**	-0.01
			(0.01)	(0.02)	(0.01)	(0.009)
Age	.	.	0.002***	0.002*	0.001**	-0.0003
			(0.0005)	(0.0009)	(0.0006)	(0.0005)
Yearly Donation Rate	.	.	-0.04	-0.17	-0.13	-0.86
			(0.19)	(0.85)	(0.64)	(0.75)
Days Since Last Donation	.	.	-0.003	0.009	0.009	0.004
			(0.004)	(0.007)	(0.006)	(0.004)
Observations	5760	3938	3938	1614	1614	1614
Pseudo R^2	0.02	0.01	0.02	0.03	0.05	0.02
Omitted Group	Control 1,2 & Don Only	Control 1 & Don Only	Control 1 & Don Only	Don Only	Don Only	Don Only
Baseline Probability	.09	.11	.11	.11	.04	.03
Controls						
Demographics	No	No	Yes	Yes	Yes	Yes
State & Site FE	No	No	Yes	Yes	Yes	Yes

Marginal effects from probit regressions reported. Robust Standard Errors in parentheses and *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

The results in columns (4) and (5) of Panel A of Table 5 are especially important since

they show the causal effects of introducing the Registry on donation behavior. The causal effect of the Registry is shown by examining the intention to treat and comparing everyone contacted in the Registry conditions in Round 1 with everyone contacted in Donation Only in Round 1, regardless of the subjects decision to join or not join the Registry. These results show that the introduction of the Registry increases the total donations and improves coordination of supply to meet demand. However, from a practical perspective, once the Registry is implemented it is a tool that the Blood Service can continually return to during periods of excess demand. Thus, it is also important to consider the treatment-on-the-treated effects of the Registry; that is, the effect of calling Registry members relative to the subjects in the Donation Only and Control conditions. We now examine this selection effect.

Result 1 *Consistent with Hypothesis 1, subjects assigned to Registry conditions are significantly more responsive to the solicitation; subjects assigned to the Registry conditions are 2 percentage points more likely to donate within 3 weeks of solicitation, but no more likely to donate in weeks 4-12 than subjects assigned to the Donation Only condition.*

In Panel B of Table 5 we consider a treatment on the treated analysis, where we replicate Panel A, but we remove the subjects who were contacted in Round 1 and opted out the Registry. The estimates here thus combine both the selection and causal effects of introducing a Registry. We find that Registry Members are significantly more likely to donate and are more responsive to solicitations than non-Registry members. Columns (2)-(6) show that Registry members are between 6 and 7 percentage points more likely to donate than non-Registry members, 6 percentage points more likely to donate within 3 weeks of the solicitation and no more likely to donate in the following nine weeks after the critical period has passed. Comparing the estimates in Panel A and Panel B provide further evidence of the positive selection into the Registry (i.e., Registry members are 6 percentage points more likely to donate than Donation Only subjects whereas all subjects in the Registry condition are no more likely to donate)–the Registry effectively identifies donors who are more willing to donate and more responsive to the solicitation.

Result 2 *Consistent with Hypothesis 2, Registry members are 7-9 percentage points more likely to donate than non-Registry members and are 6 percentage points more likely to donate within 3 weeks of solicitation, but also no more likely to donate during weeks 4-12 than non-Registry members.*

3.2 Improved Efficiency in a Simulated Solicitation Campaign

In this section, we show the extent to which using the Registry as a screening mechanism can improve market outcomes. To do so, we simulate a solicitation campaign and show that (1) soliciting Registry members, rather than non-Registry members, is cost effective and (2) both the expected probability of excess demand and excess supply are smaller when the campaign targets Registry members rather than non-Registry members. These results are driven by Registry members being more likely to donate and a smaller standard error on mean donation rates for Registry members than non-Registry members.

To analyze the effectiveness of the General Registry to reduce market failures, we focus our analysis on the donation behavior of Registry members from the Registry + Donation condition and non-Registry members from the Donation Only treatment in Round 2.[23] During the Round 2 winter shortage calls, Registry members donate within three weeks of a solicitation at an average rate of 11%, whereas non-Registry members donate at an average rate of 5%.[24] Thus, if the Blood Service desires x donations from a solicitation campaign, then, on average, they will need to attempt to call 120% more donors if they call non-Registry members than if they call Registry members, resulting in substantially higher costs.

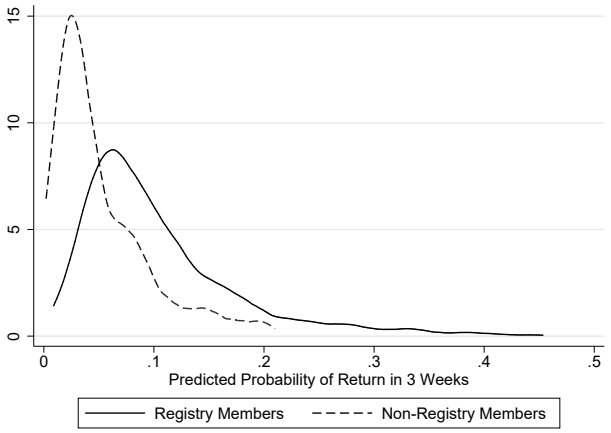
We predict individual-level probabilities of donating within 3 weeks of the solicitation that vary by our standard vector of control variables (see Table S7). We focus on donations within three weeks in order to address the timing needs during critical shortage periods when demand temporarily exceeds supply. In Figure 1a we compare the distributions of predicted probabilities of donation between Registry and non-Registry Members. The mean predicted probabilities are .10 (standard error .003) and .05 (standard error .002) for Registry and non-Registry members, respectively, implying that Registry members are more responsive than non-Registry members.

Using the means of the distributions in Figure 1a, we consider a case where the Blood Service must collect 100 donations during a critical shortage period and calculate the required solicitations to obtain an expectation of 100 donations from Registry and non-Registry members (958 and 1949, respectively). Figure 1b shows the distribution of expected donations if the required solicitations are made to the non-Registry and Registry groups. By construction, the mean of each distribution is 100, however the standard error of the Registry distribution is 2.62 donations, while the standard error of the non-Registry distribution is 4.78.

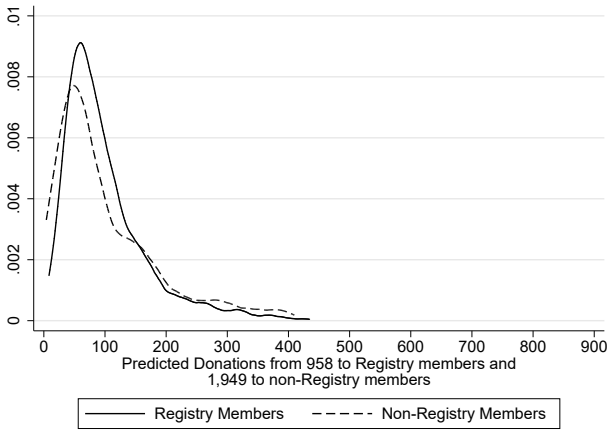
[23] We restrict our attention to these two treatment groups since all donors in these groups received one solicitation call in both Round 1 and Round 2, whereas donors in all other treatments did not receive a solicitation call in Round 1.

[24] These averages are based on attempted calls, not conditional on answering.

Figure 1: Donation Within 3 Weeks of Solicitation, Registry versus Non-Registry Members



(a) Density of Predicted Prob



(b) Density of Predicted # Don., given Required Solicitation

Finally, we calculate the probability that the Blood Service's campaign will result in excess supply or excess demand and how these likelihoods differ when the campaign solicits Registry versus non-Registry members. To do this, we integrate under the curves in Figure 1b on either side of 100 and calculate the cumulative probability that required solicitations will result in the Blood Service collecting at least x_d units of blood, where $x_d \in \{1, 2, ...99\}$ and collecting more than x_s units of blood, where $x_s \in \{101, 102, ...300\}$ when the number of donors invited is constructed such that expected donations equal 100. Thus, $\forall x < 100$, the campaign results in excess demand, while $\forall x > 100$, the campaign results in an excess supply. The results of this exercise are presented in Figure 2.

We find that in the domain of excess demand ($x < 100$), for any level of $x < 100$, the

probability that the required solicitations will result in x or fewer donations is higher for the non-Registry members than for the Registry members. Similarly, in the domain of excess supply ($x > 100$), for any level of $x > 104$, the probability that the required solicitations will result in x or more donations is higher for the non-Registry members than for the Registry members. In sum, the requisite amount of blood to address a critical temporal shortage is 103% greater for non-Registry members than for Registry members and the probability of both excess supply and excess demand is greater when those solicitations are made to non-Registry members than Registry members.[25]

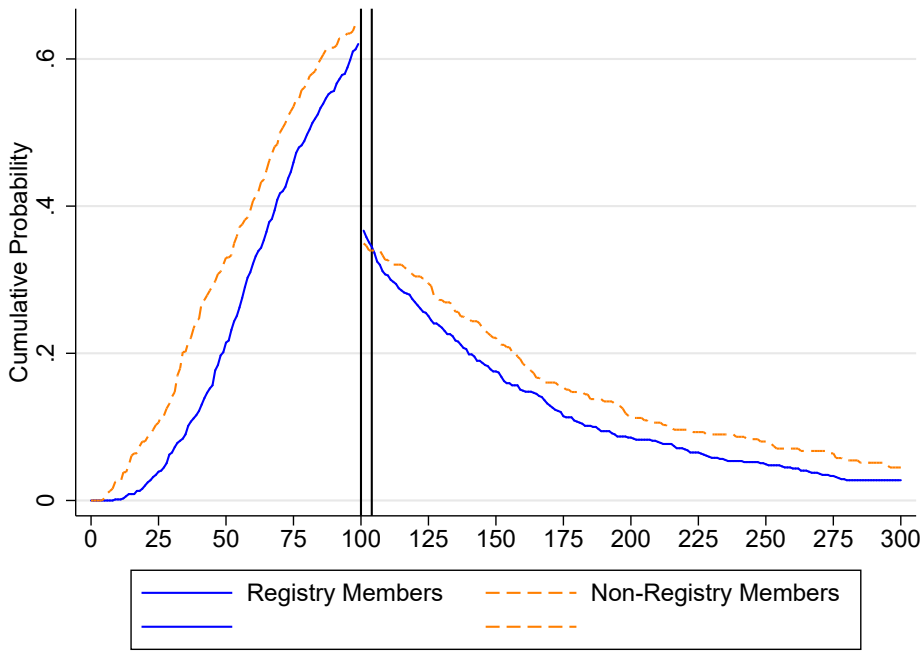


Figure 2: Excess Supply and Excess Demand.

4 Behavioral Mechanisms and Registry Demand

In this section, we examine why the Registry was effective at increasing supply and improving market outcomes. In particular, we elaborate on the three behavioral theories to explain selection into the Registry and the greater responsiveness of Registry members. Recall that our sample comes from long-lapsed donors who have expressed a propensity to donate in the

[25]Note that our analyses here ignores potentially different costs associated with excess demand and excess supply. For instance, if the cost of excess demand is (substantially) greater than an equivalent excess supply, then the optimal policy, using either Registry or non-Registry members, would likely involve targeting a mean donation rate that exceeds demand.

past, but have since ceased donation activity. Table 5, and particularly Panel B, shows that the Registry is effective at "crowding-in" donations from long-lapsed donors; that is, donors who had not given in at least 24 months are more willing to give after joining the Registry.

In this section, we are interested in understanding the preferences of donors who were crowded-in by the Registry. Section 4.2 considers selection on pure altruism; that is, if a donor is long-lapsed because he stopped giving out of concern for whether his donation is needed, then the Registry may provide the needed information about the (critical) need for whole blood, which crowds in the volunteers with pure altruism motives. Similarly, in Section 4.3, we consider selection on a preference for commitment. If a donor is long-lapsed due to problems of self-control, then the Registry may provide the needed psychological commitment to crowd-in the long-lapsed volunteer. Finally, in Section 4.4 we consider selection on "solicitation dis-utility" whereby the Registry reduces volunteers' expectations about future donation solicitations. If a donor is long-lapsed because of solicitation dis-utility and if the Registry promises to reduce future solicitations, then the Registry will crowd-in these long-lapsed volunteers.

Note that while the Registry may appeal to subjects across many dimensions, the story that explains the Registry crowding-in donations from subjects who select-in must also be consistent with the reason the donor became long-lapsed in the first place. The three motives we hypothesize can explain a donor's decision to (temporarily) stop donating and to resume donations as a Registry member. Before turning to examining these three motives, in Section 4.1 we first make some introductory observations on selection into the Registry.

4.1 Selection into the Registry

Table 4 in Section 2 shows that, conditional on answering the phone call, approximately two-thirds of individuals joined the General Registry, while the remaining one-third selected-out of the Registry. Interestingly, the available demographics do not significantly predict who selects-in and who selects-out of the Registry. Typically, one concludes that if there is no selection on observable characteristics, then it is unlikely that there is selection on unobservable characteristics (Altonji et al., 2005). However, our set of available demographics is quite limited and it is not clear that these demographics should be correlated with the preferences (pure altruism, need for commitment and solicitation dis-utility) that we hypothesize predict selection into the Registry.

For example, Gangadharan et al. (2015) find no relationship between demographics and pure altruism versus warm-glow donors,[26] while Tanaka et al. (2016) find no relationship

[26] While a series of studies have looked for a link between gender and altruism, the findings are mixed

between age or gender and present bias, and Exley and Petrie (2016) find no evidence that there are gender differences in ask avoidance behavior. Thus, there is evidence suggesting that there may not be selection into the Registry based on our available demographic evidence even if there is preference-based selection, as we hypothesize.

4.2 Pure Altruists

Let individual i's utility for altruistic behavior be separable in pure and warm glow motives (Andreoni et al., 1996; Lilley and Slonim, 2014) and given by the following function:

$$U_i(S_{-i,t}, s_{i,t}) = \beta u(S_{-i,t} + s_{i,t}) + \alpha v(s_{i,t}) - c_{i,t} + \varepsilon_{i,t} \tag{1}$$

$S_{-i,t} \geq 0$ is the total number of donations given by all other donors other than i at time t (i.e., the current supply of blood at time t) and $s_{i,t} \in \{0, 1\}$ takes a value of 1 if the individual makes a donation at t and 0 otherwise. The function u is the utility individual i receives from pure motives and the function v is the utility donor i receives from the warm glow of his donation and $v(0) = 0$. We assume that u is continuous and concave in $S_{i,t}$. The parameters $\beta \geq 0$ and $\alpha \geq 0$ determine the extent to which utility is driven by pure motives or warm glow, thus $\alpha = 0$ and $\beta > 0$ indicates a pure altruist, while $\beta = 0$ and $\alpha > 0$ indicates a warm glow giver and $\alpha > 0$ and $\beta > 0$ indicate a mixed altruist. The individual also pays a fixed cost to donate, $c_{i,t}$, and individual i's utility is subject to idiosyncratic shocks that affect his propensity to donate.

The individual faces uncertainty about whether his donation is actually needed, that is, he is uncertain about the relationship between the current supply $S_{-i,t}$ and how it relates to demand. Let D_t denote the current aggregate demand for blood at t, where $S_{-i,t} < D_t$ implies the individual i's donation is needed and $S_{-i,t} \geq D_t$ means that there is excess supply and individual i's donation is not needed. Let p_t be the probability that $S_{-i,t} < D_t$. If his blood is not needed, then he receives no marginal utility from making a donation through the pure altruism component of utility, but he still receives warm-glow marginal utility. Individual i donates if

$$\beta \left[p_t u(S_{-i,t} + 1) + (1 - p_t)u(D_t)\right] + \alpha v(1) - c_{i,t} + \varepsilon_{i,t} \geq \beta \left[p_t u(S_{-i,t}) + (1 - p_t)u(D_t)\right] \tag{2}$$

where the righthand side of the equation is the utility an individual gets from not donating

(Andreoni and Vesterlund, 2001; Andreoni et al., 2003; Conlin et al., 2003; Cox and Deck, 2006; Dellavigna et al., 2013).

(i.e., $s_{i,t} = 0$). During Round 1 solicitations, individuals assigned to the Registry conditions were informed that Registry membership entailed information about a critical need for their blood type. That is, Registry members learn that $S_{-i,t} < D_t$ before making a donation decision. Thus, joining the Registry resolves uncertainty about the relationship between $S_{-i,t}$ and D_t. If a Registry member receives a solicitation, then he knows that with certainty there is need, i.e., $p_t = 1$, and if the individual does not receive a solicitation then he believes there is no need for his donation, i.e., $p_t = 0$.[27]

From equation 2, the marginal utility of a donation, $s_{i,t} = 1$ versus $s_{i,t} = 0$, is given by

$$\beta p_t \left[u(S_{-i,t} + 1) - u(S_{-i,t})\right] + \alpha \left[v(1) - v(0)\right] \tag{3}$$

where the marginal utility of a donation increases in p_t, implying that Registry members receive a higher marginal utility from donation provided $\beta > 0$. In other words, a donor with pure motives (i.e., $\beta > 0$) receives a higher marginal utility from donating as a Registry member than he does if he is not a Registry member. Therefore, equation 3 shows that donors with non-zero pure altruistic motives will join the Registry, while other donors are indifferent about joining the Registry.

To present evidence from our experimental data that donors with pure motives self select into the Registry, we first show that donors with higher marginal utility from pure motives are also more responsive to a critical need for blood. Differentiating equation 3 with respect to $S_{-i,t}$ we have equation 4, which shows that Registry members are also more responsive to need than non-Registry members. Equation 4 shows that as need increases (i.e., $S_{i,t}$ decreases), the marginal utility of a donation increases more for donors with higher marginal utility from pure motives. Further, equation 4 indicates that if an individual has no pure motives, $\beta = 0$, then their marginal utility of a donation does not vary with "need".

$$\beta p_t \left[\frac{\partial u(S_{-i,t} + 1)}{\partial S_{-i,t}} - \frac{\partial u(S_{-i,t})}{\partial S_{-i,t}}\right] < 0 \tag{4}$$

If donors with pure motives self select into the Registry as equation 3 has shown, we would expect that Registry members would be relatively more responsive to critical calls than non-Registry members. Recall, in Round 2, there was a critical shortage call that informed individuals that there was a critical need for their blood type within the next few weeks. Thus being more responsive not only entails an increased probability of donating, but

[27] We assume that receiving the Registry call shifts p_t to 1 and not receiving the Registry call shifts p_t to 0. This is a stronger assumption than we need. All that is needed for the result here is that if a Registry member gets a registry call, p_t increases and without a registry call p_t decreases relative to the p_t used by non-Registry members.

specifically, an increase in the probability of donating within three weeks of the solicitation.

To test whether Registry members are more responsive to critical calls than non-Registry members we estimate the following equation with a probit regression

$$\begin{aligned} Prob_i\,[\text{Donate within 3 weeks=1}] = \\ \gamma_0 + \gamma_1 \mathbf{1}[Registry = 1] \times \mathbf{1}[\text{Critical Appeal} = 1] \quad + \gamma_2 \mathbf{1}[Registry = 1] \\ + \gamma_3 \mathbf{1}[Registry = 0] \times \mathbf{1}[\text{Critical Appeal} = 1] \quad + \gamma_4 \Psi_i + \varepsilon_i \end{aligned}$$

where Ψ_i is a vector of individual-level controls. If the Registry selects for donors who are driven by pure motives, then we hypothesize that $\gamma_1 > \gamma_3$. That is, the difference in response to the Critical appeal than the non-critical appeal will be greater for Registry members than for non-Registry donors.

Table 6 presents estimates that are consistent with the hypothesis that the Registry selects for donors who have pure motives. The sample in column (1) consists of Registry members and subjects contacted in Round 2 from the Donation Only and Control 1 conditions. We estimate that a Registry member who receives a critical call is 14 percentage points more likely to donate within 3 weeks of the solicitation than a Registry member who receives the standard solicitation, whereas non-Registry members who receive the critical call are no more likely to donate within 3 weeks than non-Registry members who received the standard solicitation. The relative increase in donation rates by the Registry members in the critical call treatment is significantly larger than the relative increase by the non-Registry members in the critical call condition. In column (2), we restrict this sample to only those individuals who answered the phone call in Round 2.

In columns (3) and (4), we restrict the sample from columns (1) and (2) to only those donors who were also contacted in Round 1. We think this is an important sub-sample to consider since these donors have been contacted twice and thus we remove Control Group 1 who may potentially behave differently to solicitations since this was the first time they were contacted during the study. We find similar effects with this restricted sample; the critical appeal has an 12 and 9 percentage point larger effect on Registry than non-Registry members for all attempted and answered calls, respectively.

Result 3 *Registry members are more responsive to the Critical call, relative to the Standard call, than non-Registry members.*

Table 6: Pure Altruism

	Pr[Donate within 3 weeks of solication=1]			
		Answer Only		Answer Only
	(1)	(2)	(3)	(4)
Non Reg Member × Crit Appeal	0.02	0.06*	-0.005	0.02
	(0.02)	(0.03)	(0.04)	(0.07)
Gen Reg Member × Crit Appeal	0.14***	0.1**	0.12***	0.09**
	(0.05)	(0.04)	(0.04)	(0.04)
Gen Reg Member	0.04*	0.1**	0.04**	0.08***
	(0.02)	(0.04)	(0.02)	(0.03)
Critical Reg Member	0.07	0.13*	0.08	0.13
	(0.05)	(0.08)	(0.05)	(0.08)
Female	-0.008	-0.02	-0.03**	-0.04*
	(0.007)	(0.02)	(0.01)	(0.02)
Age	0.001***	0.002**	0.001**	0.001
	(0.0003)	(0.0007)	(0.0006)	(0.001)
DonationRate	0.05	0.27	-0.28	-0.47
	(0.1)	(0.56)	(0.46)	(0.7)
Days Since Last Don	-9.82e-06	-0.0000455	0.0000804*	0.0001*
	(0.0000273)	(0.0000591)	(0.0000469)	(0.0000849)
Observations	3938	2006	1614	994
Pseudo R^2	0.11	0.03	0.11	0.05
Omitted Group	Don only + Control 1	Don only + Control 1	Don Only	Don Only
Baseline Probability	.06	.11	.05	.09
Demographics	Yes	Yes	Yes	Yes
State & Site FE	Yes	Yes	Yes	Yes
Day FE	Yes	Yes	Yes	Yes
χ^2 Tests				
Non-Registry × Crit= Gen Reg × Crit	5.40***	.45	5.22**	.75

Marginal effects from probit regressions. Outcome variable is "1" if donation occurs within 3 weeks of Round 2 call and "0" otherwise. Robust Standard Errors in parentheses and *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

4.3 Commitment Device

Next, we consider whether Registry demand is driven by donors who demand commitment to donate and whether this motive for joining the Registry can also explain the pattern of donation behavior we observe in the data.

To characterize the Registry as a commitment mechanism, we use Gul and Pesendorfer (2001) model of temptation where individuals have preferences over choice menus and the Registry serves as a way for individuals to restrict their future choice set. Consider individual i's choice set $A_i = \{d_i, n_i\}$, where d_i corresponds to donate and n_i corresponds to not donate. We assume that some fraction of our sample, γ, has preferences such that the choice set $\{d_i\}$ is preferred to the choice set $\{n_i\}$. That is, some proportion γ of individuals prefers to donate. The other $1 - \gamma$ proportion always prefers to not donate. In what follows, we consider the γ proportion of individuals.

We now consider the possibility that some individuals may be tempted to "not donate" when they face choice set A_i. Following Gul and Pesendorfer (2001), we characterize temptation (i.e., a preference for commitment) as a preference for a restricted choice set,

$$U\left[\{d_i\}\right] \succ U\left[\{d_i, n_i\}\right] \tag{5}$$

That is, an individual who faces temptation is better off facing a restricted choice set, where the only choice is to donate, because the presence of "not donate" creates costly temptation. Gul and Pesendorfer (2001) allow for individuals to exercise self-control or to face "overwhelming temptation". Those who exert self-control will abstain from choosing "not donate" when facing A_i and have a preference relation given by equation 6, although the presence of n_i in their choice set is still costly in terms of utility. On the other hand, other individuals may face overwhelming temptation and will thus succumb to choosing "not donate" from A_i.

$$U\left[\{d_i\}\right] \succ U\left[\{d_i, n_i\}\right] \succ U\left[\{n_i\}\right] \tag{6}$$

Suppose that some fraction of individuals, α, have temptation preferences and of this fraction, let $1 - \phi$ exert self-control, while fraction ϕ face overwhelming temptation. The remaining $1-\alpha$ fraction of individuals do not face temptation and thus will choose to donate when facing A_i. If individuals have no mechanism to restrict their choice set, the proportion of subjects that donate is given by

$$\gamma \left[\underbrace{\alpha(1-\phi)}_{\text{temptation \& self-control}} + \underbrace{(1-\alpha)}_{\text{no temptation}} \right] \tag{7}$$

However, if a mechanism is introduced by which individuals who face temptation can restrict their choice set then individuals who are unable to exercise self-control will be crowded-in to donate and the proportion who donate is given by

$$\gamma \left[\underbrace{\alpha(1-\phi)+\alpha\phi}_{\text{temptation \& mechanism to restrict choice set}} + \underbrace{(1-\alpha)}_{\text{no temptation}} \right] = \gamma \tag{8}$$

That is, when a commitment mechanism is available, the individuals who have a preference for commitment, α, will use the commitment mechanism to restrict their choice set. This increases the rate of donations by crowding-in those individuals who faced overwhelming temptation, $\alpha\phi$.[28]

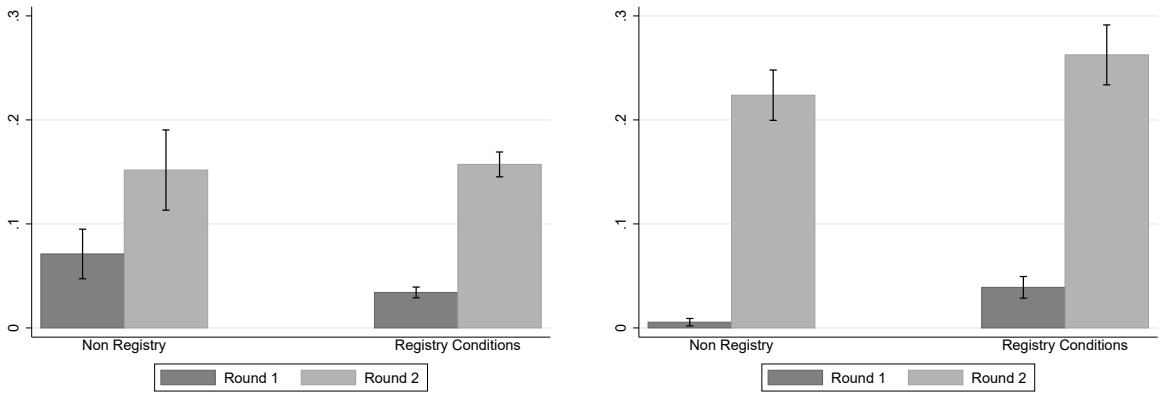
We apply this temptation-commitment model to the experimental data to generate testable implications. In Round 1, individuals in the Registry Conditions and Donation Only treatments face the choice set A_i, and due to randomization into treatment conditions, are equally likely to face temptation and self-control. In Round 1, individuals in the Registry conditions who have a preference for commitment can select into the Registry in order to restrict their choice set in the future. Equation 7 represents the predicted proportion of donations in Round 1 for individuals in both the Registry conditions and the Donation Only condition.

In the next solicitation Round (Round 2 for Registry Members and Donation Only subjects and Round 3 for Registry condition subjects who selected out of joining the Registry), individuals in the Registry conditions who selected into the Registry in Round 1 now face a restricted choice set and the rate of donation for subjects in the Registry Conditions is now given by Equation 8, while the rate of donation for the individuals in the Donation Only condition is still characterized by Equation 7.

Thus, our hypothesis 4 that Registry demand is driven by a preference for commitment results in three testable hypotheses. First, we hypothesize that Round 1 donation rates among the Registry conditions and the Donation Only treatment are not significantly different. We find evidence in favor of this hypothesis in columns (1)-(4) in Table **??**. Second, we hypothesize that donation rates for the Donation Only treatment do not significantly change

[28]Further, the fraction of individuals that faced temptation but exert self-control, $\alpha(1-\phi)$, make the donation with and without the commitment device but are better-off in terms of utility by the presence of a restricted choice set.

Figure 3: Relative Donation Rates Between Round 1 and Round 2 or 3 of Registry versus Non-Registry Conditions



(a) All Attempted Calls, Round 2 or 3 (b) Answered Calls Round 2 or 3, only

between Round 1 and Round 2, and third, the donation rates for the Registry conditions will increase from Round 1 to Round 2.

The second and third hypotheses imply that the rate of increase between the Round 1 and Round 2 donation rates should be larger for the Registry Conditions than for the Donation Only treatment. Figure 3 shows support for this implication. For example, the rate of donations among non-Registry conditions increases 5 percentage points from 0.09 to 0.14 for attempted calls from Round 1 to Round 2, whereas among Registry members the rate of donations increases 10 percentage points from 0.09 to 0.19.[29] We formally test this hypothesis with first-differences regression given in Equation 9, where the dependent variable is the change in donation rates between Round 1 and Round 2, $\Delta Donate_i$. The null hypothesis is $\beta_1 = \beta_2$ and evidence consistent with the model of the Registry as a commitment device implies $\beta_1 > \beta_2$.

$$\begin{aligned} \Delta Donate_i \quad = & \\ & \beta_1 \mathbf{1}[Registry = 1] \times [\mathbf{1}[Round2 = 1] - \mathbf{1}[Round1 = 1]] \\ + \quad & \beta_2 \mathbf{1}[Registry = 0] \times [\mathbf{1}[Round2 = 1] - \mathbf{1}[Round1 = 1]] + \Delta\varepsilon_i \end{aligned} \tag{9}$$

Table 7 presents evidence consistent with individuals using the Registry as a commitment

[29] In Figure 3, the proportion of non-Registry and Registry donors who donate in Round 1 decreases from the "Attempted Calls in Round 2" to the "Answered Calls in Round 2". This is due to the fact that we are conditioning on answering in Round 2 and not in Round 1. This means that for both non-Registry and Registry members, there is a proportion of individuals who donated in Round 1, but then did not answer the phone in Round 2.

device, where ΔR represents the change in proportions donating between Round 1 and Round 2. Registry conditions increase their donation rates in the second Round of calls, relative to Round 1, by 9 percentage points, whereas there is no significant increase in donation rates for non-Registry members. When we condition on answering the phone in the second Round of calls, we find that the Registry conditions increase donation rates by 20 percentage points, whereas non-Registry conditions increase their donation rates by 10 percentage points. These differences between Registry and non-Registry members are significant at all conventional significance levels.

Result 4 *Registry members are more likely to donate in Round 2, relative to Round 1, than non-Registry members.*

Table 7: The Registry as a Commitment Device:

	$\Delta Donate_i$	
	Don Only + Reg Members	Answer R2 Only
General Registry × Δ R	0.07***	0.18***
	(0.01)	(0.02)
Critical Registry × Δ R	-0.09*	0.08
	(0.05)	(0.07)
Non-Registry × Δ R	-0.01	0.07**
	(0.02)	(0.03)
Critical Appeal in Round 2	0.22***	0.16***
	(0.03)	(0.04)
Constant	0.08***	0.05***
	(0.008)	(0.01)
Observations	3226	1986
R^2	0.06	0.17
χ^2 Test:		
Gen Reg ×Δ R= Non-Reg ×Δ R	7.83***	9.13***

Differences in Differences regression estimates. Robust Standard Errors in parentheses and *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

4.4 Solicitation Dis-utility and Ask Avoidance

In this section, we consider the possibility that the Registry appeals to volunteers who experience direct utility loss when they are solicited for a donation and that this solicitation dis-utility drives their demand for the Registry. To examine this possible selection mechanism, we exploit the Blood Service's policy about soliciting donations. A volunteer's status, "active" versus "long-lapsed", is determined by the time since his last donation, which, in

turn, determines the number of solicitations he receives from the Blood Service. An active donor receives regular solicitations from the Blood Service, while when the donor becomes long-lapsed the Blood Service significantly reduces the number of solicitations. A volunteer donor is considered to be long-lapsed until he makes another donation, then he returns to the pool of active donors and continues receiving regular solicitations. Recall, all donors in our sample are long-lapsed, meaning that they have not made a donation for at least 24 months.[30]

To model the Blood Service's solicitation pattern, we assume that an individual has an expectation about the number of solicitations he will receive in the future given his current status as a donor (active or long-lapsed).[31] Moreover, volunteers expect that if they return to the active donor pool, then the number of solicitations will increase to a higher rate and remain at that higher rate until returning to the long-lapsed pool of donors. Let T represent the number of days since the individual has been long-lapsed and let his expectation about the number of future solicitations, s, be given by $E[s|T]$, where $E[s|T = 0]$ is the expectation of an active donor and $E[s|T > 0]$ is the expectation of a long-lapsed donor. Thus, donor i who has been lapsed for $T > 0$ faces the following decision problem,

$$U(d_i) = \begin{cases} u(d_i) - c(E_t[s|T = 0]) + \varepsilon_{i,t} & \text{if donate} \\ -c(E_t[s|T]) & \text{if not donate.} \end{cases}$$

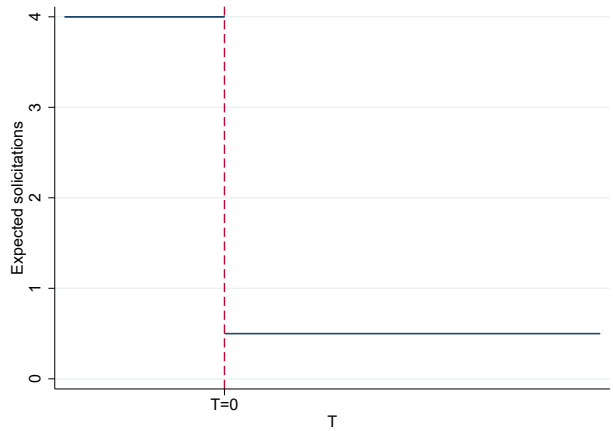
where $u(d_i)$ is the utility the donor gets from making a donation, $c(\cdot)$ is the utility cost of the expected solicitation and $\varepsilon_{i,t}$ is an idiosyncratic error term that captures shocks to the donor's utility. We assume $u(\cdot)$ and $c(\cdot)$ are increasing in their arguments.

When volunteers are invited to join the Registry, a main characteristic is the promise to "contact Registry members only once or twice a year but never more than four times" in a year. This represents substantially fewer expected solicitations than a long-lapsed donor can expect to receive by re-joining the active donor pool without the Registry (i.e., making a donation without Registry membership). Thus, if a volunteer joins the Registry and donates, then he expects the number of future solicitations following the donation to be fewer than if he donates and does not join the Registry. Let T_R represent the time since the last donation with a Registry membership, then $E_t[s|T_R = 0] < E_t[s|T = 0]$. The decision problem for a Registry member with length of lapse T'' such that $E_t[s|T = T''] < E_t[s|T_R]$ is to donate if and only if

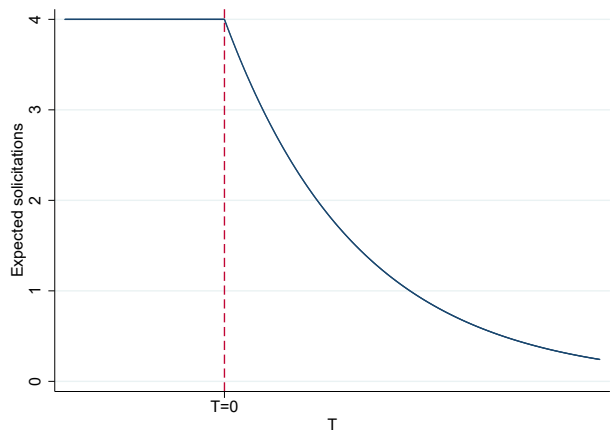
[30] Figure S3 shows that there is still significant variation in the amount of time since the last donation among our sample.

[31] We consider the "future" to be over the course of the next year.

Figure 4: Expectations about Future Solicitations



(a) Dis-Continuous in T



(b) Continuous in T

$$u(d_i) - c(E_t[s|T_R]) + \varepsilon_{i,t} \geq -c(E_t[s|T'']) \tag{10}$$

Discussions with the Blood Service indicate that once a donor becomes long-lapsed, normal communications cease until the donor returns to the active donor pool. A donor with rational expectations about the number of future annual solicitations will expect a discontinuity upon becoming long-lapsed, as illustrated in Figure 4a. Alternatively, if donors' expectations are adaptive, their expectations might be better characterized as in Figure 4b. In this case, donors learn over time that the Blood Service has reduced solicitations and only after a substantial period of lapse do they expect no solicitations. We consider the first case here and the second case in Supplementary Material B.

First, we note that there is likely to be heterogeneity in expectations between an individ-

ual who has been long-lapsed prior to this episode and those individuals who are long-lapsed for the first time. In particular, we expect that a volunteer with prior long-lapse experience to have more accurate expectations about the number of solicitations he will receive than an individual who is long-lapsed for the first time. Furthermore, recency bias suggests that first-time long-lapsed donors are more likely to believe that the number of solicitations during a long-lapse will be more similar to the number of solicitations as an active donor.

Unfortunately, we do not observe whether the individuals in our have been long-lapsed prior to this current lapse. However, using the sample of all blood donors who donated between 2011-2016 in Australia, we find that conditional on at least one episode of lapse, donors with longer donation histories were significantly more likely to experience a second period of lapse. That is, donors with longer donation histories are more likely to have experienced a prior period of lapse than donors with shorter donation histories. Thus, we assume that donors with longer donation histories will have more accurate expectations about the number of future solicitations as a long-lapsed donor, while donors with shorter donation histories will be more likely to hold inflated expectations due to recency bias.[32]

We express this heterogeneity by an expectation that relies on the donor's donation history, where y is number of years an individual has been a volunteer donor (either active or long-lapsed). We assume that $E[s|T > 0, y'] < E[s|T > 0, y'']$ if and only if $y' > y''$. Consistent with Figure 4a, we maintain that $E[s|T > 0, y]$ is constant $\forall \quad T$. An ask-avoidant individual joins the Registry if $E[s|T > 0, y] > E[s|T_R]$. Thus, volunteers with shorter donation histories will be more likely to join the Registry than volunteers with longer donation histories because the shorter the donation history, the greater the expected reduction in future donations by joining the Registry. Further, if $E[s|T > 0, y] < E[s|T_R]$, then an individual will join the Registry *only if* if he intends to donate; that is, if a long-lapsed donor does not intend to donate again, then he would not join because joining would increase the number of costly solicitations without any benefits.

The two testable implications from this model of solicitation dis-utility are as follows: (1) the probability of joining the Registry is decreasing in the number of years the individual has been a donor; (2) conditional on joining the Registry, volunteers with longer donation histories will be more likely to make a donation. We test these two hypotheses in Table 8. In columns (1) and (2) we test the first hypothesis by examining whether there is a relationship between the "years donating" and the probability of joining the Registry. We find no evidence in support of the first hypothesis; that is, we do not find evidence that donors with shorter donation histories are more likely to join the Registry.

[32] A donor who has just moved from the active pool to the long-lapsed pool for the first time has recently experienced frequent solicitations.

In columns (3)-(6) we test the second hypothesis. To test whether, among Registry members, donation rates increase in y and subsequently, that the Registry crowds-in donations from longer-term donors who would not have donated without the Registry, we use two relevant subsamples. In columns (3) & (4), we restrict our analysis to Registry members who were solicited for donations in Round 1 (Registry + Donation) and individuals in Non-Registry conditions (Donation Only) who were solicited for a donation in Round 1. In columns (5) & (6), we restrict our analysis to Registry members who were solicited for a donation in Round 2 for the first time (Registry only) and Non-Registry conditions (Control Group 1) who were solicited for a donation for the first time in Round 2. We estimate the following equation with a probit regression,

$$\begin{aligned} Prob_i\,[\text{Donate=1}] = & \\ \gamma_0 + \gamma_1 \mathbf{1}[RegistryMember = 1] \times y & \quad + \gamma_2 \mathbf{1}[RegistryMember = 0] \times y \\ + \gamma_3 \mathbf{1}[RegistryMember = 1] & \quad + \gamma_4 \Psi_i + \varepsilon_i \end{aligned} \tag{11}$$

where $\gamma_1 > 0$ indicates that donation rates are increasing in y for Registry members and $\gamma_1 > \gamma_2$ indicates that the increase in donation rates among the longer-term volunteers are larger for Registry members than for non-Registry members, suggesting that the Registry works to crowd-in longer-term volunteers who were not likely to donate without the Registry.

In columns (3)-(6), we find that the length of a Registry member's donation history has no effect on the likelihood of donation (i.e., $\gamma_1 = 0$). Moreover, in columns (3) and (4), we find that non-Registry members with long donation histories increase their donation rates more than Registry members with long donation histories (i.e., $\gamma_1 < \gamma_2$, p-values=.053 and .063, respectively), which is the opposite of our hypothesis. We find no significant difference in columns (5) and (6) (p-values=.25 and .18, respectively). Overall, we find no evidence consistent with Registry demand driven by solicitation dis-utility, nor evidence consistent with the Registry crowding-in donations from volunteers who experience solicitation dis-utility.[33]

[33] It is worth noting that the empirical tests presented here are a joint test of (1) selection on solicitation dis-utility, (2) the assumption that donors with a longer history of donations will form more rational expectations of the implications of of the change in expected donations between being a long-lapsed donor and being an active donor, and (3) that donors have dis-continuous expectations of future solicitations as shown in Figure 4a. An alternative empirical approach to test solicitation dis-utility is to alter assumptions (2) and (3). In the Supplementary Material B, we instead use the days the donors are currently long-lapsed, and assume expectations of future solicitations are continuous as shown in Figure 4b to derive predictions. In this case, our model of solicitation dis-utility predicts (1) that increasingly longer-lapsed donors would be increasingly less likely to join the Registry since their expectation of future solicitations will be decreasing, thus the need for the Registry to avoid solicitations will be diminishing, and (2) increasingly longer lapsed donors who join the Registry will be more likely to donate. We find no support for the first prediction, and mixed support for the second prediction. Overall, we thus find very little empirical support with this alternative specification.

Result 5 *Donation history does not predict selection into the Registry. Longer donation histories are not associated with an increased probability of donating among Registry members.*

Table 8: Registry as a Selection on Solicitation Dis-utility, Expectations as Discontinuous in T

	Join General Reg Answered in R1		Donate in R1 Reg + Don & Don Only		Donate in R2 Reg Only & Control 1	
	(1)	(2)	(3)	(4)	(5)	(6)
YearsDonating	0.001	0.0004	.	.	.	.
	(0.002)	(0.002)				
Years Donating × Gen Reg Members	.	.	0.0007	-0.0004	0.0008	-0.0003
			(0.002)	(0.002)	(0.004)	(0.004)
Years Donating × Non-Reg Condition	.	.	0.007**	0.006**	0.005*	0.003
			(0.003)	(0.003)	(0.003)	(0.003)
Gen Reg Member	.	.	0.05**	0.04*	0.08**	0.08**
			(0.02)	(0.02)	(0.03)	(0.04)
Female	.	0.02	.	0.03	.	-0.02
		(0.02)		(0.02)		(0.02)
Age	.	0.0000476	.	0.001	.	0.001
		(0.0009)		(0.0009)		(0.001)
Yearly Donation Rate	.	1.08	.	0.26	.	0.11
		(0.81)		(0.61)		(1.10)
Days Since Last Donation	.	0.004	.	0.01	.	-0.01
		(0.008)		(0.008)		(0.009)
Critical Appeal	.	.	.	.	.	0.04
						(0.03)
Observations	2698	2697	1020	1020	1301	1211
Pseudo R^2	0.0001	0.02	0.01	0.05	0.007	0.02
Baseline Probability			.09	.09	.20	.20
χ^2 Test:						
Gen Reg Member × T= Non-Reg × T			3.24*	3.28*	.62	.50
Controls						
Demographics	No	Yes	No	Yes	No	Yes
State & Site FE	No	Yes	No	Yes	No	Yes
Call Day FE	No	Yes	No	Yes	No	Yes
Call Agent FE	No	Yes	No	Yes	No	Yes

Marginal effects from probit regressions reported. Robust Standard Errors in parentheses and *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

5 Conclusion

This paper addresses volunteer labor markets, where the lack of price signals, non-pecuniary motivations to supply labor, and limited fungibility of supply lead to market failure. We introduce a market-clearing mechanism, the Registry, that takes these market aspects into account. The Registry was designed to appeal to volunteers across three behavioral preferences: volunteers motivated by pure altruism, volunteers in need of a commitment device and volunteers who experience solicitation dis-utility.

We find that the introduction of the Registry is effective at improving market outcomes. This positive effect is driven by the Registry successfully screening for donors who find the Registry appealing enough (i.e., those who select-in) that they are motivated to resume donation activities. In particular, we find evidence consistent with the Registry crowding-in volunteers with pure motives and volunteers who have a preference for commitment. We find no evidence consistent with the Registry appealing to volunteers who experience solicitation dis-utility. Given past evidence in support of solicitation dis-utility that contrasts with our lack of evidence (Andreoni et al., 2017; DellaVigna et al., 2012), future research exploring the boundaries of solicitation dis-utility is important. One potential reason for the different results may be that in our study we examine volunteer labor supply, whereas in previous work subjects were involved in a one-off monetary donation request. It is thus possible that selection into a population of volunteer labor supply already sorts out individuals who would suffer from solicitation dis-utility. Another possibility is that the Registry was simply not attractive to subjects who experienced solicitation dis-utility. More work in better understanding which conditions result in solicitation dis-utility has important implications for welfare.

Although we introduce the Registry in the whole blood market, the Registry provides a general framework for managing voluntary labor markets. Because the supply of voluntary labor operates quite differently from traditional labor markets dictated by wages, we believe that identifying the behavioral mechanisms is an important contribution, providing useful insights into how to design future Registries or expand existing Registries.[34]

[34]The costs associated with building and maintaining a Registry are not prohibitive. In Australia, the Blood Service added the Registry invitation to already planned solicitation campaigns.

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