Commitment Mechanisms and Blood Donation

Ashley Craig
SID: 306200368

Supervisor: Professor Robert Slonim

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Abstract

The Australian Red Cross Blood Service (ARCBS) recently introduced a policy of compulsory appointments for blood donations. This thesis examines the effect of these appointments on donor satisfaction and donation behaviour. Overall, aggregate tests indicate that the policy transition initially had a negative effect. However, conditional on having donated once after the transition, donors are more likely to return.

In order to isolate individual mechanisms that contribute to these results, a survey of blood donors is used to test two specific theories from behavioural economics. On the positive side, appointments are found to increase the likelihood that a donor will return, possibly by circumventing a problem of time-inconsistent preferences. However, the results also support a theory from the marketing literature that appointments change donors' expectations, causing wait time to be more negatively perceived. Furthermore, this is found to cause a significant change in donors' intended actions.

The results of this thesis also allow specific policy recommendations to be made. First, staff should be encouraged to ask as many donors as possible to make a new appointment at the end of each donation, since donors who are asked to make an appointment are much more likely to do so, and making an appointment increases the likelihood of return. Second, it is suggested that donors with appointments be given some priority in the wait queue, in order to minimise the impact of long wait time on these donors. Finally, the finding that new donors are more negatively affected by wait time than others suggests that they too should be given some priority.

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Contents

1 Introduction

Standard economic models have only a limited ability to explain pro-social activities such as blood donation. If people voluntarily give money or time for the benefit of others, then it is difficult to maintain the assumption that they are inherently selfish and that individuals' preferences are independent of the well-being of others. Given the important role that pro-social activities play in our society, it is essential that we improve our understanding of such behaviour.

The donation of blood is a particularly vital pro-social activity, since donations facilitate life-saving medical procedures. It is widely recognised that national self-sufficiency in blood is highly desirable, since blood products do not last long and security of supply is essential. However, in recent years, Australia has had to import increasing quantities of blood products to supplement the domestic supply, which is obtained exclusively through voluntary donation to the *Australian Red Cross Blood Service* (ARCBS).

Between 2003 and 2006, the ARCBS phased in a policy that makes it officially compulsory for appointments to be made for all blood donations. While centres still accept some donors without an appointment if there is space in their schedules, appointments are now much more strongly encouraged. The primary aim of this policy is to reduce costs by facilitating better planning and allocation of resources across centres and over time. However, there are several reasons to believe that the policy could also have affected the rate of blood donation.

The focus of this thesis is to improve our understanding of pro-social behaviour by examining the effect that compulsory appointments have had on blood donors' utility and on the likelihood that they will donate again. The first empirical contribution is to test the overall effect of the policy, using de-identified ARCBS databases of approximately 9.5 million donations and two million blood donors. The fact that the policy was implemented on a state-by-state basis is used to specify a set of difference-in-difference regressions for each transition. Overall, preliminary findings indicate that the policy was initially associated with a decrease in the rate of blood donation. However, conditional on having donated once after the transition, donors are more likely to return.

The next stage of the analysis attempts to isolate specific mechanisms are suggested in the literature. The first theory to be tested is that compulsory appointments could increase donations by encouraging potential donors to make a commitment. If it is psychologically costly to break this commitment, then individuals may be more likely to go through with a planned donation. Although intuitively appealing, this mechanism is not compatible with standard exponential discounting of the costs and benefits of donation. Such preferences imply that donors will always act according to their plans, rendering a commitment mechanism unnecessary. A conclusion that appointments do increase the likelihood of return would therefore suggest that utility is not discounted in a time-consistent manner.

In addition, an increase in efficiency from the appointment policy may have reduced donors' wait times, leading to increased satisfaction and a higher likelihood of return. However, it is suggested by Maister (1985) that satisfaction could actually be negatively affected by appointments, if service expectations are increased. In the case of blood donation, it is anticipated that donors with appointments will expect shorter wait time. If these heightened expectations are not met, then donors with appointments may be less satisfied with their experience and less likely to return.

In order to test these two theories, additional information was collected about the experiences of donors. A team of researchers was sent to four donation centres across Sydney to collect surveys from approximately 1500 blood donors. The researchers were able to achieve a response rate of 96.7 percent, which essentially mitigates the possibility of response bias. The survey data provide detailed information about perceptions and expectations of wait time, satisfaction, likelihood of return, the choice to make an appointment and an extensive array of control variables.

The results of the data analysis suggest that appointments do increase the likelihood that a donor will return, possibly by circumventing a problem of time-inconsistent preferences. However, appointments are also found to reduce expected wait time, causing the same perceived wait time to more negatively affect satisfaction. This interaction is also an important determinant of donors' self-reported likelihood of return. No conclusive evidence has so far been found to suggest a change in subsequent donation behaviour. However, this is possibly due to the fact that insufficient time has passed for whole blood donors to be eligible to return.

The next section proceeds with a review of the literature (Section 2), followed by an explanation of the institutional background of the project (Section 3) and a description of the available data (Section 4). Section 5 describes the empirical strategies that are adopted to test each hypothesis and presents the results. Finally, Section 6 discusses the theoretical and practical implications of the results and Section 7 concludes.

2 Literature Review

An analysis of previous research in the Economics and Marketing literatures does not produce a clear prediction for the overall effect of the new ARCBS appointment policy. On the one hand, research from behavioural economics indicates that an appointment could have a positive effect, if the adoption of a commitment mechanism makes a donor more likely to go through with a planned donation. However, evidence from the service expectations literature suggests that compulsory appointments could decrease satisfaction with the donation process by increasing expectations. In both cases, it is not known to what extent previous research will apply to pro-social activities such as blood donation.

2.1 Appointments and time-inconsistent preferences

Several authors have shown that commitment mechanisms can encourage individuals to go through with behaviour that they would otherwise have avoided. For example, mandatory pension funds have been found to increase total saving (Thaler and Shefrin 1981) and regular smokers have been observed to deliberately buy single packs rather than whole cartons of cigarettes, in an effort to impose an additional marginal cost to smoking and minimise future consumption (Wertenbroch 1998). In the case of blood donation, it is therefore hypothesised that a person who makes an appointment may, *ceteris paribus*, be more likely to actually donate.

The concept that a commitment mechanism can alter future behaviour is intuitively appealing. However, as originally highlighted by Strotz (1955), this proposition challenges the standard specification of intertemporal preferences. The most common assumption in Economics is that the discount rate of an agent is constant between any two equidistant time periods, which is equivalent to assuming that the discount function has an exponential functional form in continuous time. Moreover, this is the only functional form that guarantees that an agent will confirm previous choices as they are reevaluated over time (Strotz 1955). A problem with a violation of this principle is therefore that an agent will make a set of intertemporal choices, but then systematically revise these choices in subsequent time periods. In other words, the agents preferences are *time-inconsistent*.

Nonetheless, there is evidence to suggest that individuals' intertemporal preferences are *not* consistent with exponential discounting. For example, in an experiment by Thaler (1981), participants were offered a choice between receiving various values of a reward immediately or a higher value after three months, one year or three years. The per-period discount rate implied by participants' decisions is found to decline as the waiting period lengthens. This finding is confirmed by a more complex experiment by Kirby and Herrnstein (1995), in which participants were first offered a choice between a small immediate reward or a delayed larger reward. The delay was then increased or decreased until the individual expressed indifference between the alternatives. When the same intertemporal choice was gradually shifted away from the present, all except one participant eventually shifted to choosing the earlier reward. As was the case in Thaler's (1981) experiment, this implies that the discount *rate* is dependent on the delay. Similar results have been found in other experiments (e.g. Kirby 1997, Ainslie and Haslam 1992, Benzion, Rapoport and Yagil 1989).

The finding that the discount rate is inversely related to the timing of a decision has led some authors to characterise the discount function as approximately hyperbolic in form (e.g. Laibson 1997, Phelps and Pollak 1968). The term ‘hyperbolic discounting’ has now come to refer to any discount function that is initially steeper than a standard exponential function (Kirby 1997). A simple example of such a specification is shown in equation (1), which implies that the discount rate between $t = 0$ and $t = 1$ is $\beta\delta < \delta$, whereas the discount rate between any two other consecutive periods is δ.

$$D(t) = \begin{cases} 1 & \text{for } t = 0 \\ \beta\delta^t & \text{for } t = 1, 2, \ldots, \infty \end{cases} \quad \text{where } 0 < \beta, \delta < 1 \tag{1}$$

In other words, payoffs in all future periods are discounted by an additional factor (β), but the discount function is otherwise identical to the standard specification. Originally suggested by Phelps and Pollak (1968) this has become a particularly popular functional form, partly due to its tractability (Frederick, Loewenstein and O’Donoghue 2008, Laibson 1997).

An alternative explanation of a decreasing discount rate is provided by the theory of *sub-additive discounting*, which assumes that the discount rate is constant over time, but inversely related to the length of the time period (Frederick et al. 2008). For example, when an agent’s discount rate is estimated for each of the twelve months in one year, the implied discount rate for the year as a whole is larger than the agent’s yearly discount rate. Such a model can readily explain the observations from some previous experiments (e.g. Thaler 1981) and there is some evidence that it may be superior to its hyperbolic counterpart (Read 2001). However, as Frederick et al. (2008) point out, this simply provides an alternative psychological underpinning for the use of a hyperbolic discount function. Providing that we are looking at choices made at the present, the implied decisions are identical.

The psychological process behind declining discount rates has been explained by some authors using a version of *agency theory*. According to this argument, economic agents are internally divided into a myopic and a far-sighted self, which fight for control over a decision (Schelling 1984, Winston 1980, Thaler and Shefrin 1981). While the far-sighted self attempts to maximise intertemporal utility in a time-consistent manner, the myopic agent heavily discounts future utility and attempts to maximise present gain. Such a theory does not substantially influence the practical implications of time-inconsistent preferences, but it does provide a normative justification for both of the models discussed above.

A different stream of research explains time-inconsistent preferences using loss-aversion models, which imply that the utility function is more steeply sloped for losses than for gains, compared to a reference point (Kahneman and Tversky 1979). For example, Hoch and Loewenstein (1991) show how this type of model can lead to a last-minute change in a consumer's purchasing decision. Before the date of purchase, the consumer's reference point is characterised by the *lack* of the good to be bought and the *ownership* of the money required to make the purchase. Thus, attainment of the good is a gain, and parting with money is a loss. However, once the date of decision arrives, the reference point is shifted toward possession of the good, as the consumer moves to a position that is halfway between making and not making the purchase. As a result, the lack of the good becomes evaluated as a loss and is assessed using the steeper part of the utility function, while the retainment of money is now seen as a gain. For a customer on the margin, this leads to a change in the optimal decision.

Regardless of the precise nature of the discount function, time-inconsistent preferences introduce the possibility that a potential blood donor's assessment of the optimal decision may systematically change as time progresses. For example, consider a simplified model of a donor's decision to donate, in which the altruistic benefits (B) from donation are distributed over infinite periods, while the costs (C) are incurred in the period of donation only. If donors' preferences are modeled using Phelps and Pollak's (1968) specification in equation (1), then the donor at time 0 will plan to donate in the subsequent period (time 1) if equation (2) holds.

$$\sum_{t=1}^{\infty} \beta\delta^t B_t - \beta\delta C_1 > 0 \tag{2}$$

However, when the day of decision actually arrives, the donor will proceed with the donation only if equation (3) holds.

$$B_0 + \sum_{t=1}^{\infty} \beta\delta^t B_t - C_0 > 0 \tag{3}$$

Assume for simplicity that $C_t = C$ and $B_t = B$ for all $t = 1, \ldots, \infty$. Combining equations (2) and (3), simplifying the summations and rearranging, it can be shown that three types of decision can occur:

$$B > \frac{(1-\delta)C}{1-\delta(1-\beta)} > (1-\delta)C \tag{4}$$

$$\frac{(1-\delta)C}{1-\delta(1-\beta)} > (1-\delta)C > B \tag{5}$$

$$\frac{(1-\delta)C}{1-\delta(1-\beta)} > B > (1-\delta)C \tag{6}$$

A donor who satisfies condition (4) will both plan to donate and proceed with the donation. At the other extreme, condition (5) guarantees that a donor will never plan to donate and will never donate. Finally, if condition (6) is satisfied, time-inconsistency occurs. Such a donor always plans to donate one period ahead, but systematically postpones the donation when the date of decision arrives. Furthermore, an entirely equivalent set of conditions can be derived for any specification of preferences with declining discount rates, including if the benefits are distributed over a finite number of periods.

If an individual's preferences satisfy condition (6), then a role for a commitment device becomes theoretically possible. Moreover, it can be seen from equation (3) that the *ex ante* utility of an individual who intends to donate is always maximised by proceeding with the donation. Thus, if it is possible to commit to donating, we would expect donors to make use of the opportunity. For example, consider a donor who plans to donate and who has made an appointment. If breaking this appointment entails a psychological cost ($P_C > 0$) then the condition for proceeding with the donation becomes:

$$B_0 + \sum_{t=1}^{\infty} \beta\delta^t B_t - C_0 > -P_C \tag{7}$$

Moreover, the condition required for time-inconsistency becomes:

$$\frac{(1-\delta)(C-P_C)}{1-\delta(1-\beta)} > B > (1-\delta)C \tag{8}$$

Since $P_C > 0$, this implies that a donor on the margin will now obtain positive net utility from proceeding with a planned donation. The problem is therefore solved for such a donor and the donation rate is increased. The condition required to eliminate the problem for *all* donors is:

$$\frac{(1-\delta)(C-P_C)}{1-\delta(1-\beta)} \leq (1-\delta)C$$

$$P_C = P_C^* \geq \delta(1-\beta)C \tag{9}$$

This condition implies that the psychological cost of an appointment that is required to eliminate time-inconsistency for all donors is a positive function of the costs of donation (C) and the exponential discount factor (δ), and a negative function of the hyperbolic discount factor (β). For any lower level of P_C, the problem is solved for some donors, but not for all. P_C^* therefore represents an upper limit on the effectiveness of appointments as a commitment device.

The acceptability and effectiveness of voluntary commitment mechanisms has been demonstrated in an experiment by Ariely and Wertenbroch (2002), in which students in an executive education course were asked to set their own binding deadlines. Not only did students tend to set earlier deadlines than were required, but the performance of these students was better than those who set later deadlines. This finding is also supported by evidence from the purchasing decisions of long term smokers (Wertenbroch 1998) and the behaviour of drug addicts (Schelling 1984).

It is important to observe, however, that evidence to suggest a role for voluntary appointments does not necessarily imply that commitment mechanisms should be made compulsory. For example, if a blood donor is aware of her own propensity to procrastinate, then she will make voluntary use of appointments. Making these appointments compulsory would therefore be expected to have no effect on such a donor. For this reason, a positive effect of a compulsory commitment mechanism through this channel requires not only that donors' preferences are time-inconsistent, but that at least some donors are unaware of this fact. Although there is some evidence to suggest that compulsory commitments can be effective to increase saving rates (Thaler and Shefrin 1981), it is not guaranteed that such findings will extend to a voluntary altruistic act such as blood donation.

2.2 Appointments and service expectations

An additional mechanism through which appointments could affect donations is by affecting utility. In particular, if the ARCBS appointment policy has achieved its aim of increasing efficiency, then donors' wait times will have been reduced, leading to increased satisfaction and a higher willingness to donate again. However, the adoption of an appointment could also affect expectations, causing the same wait time to be more negatively perceived. If this change is large enough, then the policy may actually have led to a decrease in donors' utility and a lower likelihood of return.

The importance of expectations as a determinant of customers' satisfaction is well accepted in the Marketing literature, although there is no consensus on the precise nature of the relationship. In particular, there has been considerable dispute as to whether satisfaction is a direct function of the difference between perceived and expected performance (Cadotte, Woodruff and Jenkins 1987, Anderson 1973, Parasuraman, Zeithaml and Berry 1994) or a function of perceptions only (Babakus and Boller 1992, Cronin and Taylor 1992, Teas 1993). The available evidence in the context of waiting time suggests that a measure of perceptions alone is most useful as a predictor of satisfaction, with no strong evidence to suggest a role for expectations (Davis and Heineke 1998). However, this may largely be due to a lack of high quality empirical research in the area. Finally, the specific hypothesis that the acceptance of an appointment could alter service expectations has never been empirically tested, despite having been suggested by multiple authors (e.g. Kostecki 1996, Maister 1985).

The theory that satisfaction is related to the difference between expected and perceived service levels achieved widespread popularity with invention of the

SERVQUAL index by Parasuraman, Zeithaml and Berry (1988). While previous theoretical discussion and empirical evidence had already suggested an important role for expectations (Sasser, Olsen and Wyckoff 1978, Gronroos 1982, Parasuraman, Zeithaml and Berry 1985), this index is the culmination of a more ambitious project, which attempts to use the theory to define a measure of satisfaction that is readily applicable to a wide variety of industries. To this end, Parasuraman et al. (1988) define 22 measures of service perceptions, along with 22 parallel measures of expectations. The differences between expectations and perceptions for each of these items are then combined to form a set of five easily interpretable statistics.

The conceptualisation of satisfaction as the difference between perceptions and expectations is intuitively very appealing. However, subsequent authors have identified several problems with this approach, at least three of which could influence the study at hand. First, as Babakus and Boller (1992) point out, there is evidence to indicate that customers' reported expectations are positively correlated with perceived service quality (Wall and Payne 1973), which implies that difference scores such as those specified by Parasuraman et al. (1988) will be negatively biased. Second, Babakus and Boller (1992) argue that difference scores tend not to be robust across different contexts. Finally, Teas (1993) criticises this type of specification on the basis that it disregards the absolute level of quality. For example, consider a customer who is observed to have high but equal expectations and perceptions of the quality of Service A, and similarly low expectations and perceptions of Service B. Since the difference between the two measures is the same in both cases, the two experiences would be measured as equally satisfactory. As Teas points out, this is not a reasonable implication.

Despite these theoretical problems, some support for the *SERVQUAL* index has been found empirically (e.g. Cadotte et al. 1987). However, the index has not tended to perform well when explicitly compared to alternatives. For example, several authors have found that the separation of perceptions and expectations into two different variables provides superior explanatory power (Boulding, Kalra, Staelin and Zeithaml 1993, Babakus and Boller 1992). Alternatively, the comparison of customers' perceptions to their estimated feasible ideals has also been found to perform well (Cronin and Taylor 1992). In some of these studies, a significant role for expectations is still found (Boulding et al. 1993), while others find that it contributes little additional information (Babakus and Boller 1992).

The specific role of *wait time expectations* has been afforded little attention in the literature, despite the fact that wait time is one of the most easily quantifiable dimensions of service quality. One of the few authors who has discussed the issue is Maister (1985), who provides a practical overview of the factors important to the waiting experience. Much like Parasuraman et al. (1988), Maister conceptualises satisfaction with wait time as the difference between perceptions and expectations, although it is not clear that this formulation is intended to be as rigid as the *SERVQUAL* index. The only empirical test of this hypothesis is provided by a study of fast food customers by Davis and Heineke (1998), which does not find strong support for the role of expectations. However, the only statistic used to support this claim is the R^2 from an OLS regression with a discrete dependent variable. Not only is this an inappropriate econometric model, but a small R^2 may simply be due to low variation in expectations in this particular context[1].

For the purposes of this study, the most important of Maister's (1985) predictions is that an appointment is likely to reduce the expected length of wait

[1] Davis and Heineke (1998) do not provide a measure of the variability of expectations.

time. If this expectation is not met, it is argued, then the same wait time will be more negatively perceived. This same hypothesis is also postulated by Kostecki (1996). However, the validity of the theory has never been empirically examined. The introduction of the new ARCBS appointment policy provides an ideal opportunity to bridge this gap by testing the effect of the interaction between appointments and wait time on both satisfaction and subsequent behaviour.

In addition to the role of appointments, Maister (1985) also suggests several potential control variables. These include the observations that (1) anxiety can increase the negative effect of wait time, (2) customers who are offered an explanation may be more tolerant of delays, (3) the same wait time spent alone may seem longer than that spent with a group, (4) the presence of a diversion may reduce perceived wait time and (5) subsequent waits within the same service encounter may be less negatively received than wait time before the first human contact is made with the organisation. In addition, Davis and Vollmann (1990) find evidence to suggest that time pressure may reduce tolerance of wait time. All of these variables were included in the donor survey.

2.2.1 Expectations and loss aversion

A standard economic specification of preferences would define utility as a function only of actual experience. However, if appointments affect satisfaction by changing expectations, then some adjustment is required. One way to accommodate a role for expectations is to assume loss-aversion, as suggested by Kahneman and Tversky (1979). In particular, it is hypothesised that a longer than expected wait time is experienced as a loss, whereas a shorter wait time is felt as a gain. If agents are loss-averse, then a given increase in wait time will cause a greater reduction in utility if the wait is longer than anticipated. For example, consider the following utility function, which is defined over actual wait time (w_A) and expected wait time ($w_E(M)$), where M is an indicator for whether the donor has made an appointment ($M = 1$) or not ($M = 0$):

$$\begin{aligned} U[w_A, w_E(M)] = \kappa w_A + \alpha[w_E(M) - w_A | w_E(M) > w_A] \\ - \beta[w_A - w_E(M) | w_A > w_E(M)] \end{aligned} \tag{10}$$

where $\kappa < 0$ and $\alpha, \beta > 0$. If $\alpha = \beta$, there is no loss aversion, although the donor is still reference dependent unless $\alpha = \beta = 0$. However, if $\beta > \alpha$, then a given increase in w_A will have a greater negative effect on utility in the realm of losses ($w_A > w_E$) than in the realm of gains ($w_E > w_A$). Thus, if donors with appointments expect shorter wait time ($w_E(M = 1) < w_E(M = 0)$), then it follows that, *ceteris paribus*:

$$U[w_A, w_E(M = 0)|w_A] > U[w_A, w_E(M = 1)|w_A] \text{ for all } w_A > 0 \tag{11}$$

In words, equation (11) states that an appointment lowers expected wait time, causing the same actual wait time to be more negatively perceived. All else equal, this leads to lower utility from donation. If this effect is strong enough, then this reduction in utility may cause donors with appointments to be less likely to donate in the future.

2.3 Summary of hypotheses from the literature

Based on the considerations above, it is anticipated that the policy of compulsory appointments may have influenced donor behaviour through at least two mutually compatible channels, both of which can be isolated in empirical tests. First, it is expected that the interaction between appointments and longer wait time will negatively affect satisfaction and will therefore be associated with a reduction in the probability that a donor will return. Second, an individual who makes an appointment is expected to be more likely to donate, holding all else constant.

The overall result of the policy transition is not predicted by theory, since the two primary effects suggested in the literature work in opposite directions. Furthermore, these channels will be combined with several additional factors. For example, compulsory appointments reduce flexibility. If donors are unsure of their availabilities, they may be unwilling to make an appointment in advance and unable to donate without one. Furthermore, many donors without appointments may have been initially turned away at the donation centres, simply because they were not aware of the policy change. At the same time, if efficiency has been increased, it is possible that wait times have been reduced and satisfaction improved in the long term. The net effect of such a complex set of interactions can only be determined empirically.

3 Institutional Background

The domestic supply of whole blood in Australia is obtained exclusively through voluntary donation to the *Australian Red Cross Blood Service* (ARCBS). Until recently, this supply has been adequate to satisfy domestic requirements of the most common blood products. However, a persistent shortage in recent years has made it necessary to import increasing quantities of blood derivatives. In the long term, it is generally agreed that this position is not sustainable, since blood products do not last long and security of supply is essential to facilitate a variety of life-saving medical procedures (Plasma Fractionation Review Committee 2006). In order to maximise the supply of blood in the future, further research is required to understand the behaviour and motivations of blood donors.

3.1 Blood collection and distribution

Blood collection and distribution in Australia is jointly funded by the Commonwealth (63 percent) and state and territory governments (37 percent), and is overseen by the *National Blood Authority* (NBA). Established under the *National Blood Authority Act 2003 (Cwlth)*, the responsibilities of the NBA include the management of the blood supply, the monitoring of demand and the negotiation of contracts with suppliers of blood products.

The first step in the distribution process is the collection of whole blood and plasma by the ARCBS via 119 mobile and fixed donation centres. Once collected, blood is tested for pathogens and separated into red blood cells, plasma and platelets. The majority of the resulting plasma is then transferred to the *Commonwealth Serum Laboratories* (CSL Limited) for further testing and fractionation into an extensive variety of final products, before being returned to the ARCBS for distribution to the hospital system.

The collection of blood is a necessarily expensive process. According to recent estimates, the annual cost of ARCBS operations alone is now AU$298 million (2005/06), having risen by 66 percent in the past five years (Plasma Fractionation Review Committee 2006). It is as part of an ongoing effort to reduce these costs that appointments have been made compulsory. As a result, it is expected that donor numbers will be more predictable, facilitating better allocation of resources. However, there are several reasons to believe that the policy could also have affected the rate of donation.

Australia has never been completely self-sufficient in the supply of all blood derivatives. However, the volume of imports has been small and restricted to specific products that are produced under conditions of significant economies of scale. This situation changed considerably from 1990 to 2004, as a domestic shortage made it necessary to import large volumes of unprocessed plasma. Furthermore, domestic demand for plasma is predicted to more than double over the next decade. In order for Australia to meet this demand and achieve its goal of self-sufficiency, collections of blood by the ARCBS will be required to increase by 123 percent, which represents a growth rate in donations of approximately 8 percent per annum (Plasma Fractionation Review Committee 2006).

Fortunately, there is considerable scope to increase the donation rate, since only 3.5 percent of eligible Australians are registered blood donors and only 60 percent of first time donors return within two years (Plasma Fractionation Review Committee 2006). Nonetheless, the achievement of such a large increase in voluntary donations will require innovative policies to attract new donors, as well as the careful management of existing donors.

3.2 The experience of blood donation

The donation experience may be thought of as beginning when a potential donor first makes contact with the ARCBS, which usually occurs online or over the phone. If interest is expressed in donating blood, the donor is informed of the centres that are most conveniently located, and asked if she would like to make an appointment.

Upon arrival at the donation centre, a donor *without an appointment* may or may not be accepted, depending on the schedule of the centre. Assuming acceptance, a donor is asked to present photographic identification and is required to complete an eligibility form. For a first time donor, the completion of this form takes considerably longer, as more detailed questions are asked about the donor's lifestyle. Once the form is returned, the donor is asked to wait in the first of two waiting rooms (this is referred to as *Wait 1* in the empirical analysis). The donor is then interviewed by an ARCBS staff member, in order to check the details of the eligibility form and to ask more questions if necessary. The primary purposes of both the form and the interview are to ensure that the donor is fit to donate and that the donor's lifestyle does not present a risk to the recipient of the blood. Upon completion of the interview, an eligible donor is escorted to a second waiting room (referred to as *Wait 2*), after which the blood draw begins.

At this point, the experience of a *plasma* donor differs considerably from that of a *whole blood* donor. Most importantly, the process of plasma donation requires approximately 40 minutes, whereas a whole blood donation requires less than 10 minutes. It is for this reason that plasma donors are given priority in the wait queue. The major advantage of plasma donation is that red blood cells are constantly returned to the donor, which means that a much larger volume can be extracted and that the donor can return every two weeks, as opposed to every twelve weeks for whole blood. Plasma donors therefore tend to be the most frequent and valuable of blood donors.

Once the blood draw is complete, donors are escorted to the recovery area, where they are offered refreshments and asked to remain for at least ten minutes. In order to minimise the inconvenience both to staff and to donors, this was chosen as the most appropriate time to administer the donor survey, which is further discussed in Section 4.4. Providing that no side-effects are observed, this marks the end of the donation process.

4 Datasets

The ARCBS has generously provided extensive datasets on donations, donor characteristics and appointments. In addition, a survey of 1461 blood donors was conducted. All four of these databases can be linked using a unique unidentifiable donor ID code that the ARCBS created for this project. This section commences with a discussion of the three aggregate databases, followed by an explanation of the donor survey and the information that it provides. Descriptive statistics are provided in Appendix A.

4.1 ARCBS donation data

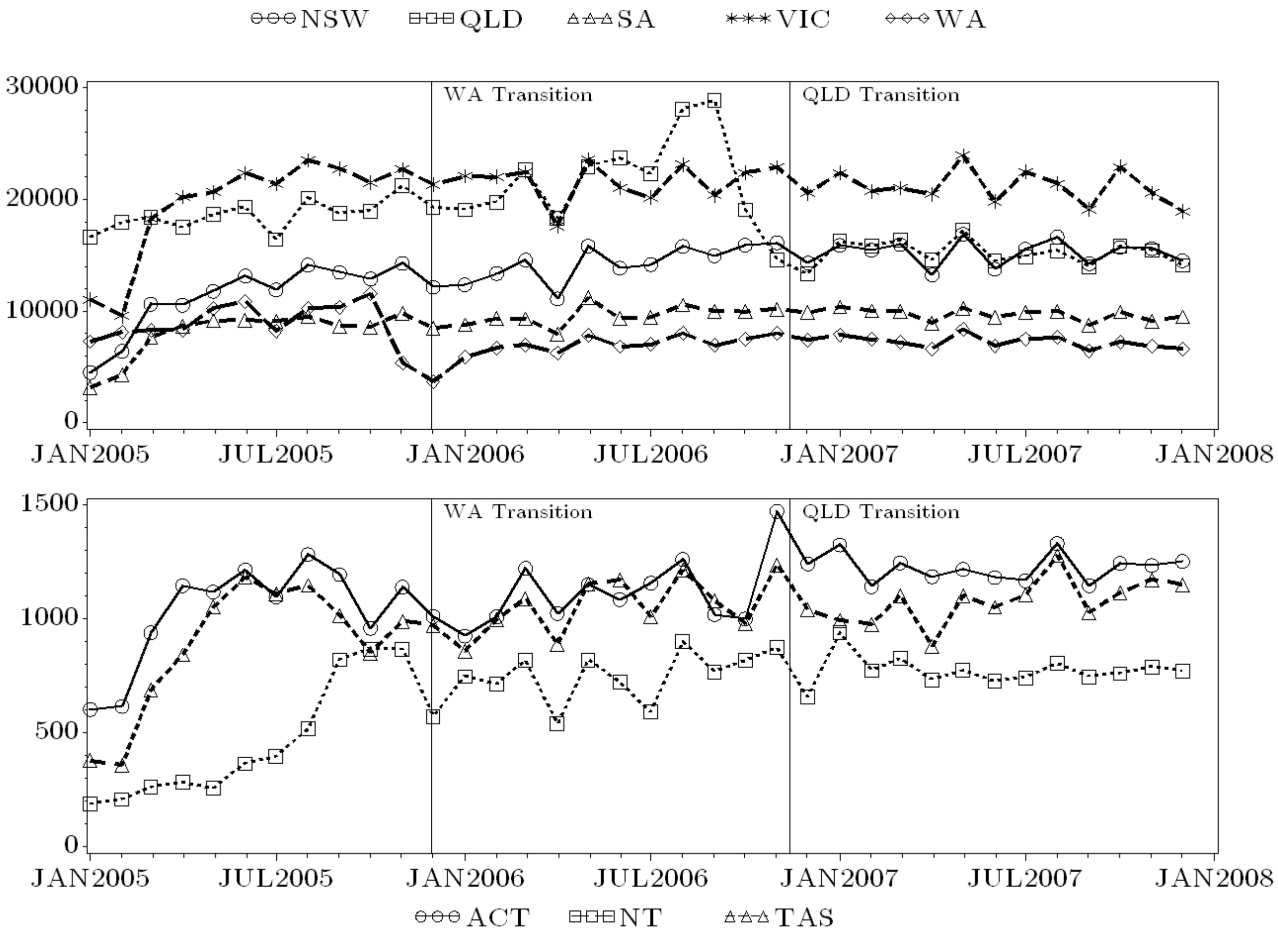
Table 1 describes the ARCBS donation database, which contains approximately 9.5 million donations from all Australian states and territories. The variables *ID*, *Type* and *Date* are required to link the databases and classify the survey responses according to the type of donation.

Table 1: Catalogue of Donation Variables

Variable	Description
ID	The donor's unique non-identifiable ID number.
Centre	The centre at which the donation occurred.
Count	Cumulative total of donations to date.
Date	The date of attendance.
Mode	Whether the donation occurred at a fixed or mobile centre.
Type	The type of donation (e.g. whole blood or plasma).
Result	Result of donation (success or reason for failure).
Deferral	Dates between which the donor has been deferred.

Figure 1 shows the monthly frequencies of donations by state, from January 2005 to December 2007. Since there are very large differences between states, the graph has been divided into two panels. The first panel shows the five largest states, while the lower panel shows the smaller states and territories, using a reduced scale.

Figure 1: Monthly Donation Count Over Time (Whole Blood Donors Only)



For most states, the donation records appear to be complete from April 2005, as suggested by sudden rises in the monthly volume of donations and confirmed by an examination of donors' cumulative donation counts. The lack of data in earlier periods is due to a gradual transition by the ARCBS from individual databases in each state to a unified national system. Table 2 contains the approximate dates from which the data appear complete, along with the policy transition date for each state. This table indicates that only the Western Australian (WA) and Queensland (QLD) transitions occurred at a time when records are sufficiently comprehensive for reliable analysis. In Figure 1, the exact times of each transition are indicated by the two vertical lines labelled *WA Transition* and *QLD Transition*.

TABLE 2: POLICY TRANSITION DATES

State	Policy Transition Date[a]	Month from which data appear clean[b]
Australian Capital Territory	29/06/2004	April 2005
New South Wales	29/06/2004	July 2005
Northern Territory	29/11/2005	October 2005
Queensland	13/11/2006	October 2004
South Australia	26/05/2003	April 2005
Tasmania	26/07/2004	April 2005
Victoria	17/02/2005	April 2005
Western Australia	29/11/2005	February 2004

[a] Obtained through correspondence with the ARCBS.
[b] Based on monthly donation frequencies and correspondence with the ARCBS.

Figure 1 shows that the monthly frequencies are extremely volatile, but that the states generally move together over time. However, there was an unusually large increase in the donation rate in Queensland from July to September 2006 and a smaller build-up in Western Australia from August to October 2005. In both cases, the rises were followed closely by sharp falls. The donation rates then stablised at permanently lower levels. The policy transitions occurred almost exactly at the times of these troughs.

One explanation of these dynamics is that they were caused by the implementation of the appointment policy. However, a change of almost 50 percent seems too large to have been caused by compulsory appointments alone. Furthermore, the initial peak in donations in each state occurred several months prior to transition. While it possible that donors learned of the appointment policy before it was implemented, none of the hypothesised mechanisms seem capable of explaining such a large effect so far in advance[2]. An alternative possibility is that the changes were caused by an exogenous event, such as a natural disaster. However, news articles at the times of the Western Australian and Queensland transitions do not reveal any large scale state-specific events.

Although it is unlikely that the policy transitions are responsible for the observed changes in donation patterns, the fact that a convincing alternative explanation has not been found means that this possibility cannot be ruled out. This uncertainty influenced the choice to use an individual level Probit model for the difference-in-difference analysis, which is more robust to aggregate volatility than an analysis of donation frequencies. Section 5 discusses the choice of empirical strategy in more detail.

4.2 ARCBS donor data

The donor database contains characteristics of approximately two million blood donors, including all those who have donated during the time period of this study. The information in each record is summarised in Table 3. Most critical to this thesis is the donor's state of residence, which is required to classify donations for the difference-in-difference analysis.

[2] It is unlikely that donors were aware of the policy in advance, since they would have been informed on the day of their first post-transition communication with the ARCBS.

Table 3: Catalogue of Donor Characteristics

Variable	Description
ID	The donor's unique non-identifiable ID number.
Birth Year	The donor's year of birth.
Deceased	A binary variable to indicate that the donor is deceased.
Postcode	The donor's postcode.
Suburb	The donor's suburb of residence.
State	The donor's state of residence.
Stop Reason	The reason for stopping, if the donor has stopped donating.
Weight	The donor's weight in kilograms.

4.3 ARCBS appointment data

The final dataset contains official ARCBS appointment records, which are complete from at least 2007. In addition to the date and time of the appointment, each observation contains a record of whether or not the donor arrived, as well as the centre for which the appointment was made.

Table 4: Catalogue of Appointment Variables

Variable	Description
ID	The donor's unique non-identifiable ID number.
Centre	The centre for which the appointment was made.
Date	The date of the appointment.
Time	The time of the appointment.
Attendance	Whether or not the donor attended the appointment.

When linked to the donation database, this information makes it possible to test the theory that the adoption of an appointment increases the likelihood that a donor will go through with a donation. In combination with Australia-wide wait time data, it could also be used to formulate a large sample test of the effect on donation behaviour of the interaction between longer wait times and appointments[3].

[3]The wait time dataset is forthcoming and will be utilised for further research.

4.4 Survey of blood donors

4.4.1 Design of the survey

While the aggregate ARCBS datasets are useful independently, full tests of the hypotheses suggested by the literature require more information. Most importantly, measures of donor satisfaction are required, along with estimates of perceived and expected wait times and information about appointments made both before and after donation. In order to obtain this information, a survey was administered to a large sample of donors. The most important variables that were collected are summarised in Table 5 and a copy of the survey is attached.

The variables that were collected can be broadly classified into four categories. First, donors were asked about their satisfaction with the overall donation experience and the acceptability of the total length of wait time. As a measure of future intentions, donors were asked to report the likelihood that they would return within six months.

The second set of questions asked for a series of wait time estimates, including the perceived length of time spent in each of the two waiting rooms and the total time taken from arrival at the centre to entering the recovery room. In addition, donors were asked for their prior expectations of each of these times. This information is essential to test the theory that the interaction of appointments with longer wait times could reduce satisfaction.

A third group of questions was used to collect information about appointments. Most importantly, donors were asked whether or not they had an appointment on arrival, how early or late they arrived, whether or not they were *asked* to make an appointment for their next donation and whether or not they *did* make an appointment. While official appointment data are

Table 5: Summary of Selected Survey Variables[a]

Variable	Survey Question
New Donor	*New Donor (Yes/No)*
Appointment	*Did you have an appointment today? (Yes/No)*
Appointment Time	*If yes, what time was your appointment?*
Early / Late	*And when did you arrive? (Before your appointment time / on time / after your appointment time)*
How Early/Late	*If so, how many minutes before / after?*
Wait 1 (Expected)	*Before arriving, how long did you expect to wait before your eligibility interview? (in minutes)*
Wait 1 (Perceived)	*Without looking at the time, how long do you think you actually waited before your eligibility interview? (in minutes)*
Wait 2 (Expected)	*Before arriving, how long did you expect to wait from the end of your eligibility interview until the beginning of the blood draw? (in minutes)*
Wait 2 (Perceived)	*Without looking at the time, how long do you think you actually waited from the end of your eligibility interview until the beginning of the blood draw? (in minutes)*
Acceptability of Wait	*How acceptable was the total wait time you experienced today? (1=Completely Unacceptable to 7=Completely Acceptable)*
Overall Satisfaction	*How satisfied were you with the overall experience today? (1=Not at All Satisfied to 7=Completely Satisfied)*
Likelihood of Return	*What is the likelihood that you will donate again in the next 6 months? (0=No Chance to 7=Practically Certain)*
Wait Time Comparison	*If you have donated in the past, how did your wait time today compare to a typical past visit? (1=Previously Much Shorter to 7=Previously Much Longer)*
Wait Time Vs Peer	*How did your wait time today compare to the wait time of the other people in the waiting room? (1=Waited Less Than Others to 4=Same to 7=Waited More Than Others)*
Asked to Make Appt	*Were you asked to make an appointment for a future donation? (Yes/No)*
New Appointment	*If yes, did you make (or will you be making) an appointment? (Yes/No)*
# Others Waiting	*How many other people were waiting to donate while you were waiting to donate today?*
Time Pressure (Now)	*How time-pressured do you feel currently? (1=Minimal Time Pressure to 7=Intense Time Pressure)*

[a] A copy of the full donor survey is attached.

also available, these records are less detailed and significantly less accurate, compared to the information produced by the survey. In particular, 19 percent of donors who report themselves as having an appointment are not registered in the official records[4].

The remaining questions in the survey were used to create control variables. In accordance with the suggestions of Maister (1985), measures of the donor's emotional state were collected, along with questions about the handling of delays by ARCBS staff, the presence of diversions and membership of a larger group of donors. In order to test for different types of reference dependence, questions were included to measure the *relative* length of wait time, compared to other donors and to previous experience. In addition, several questions were asked about time pressure and about donors' attitudes toward blood donation and the ARCBS.

4.4.2 Administration of the survey

The collection of the survey data occurred from July 6 to July 31, 2009. Throughout this period, five researchers were sent to four donation centres across Sydney, collecting a total of 1461 surveys. During the times that a researcher was present, an attempt was made to survey all donors. A meticulous record was kept of the donors who either declined to participate or were not able to be approached. Due to the nature of the target audience and the convenient timing of the survey, the researchers were able to achieve an extraordinary 96.7 percent response rate, which will have essentially mitigated response bias.

[4]The discrepancy between official records and donors' reports is partially due to the inability of the official system to capture the identity of donors who make an appointment as a group.

The survey process typically proceeded as follows. When a donor exited the donation room and entered the recovery area, a short period was allowed for the donor to order and receive refreshments. Once the refreshments arrived, the donor was approached, using the following script as a guide:

> Hello, my name is [Researcher's Name]. I am working on a research project for the University of Sydney to improve blood donor services. I was wondering if I might ask you to complete a short survey concerning your blood donation experience today. To participate, you must be at least 18 years old and comfortable completing a survey in English. The survey asks no personal questions and will take approximately 5–10 minutes.

If the donor agreed to participate, then a copy of the survey was provided, along with a *Participant Information Statement*, which included contact details and additional information about the study, and emphasised that that participation was strictly voluntary. With the cooperation of ARCBS staff, the donor's unique ID code was also included on the survey, to facilitate the linking of survey responses to the aggregate datasets. Any donor who declined to participate was thanked and a note was made of the time and date of rejection.

While selection bias will have been minimised by the very high response rate, it is impossible to eliminate entirely. First, the problem remains that a significant fraction of donors did not provide a usable response for some questions. Second, the 3.3 percent of donors who did not participate were usually missed when the centres were busiest and wait times longest. Finally, a conscious attempt was made to minimise the cost of the data collection by administering the surveys at times when a large volume of donors was anticipated. However, while both of the last two factors will have influenced average wait times, it is unlikely that donors' *reactions* to a unit increase in wait time will have been affected. Furthermore, the number of other donors waiting is explicitly controlled for in the data analysis.

4.4.3 Entry and cleaning of the data

Once collected, as many surveys as possible were entered electronically, producing a database of 1185 donations. While not every survey has been entered, all successful donations have been included[5]. In order to minimise errors, each response was entered multiple times, filtered with a VBA script and further cleaned manually. Finally, the data were linked to all available aggregate information using the donor's unique ID code. At this stage, additional surveys were removed due to linking problems and the sample was truncated to include only whole blood and plasma donors, producing a final pool of 916 observations for analysis.

[5]Analysis of surveys from deferred donors will be included in a future study.

5 Results

5.1 The aggregate effect of the appointment policy

The first step of the data analysis is to examine the aggregate effect of the appointment policy by comparing donations before and after it was implemented in each state. As discussed in Section 4.1, data availability means that it is only possible to analyse the transitions in Western Australian and Queensland. The first part of this section explains the empirical strategy, followed by an analysis of the results.

5.1.1 Empirical strategy

For each state's transition, the analysis is divided into two components. First, the likelihood of return is compared for donors who were required to make an appointment for a repeat donation and those who were not, conditional on all donors having donated before the policy transition. Second, the likelihood of return of a donor who was required to make an appointment for both her initial and repeat donations is compared to that of a donor who was not required to make an appointment for either donation. The second analysis thus captures the entire effect of compulsory appointments.

These comparisons are made using three groups of whole blood donors, as defined in Table 6. Each cohort is made up of donors who are initially observed to have donated during a different fifty day period. As whole blood donors, they were then required by the ARCBS to wait at least 84 days before donating again. The dependent variable of the regressions is set to one if the donor returned within 50 days of eligibility and zero otherwise.

Let T be the date of transition for each state. The first cohort of donors (Pre

$\Rightarrow$ Pre) is initially observed to have donated between $T - 214$ and $T - 164$. A donor who initially donated at $T - t$ ($164 \leq t \leq 214$) became eligible to donate again at $T - t + 84$. The dependent variable is therefore set to one if the donor returned within 50 days of this date ($T - t + 84$ to $T - t + 134$). For example, a donor who initially donated at $T - 214$ became eligible to return at $T - 130$, so the dependent variable is set to one if the donor returned between $T - 130$ and $T - 80$. Similarly, a donor whose initial donation was on the final day of the period became eligible at $T - 80$, so the dependent variable is set to one if a repeat donation occurred between $T - 80$ and $T - 30$. This entire process finishes 30 days before the implementation of the appointment policy. Providing that donors did not learn of the policy more than 30 days in advance, this implies that the transition should not have affected their donation decisions.

TABLE 6: DONOR GROUPS FOR DIFFERENCE-IN-DIFFERENCE

	Period of Initial Observed Donation	50 Day Window for First Donors	50 Day Window for Last Donors
Pre $\Rightarrow$ Pre	$T - 214$ to $T - 164$	$T - 130$ to $T - 80$	$T - 80$ to $T - 30$
Pre $\Rightarrow$ Post	$T - 80$ to $T - 30$	$T + 4$ to $T + 54$	$T + 54$ to $T + 104$
Post $\Rightarrow$ Post	T to $T + 50$	$T + 84$ to $T + 134$	$T + 134$ to $T + 184$

An almost identical method is used to create the dependent variable for the other two groups. For the Pre $\Rightarrow$ Post group, the initial donation occurred before the policy was implemented (T–80 to T–30). However, the first of these donors only became eligible to return *after* the transition (T+4). Finally, for the Post $\Rightarrow$ Post group, both the initial and repeat donations occurred after the date of implementation.

If the effect of the policy was immediate, then both the Pre $\Rightarrow$ Post and Post $\Rightarrow$ Post groups will have been influenced by the change. However, a donor in the former group can only have been affected by the requirement to make an appointment, whereas a donor in the Post ⇒ Post group may have been affected through the initial donation experience as well. In each part of the analysis, the likelihood of return of a donor in one of these two groups is compared to that of a donor in the Pre ⇒ Pre group.

For each comparison, the following individual level Probit difference-in-difference regression is specified:

$$
\begin{aligned}
&Pr(y_i = 1 | P_i, S_i, x_1 \ldots x_n) \\
&\qquad = \Phi(\alpha + \beta_1 P_i + \beta_2 P_i S_i + \gamma_1 x_1 + \ldots + \gamma_n x_n) \qquad (12)
\end{aligned}
$$

where Φ is the cumulative distribution of a standard normal random variable, P_i is a dummy variable to indicate whether the policy had been implemented ($P_i = 1$) or not ($P_i = 0$) for each observation, $S_i = 1$ for all observations from the state undergoing the transition and zero otherwise, and $x_1 \ldots x_n$ are control variables, including a dummy variable for all states except the transition state.

The key effect for this analysis is the interaction between the policy (P_i) and treatment (S_i) variables, which captures the difference between the change in donation behaviour that occurred in the treatment state (the state in the process of implementing the policy) and the contemporaneous change that occurred in the reference states, which did not experience the transition at this time. Thus, the critical parameter estimate in each regression is the coefficient β_2 of the interaction $P_i S_i$.

Finally, each regression is run six times, in order to isolate the impact on donors of differing regularity. First, the model is estimated for all whole blood donors, with and without control variables. Subsequent regressions then subdivide donors into four categories. The first of these examines new donors, while the last three divide repeat donors into those who had donated zero, one or two times in the six months before the initial 50 day window.

5.1.2 The Queensland transition

Table 7 presents the results for the Queensland transition. This table contains only the marginal effect of the QLD*Policy interaction for each regression, while the full sets of estimates are included in Appendix B. Since data are available in all states during this period, the changes in Queensland are compared to the contemporaneous change in all other states and territories, all of which implemented the policy at least one year before Queensland. An econometric assessment of the results will now proceed, while a discussion of practical implications is left to Section 6.

Table 7: Policy Transition in Queensland[a]

	Compared to All Other States	
	Pre⇒Post vs Pre⇒Pre	Post⇒Post vs Pre⇒Pre
All (No Controls)	–8.65%***	3.94%***
	(n=192185)	(n=181038)
All (Controls)	–8.84%***	3.32%***
	(n=192185)	(n=181038)
New Donors	–6.63%***	6.98%***
	(n=29701)	(n=25519)
Zero Donations	–8.46%***	–0.68%
	(n=53414)	(n=45978)
One Donation	–8.72%***	4.22%***
	(n=81220)	(n=79234)
Two Donations	–11.89%	3.17%***
	(n=27855)	(n=30307)

[a] Reported values are the average marginal effects of the Queensland*Policy interaction. Whole blood only. * indicates significance at the 10% level, ** at the 5% level and *** at 1%. Sample sizes in brackets. More details available in Appendix B.

The estimated effect of a donor having to make an appointment (Pre ⇒ Post vs Pre ⇒ Pre) is strongly and consistently negative and significant at the one percent level in five of the six regressions. The lack of statistical significance of the parameter for the most frequent donors appears to be due to the much lower variation in the likelihood of return, which reduces the power of the regression[6]. The policy is estimated to have reduced the likelihood that a donor returned within 50 days of eligibility by 8.84 percent across the entire population of whole blood donors, while the effect is slightly smaller for new donors and larger for more frequent donors.

The estimate of the overall effect of the policy (Post $\Rightarrow$ Post vs Pre $\Rightarrow$ Pre) is generally positive, with all except one of the coefficients significant at the one percent level. The likelihood of return within 50 days of eligibility is estimated to have increased by 3.32 percent. While a negative estimate is produced for repeat donors who have not recently donated, this effect is small and is not significantly different from zero. In contrast to the previous comparison, the effect is estimated to be largest for new donors, with no consistent pattern across different types of repeat donors.

5.1.3 The Western Australian transition

The analysis of the Western Australian transition is divided into two parts, in anticipation that the measured effect of the transition could differ if the reference states had already implemented the policy and were still adjusting to the change. The first set of regressions compare Western Australia to Queensland, which had not adopted the policy at this time. The second set uses four other reference states, all of which transitioned well before Western Australia (April 2005). The marginal effects of the WA*Policy interaction are summarised in Table 8, while the full sets of estimates are available in Appendix B.

[6] This is also reflected in the low miscalculation rate for this regression (see Table 16), which is due to the fact that frequent donors are unconditionally very likely to return.

Table 8: Policy Transition in Western Australia[a]

	Compared to Queensland		Compared to VIC, ACT, TAS & SA	
	Pre⇒Post vs Pre⇒Pre	Post⇒Post vs Pre⇒Pre	Pre⇒Post vs Pre⇒Pre	Post⇒Post vs Pre⇒Pre
All (No Controls)	–1.17%	7.60%***	–2.16%***	5.50%***
	(n=65573)	(n=64555)	(n=140897)	(n=140189)
All (Controls)	–1.65%*	7.78%***	–2.10%**	3.22%***
	(n=65573)	(n=64555)	(n=140897)	(n=140189)
New Donors	–2.35%	3.62%	0.07%***	–0.26%
	(n=9242)	(n=8168)	(n=18495)	(n=16708)
Zero Donations	–0.17%	10.94%***	9.64%***	11.43%***
	(n=18835)	(n=18873)	(n=52129)	(n=52555)
One Donation	–5.53%***	6.06%***	0.98%	5.70%***
	(n=27604)	(n=27720)	(n=54707)	(n=54570)
Two Donations	–9.98%***	2.67%	2.25%	–2.65%
	(n=9897)	(n=9794)	(n=15585)	(n=16357)

[a] Reported values are the average marginal effects of the WA*Policy interaction. Whole blood only. * indicates significance at the 10% level, ** at the 5% level and *** at 1%. Sample sizes in brackets. More details available in Appendix B.

The results for the Western Australian regressions are not as robust as those for Queensland, although the dynamics are qualitatively similar. The estimates of the effect of having to make an appointment (Pre ⇒ Post vs Pre ⇒ Pre) are consistently negative when Queensland is used as a reference state, which agrees with the findings for the Queensland transition. However, the marginal effect of the policy across all whole blood donors is only –1.17 percent, which is much weaker than the estimate for Queensland. Furthermore, only two of the estimates are statistically significant at a high level. In particular, the estimate for infrequent returning donors is approximately zero and statistically insignificant. As before, the effect is weaker for new donors and stronger for more frequent donors.

The third column of Table 8 contains the marginal effects of having to make an appointment (Pre ⇒ Post vs Pre ⇒ Pre) using Victoria, Tasmania, South Australia and the Australian Capital Territory as reference states. The results from these regressions are not nearly as consistent. In particular, the policy is estimated to have reduced the likelihood of return across the entire cohort of whole blood donors, while the estimates for each of the four subgroups are positive, although not always statistically significant. Table 17 shows that the intercepts for each of the states are also much lower in the aggregated regressions, while the change in donation behaviour in the reference states is statistically significantly higher. A possible explanation of these results is that an important variable has been omitted, which is correlated with both the frequency of donation and the policy transition dummy in the reference states. This would only have affected the full regressions and not the results for each subgroup.

The third set of results to be discussed are the estimates of the overall effect of the policy (Post $\Rightarrow$ Post vs Pre $\Rightarrow$ Pre) using Queensland as a reference state. These are summarised in the second column of Table 8. The results here are broadly similar to those for the Queensland transition, with consistently positive marginal effects. However, the policy is estimated to have increased the likelihood of return by approximately 7.78 percent, which is much larger than the effect that was found for Queensland. Furthermore, the effect of the policy is estimated to be lower for both new donors and the most frequent of donors and neither of these two coefficients are statistically significant. This does not agree with the findings from regressions with the same subgroups in Queensland.

The final column of Table 8 shows the estimates of the overall effect of the policy (Post $\Rightarrow$ Post vs Pre $\Rightarrow$ Pre) using the four states that had already transitioned as reference states. As before, these results are not quite as consistent as for the comparison to Queensland, with a negative estimate produced for two groups of donors. However, neither of the negative estimates are statistically different from zero, while all four positive estimates are significant at the one percent level. Overall, the appointment policy is estimated to have increased the likelihood of return by approximately 3.22 percent, with a smaller effect for new and very frequent donors. This is consistent with the earlier findings for Western Australia, but not with the analysis of the Queensland transition.

5.1.4 Robustness of the results

A potential problem with the difference-in-difference analysis is that the large fluctuations in the aggregate series may have biased the results if the observed changes were not due to the policy. While the specification of individual-level regressions will have minimised the impact of such a problem, the direction of the estimates are those that would be expected from regressions that are driven by the same events that caused the changes in levels in each state. This is a limitation of the results presented here, but one which cannot be solved until more data become available from earlier years. When additional data do become available, several other transitions will be examined to determine whether the findings for Queensland and Western Australia can be generalised to the rest of Australia.

The second problem that needs to be highlighted is that only three control variables were available to include in these regressions. As a result, despite very large sample sizes, much of the propensity to donate remains unexplained[7]. Furthermore, if any of the omitted variables are correlated with both the treatment variable and the likelihood of return, the estimates will be biased. However, this problem can only be solved through the addition of more control variables, which are not available at present.

[7] This can be seen from the misclassification rates, which are reported in Appendix B.

5.2 Survey data analysis

This section isolates two individual mechanisms that are suggested in the literature. The first theory to be tested is that donors with appointments will expect shorter wait time and that the interaction between appointments and longer wait time could therefore negatively affect a donor's satisfaction and likelihood of return. This is followed by an assessment of the hypothesis that the adoption of an appointment could directly increase the probability of return. Except where otherwise specified, the analysis is restricted to whole blood donors, since almost all plasma donors have appointments and because there is much less variation in wait time for these donors.

Section 5.2.1 assesses the effect of appointments on expected and perceived wait time. Sections 5.2.2 to 5.2.4 then examine the effect of the interaction between wait time and appointments on satisfaction, self-reported likelihood of return and the probability that a donor will make an appointment for a subsequent donation. Finally, Probit and survival models are used to assess whether the same dynamics affect subsequent behaviour (Section 5.2.5). These final regressions are also used to test the hypothesis that the acceptance of an appointment directly increases the probability of return.

Throughout the analysis, the regressions have been refined by dropping insignificant variables, except where their removal caused significant changes in other parameter estimates. The choice between functional forms was made primarily with reference to the *Akaike Information Criterion* (AIC). In all cases, wait time in logarithmic form performed best, despite the disadvantage that donors with zero wait times are dropped from the analysis[8]. In most cases, only one specification for each test is presented.

[8] Approximately 4.5 percent of donors reported zero wait times. However, the removal of these observations did not cause qualitative changes in the estimates.

5.2.1 Expectations and perceptions of wait time

The analysis of expected and perceived wait time is performed using linear regressions with log dependent variables, which are replicated for each component of wait time. The first component (*Wait 1*) is defined as the time between arrival and the start of the eligibility interview, while the second stage (*Wait 2*) is the time between the end of the interview and the start of the blood draw. In each case, the following model is estimated:

$$ln(y_i) = \alpha + \beta_1 A_i + \beta_2 A_i E_i + \gamma_1 x_1 + \ldots + \gamma_n x_n + \epsilon_i \tag{13}$$

where $A_i = 1$ if a donor has an appointment and zero otherwise, E_i is an indicator of whether a donor arrived early to her appointment ($E_i = 1$) or not ($E_i = 0$) and $x_1 \ldots x_n$ are control variables, including the number of other people in the waiting room and centre-specific intercepts[9].

TABLE 9: EXPECTED WAIT TIME[a]

	Average Effect of Appointment		Interaction with Early Arrival	
	ln(Wait1)	ln(Wait2)	ln(Wait1)	ln(Wait2)
Appointment	–8.56%	–20.36%***	–16.18%**	–21.62%***
	(6.17%)	(6.34%)	(6.77%)	(7.02%)
Appointment*Early	–	–	14.21%***	2.32%
	–	–	(5.34%)	(5.54%)
# Others Waiting	2.40%***	1.32%*	2.40%***	1.32%*
	(0.69%)	(0.72%)	(0.69%)	(0.72%)
Sample size	649	655	649	655
R^2	2.59%	8.04%	3.65%	8.06%

[a] Marginal effects from OLS regressions with log dependent variables. Whole blood only. Centre intercepts not reported. * indicates significance at the 10% level, ** at 5% and *** at 1%. Percentage standard errors in brackets.

The first two columns of Table 9 show that the adoption of an appointment is associated with a reduction in expectations of both first and second stage wait time. More specifically, donors with appointments are estimated to

[9] These are the only control variables that were found to be significant.

expect an 8.56 percent shorter first stage and a 20.36 percent shorter second stage wait time. However, the last two columns show that the first stage effect is significantly different for donors who arrive before their appointment times. While donors who arrive on time or late to their appointments are estimated to expect a 16.18 percent shorter first stage wait, those who arrive early expect only a 1.97 percent reduction ($-1.97 = -16.18 + 14.21$).

An intuitive explanation of this phenomenon is that donors do not expect to be served before the time of their appointment. However, direct tests of this hypothesis do not support such an explanation. In regressions not shown here, wait time was divided into the components before and after a donor's appointment time, to test whether the changes in expectations were significantly different for each component. Several specifications were attempted, including regressions with separate log or level variables and the division of a single log variable into two parts. In none of these specifications was it possible to reject the null hypothesis that the true parameters are the same before and after the appointment time. While the correct specification may still not have been found, the evidence so far suggests that early arrival changes the perception of the entire length of wait time, rather than only the part that occurs before the time of a donor's appointment.

Table 10 shows that the acceptance of an appointment is not associated with a decrease in *perceived* wait time, while the relative increase in expected wait time for donors who arrive early is almost exactly matched by an increase in the perceived wait. When combined, these estimates imply that, for all donors, acceptance of an appointment tends to have a more negative (or less positive) effect on expected than perceived wait time. This is an important preliminary indication that donors with appointments may be more negatively affected by longer waits.

Table 10: Perceived Wait Time[a]

	Average Effect of Appointment		Interaction with Early Arrival	
	ln(Wait1)	ln(Wait2)	ln(Wait1)	ln(Wait2)
Appointment	7.59%	4.81%	–0.25%	2.86%
	(8.37%)	(8.30%)	(9.24%)	(9.22%)
Appointment*Early	–	–	14.65%**	3.53%
	–	–	(7.39%)	(7.27%)
# Others Waiting	14.27%***	8.50%***	14.30%***	8.50%***
	(0.96%)	(0.93%)	(0.96%)	(0.93%)
Sample size	634	656	634	656
R^2	26.34%	16.25%	26.80%	16.28%

[a] Marginal effects from OLS regressions with log dependent variables. Whole blood only. Centre intercepts not reported. * indicates significance at the 10% level, ** at 5% and *** at 1%. Percentage standard errors in brackets.

It is important to highlight that only a small part of the variation in expectations is explained by the models presented here. Furthermore, none of the regressions are significantly improved by the inclusion of additional control variables from the ARCBS datasets or the survey responses. Finally, it is interesting to note that donors' estimates of *expected* wait time are significantly influenced by the number of other people waiting. While donors were specifically asked to report their expectations prior to arrival, this indicates that some donors have interpreted the question differently. Nonetheless, while these problems will unavoidably have affected the precision of the estimates, the qualitative results should not have been distorted.

5.2.2 Satisfaction with wait time

The next stage of the analysis examines the effect of the interaction between appointments and wait time on the *Acceptability of Wait Time* and *Overall Satisfaction*. As both of these variables are measured with discrete scales from one to seven, Ordered Probit models are estimated:

$$\begin{aligned}
Pr(y_i = 1|\boldsymbol{x}_i) &= \Phi(-\alpha - \boldsymbol{\beta}'\boldsymbol{x}_i) \\
Pr(y_i = 2|\boldsymbol{x}_i) &= \Phi(\mu_2 - \alpha - \boldsymbol{\beta}'\boldsymbol{x}_i) - \Phi(-\alpha - \boldsymbol{\beta}'\boldsymbol{x}_i) \\
Pr(y_i = 3|\boldsymbol{x}_i) &= \Phi(\mu_3 - \alpha - \boldsymbol{\beta}'\boldsymbol{x}_i) - \Phi(\mu_2 - \alpha - \boldsymbol{\beta}'\boldsymbol{x}_i) \\
&\vdots \\
Pr(y_i = 7|\boldsymbol{x}_i) &= 1 - \Phi(\mu_6 - \alpha - \boldsymbol{\beta}'\boldsymbol{x}_i)
\end{aligned}$$

where Φ is the cumulative distribution of a standard normal random variable, $\mu_2 \dots \mu_6$ are the thresholds of the latent variable (μ_1 is normalised to zero), and $\boldsymbol{x}_i$ is the vector of covariates.

The first three columns of Table 11 present the marginal effect of each variable on the probability that wait time is 'completely acceptable' ($y_i = 7$). As expected based on the previous analysis, wait time is more negatively perceived by donors with appointments, compared to those without. However, the effect is far weaker for donors who arrive early. More specifically, a one percent increase in the wait time of a donor without an appointment is estimated to reduce the probability that a donor reports her wait time to be 'completely acceptable' by 14.36 percent. For a donor with an appointment and who is on time or late, this effect is approximately doubled to –28.69 percent. Finally, the estimate for a donor who is early to her appointment is only 0.9 percent lower than for a donor with no appointment.

Table 11: Satisfaction and Self-reported Likelihood of Return[a]

	Acceptability of Wait Time[b]				Self-reported	Likelihood of Making a New Appointment[e]		
	Average Wait Effect	Average Appt Effect	Interaction with Early	Overall Satisfaction[c]	Likelihood of Return[d]	Full Sample	Certain of Return[f]	All Other Donors
ln(Wait1)	–21.50%***	–14.46%***	–14.36%***	–0.10%	3.56%	9.63%**	15.37%**	1.57%
ln(Wait2)	–5.75%***	–6.29%***	–6.18%***	–2.22%	–1.80%	–	–	–
Appointment (Today)	–7.16%*	5.35%	24.99%**	41.86%***	25.06%***	41.77%***	55.11%***	14.27%
Appointment*Early	–	–	–29.99%***	–28.40%***	–13.03%	–	–	–
ln(Wait1)*Appt	–	–5.61%	–14.33%***	–19.47%***	–8.85%**	–8.27%*	–12.03%*	–1.20%
ln(Wait1)*Appt*Early	–	–	13.43%***	10.49%**	8.91%**	–	–	–
ln(Wait1)*UnusuallyLong	–	–4.42%***	–4.19%***	–2.96%**	–2.37%	–	–	–
ln(Wait1)*LongVsPeer	–	–2.38%	–2.57%	–4.71%**	–0.70%	–	–	–
ln(Wait1)*NewDonor	–	–	–	–	–5.86%***	–	–	–
Asked to Make Appt	–	–	–	–	–	41.56%***	42.88%***	31.48%***
Time Pressure (Now)	–5.39%***	–5.18%***	–5.32%***	–3.88%***	–2.12%**	0.53%	1.16%	1.05%
Age	0.13%	0.10%	0.09%	–0.08%	0.59%***	0.25%**	0.11%	0.26%
Male	–	–	–	–	–9.20%***	–8.29%**	–11.35%***	2.61%
Sample size	599	599	599	594	599	620	459	161
Misclassification[g]	46%	45%	44%	34%	26%	21%	22%	20%

[a] Average marginal effects from Probit or Ordered Probit regressions. Whole blood only. Centre intercepts not reported. * indicates significance at the 10% level, ** at the 5% level and *** at the 1% level.
[b] This variable can take a value from 1 (completely acceptable) to 7 (completely unacceptable).
[c] This variable can take a value from 1 (not at all satisfied) to 7 (completely satisfied).
[d] This variable can take a value from 0 (no chance of return) to 10 (practically certain to return).
[e] This variable is equal to 1 if the donor made an appointment for their next donation and zero otherwise.
[f] This regression includes only donors who are 'practically certain' of return.
[g] The percentage of incorrect predictions of the models.

The fourth column of Table 11 shows that the most important dynamics also extend to satisfaction with the overall experience. Interestingly, longer wait times do not have a strong effect on overall satisfaction for donors without appointments. However, for donors with appointments who are on time or late, a one percent increase in wait time is associated with a 19.57 percent total decrease in the likelihood that a donor is 'completely satisfied'. This effect is partially mitigated if a donor arrives early to her appointment, but the marginal effect is still approximately –9.08 percent.

In regressions not reported here, the hypothesis was directly tested that there is a sudden change in the slope of a donor's utility function at the point where perceived and expected wait times are equal. In order to do this, a donor's *wait loss* was defined as an excess of perceived over expected wait time, while a *wait gain* was defined as an excess of expected over perceived wait time. This test was repeated for several functional forms, but it was never possible to reject the null hypothesis that the slopes are the same on both sides of the reference point. This suggests that, while donors are reference dependent, they are not loss averse with respect to expectations.

Several other types of reference dependence can also be observed. In particular, wait time is significantly more negatively perceived if the wait is longer than usual[10]. A similar dynamic is observed if wait time is longer than that of other donors[11], although the latter interaction is not significant in one of the two regressions. No equivalent effect is observed for variables to indicate that wait time is shorter than usual or shorter compared to peers. To test the specific nature of these relationships, additional variables were

[10] UnusuallyLong=1 if a donor reports *previous* wait time to have been shorter (not the same or longer) than on the day of the survey, and zero otherwise.

[11] LongVsPeer=1 if a donor reports her wait to have been longer (not the same or shorter) than others in the waiting room, and zero otherwise.

also tested, which measured *the extent* to which wait time is different from each reference point. In both cases, the marginal effects of these variables were near zero and not significant, which indicates that the interactions are binary and are not due to curvature from misspecification of the model.

All four satisfaction regressions show a strongly positive direct effect of the appointment variable, which is not significantly reduced by the addition of variables for new donor status, cumulative donation counts or the measures of time pressure. Given that having an appointment is not associated with lower perceived wait time, it seems unlikely that the acceptance of an appointment is directly causing this dynamic. While it is possible that an appointment could influence satisfaction by affecting other elements of a donor's treatment, it is more plausible that there exists an unobserved donor characteristic that influences both satisfaction and the likelihood of making an appointment. It is not anticipated that this unobserved heterogeneity would also be correlated with the marginal effect of wait time, but the key parameter estimates will be biased if this is the case.

5.2.3 Self-reported likelihood of return within six months

The next step is to assess how these dynamics affect a donor's self-reported likelihood of return. Since this variable is measured using a discrete scale from zero to ten, the following Ordered Probit model is specified:

$$
\begin{aligned}
Pr(y_i = 0|\boldsymbol{x}_i) &= \Phi(-\alpha - \boldsymbol{\beta}'\boldsymbol{x}_i) \\
Pr(y_i = 1|\boldsymbol{x}_i) &= \Phi(\mu_2 - \alpha - \boldsymbol{\beta}'\boldsymbol{x}_i) - \Phi(-\alpha - \boldsymbol{\beta}'\boldsymbol{x}_i) \\
Pr(y_i = 2|\boldsymbol{x}_i) &= \Phi(\mu_3 - \alpha - \boldsymbol{\beta}'\boldsymbol{x}_i) - \Phi(\mu_2 - \alpha - \boldsymbol{\beta}'\boldsymbol{x}_i) \\
&\vdots \\
Pr(y_i = 10|\boldsymbol{x}_i) &= 1 - \Phi(\mu_{10} - \alpha - \boldsymbol{\beta}'\boldsymbol{x}_i)
\end{aligned}
$$

where Φ is the cumulative distribution of a standard normal random variable, $\mu_2 \ldots \mu_{10}$ are the thresholds of the latent variable (μ_1 is normalised to zero), and $\boldsymbol{x}_i$ is the vector of covariates.

The fifth column of Table 11 presents the marginal effect of each variable on the probability that a donor reports herself as 'practically certain' to return ($y_i = 10$). The interaction between appointments and wait time is observed to have the same qualitative effect as in the satisfaction regressions. As was the case for overall satisfaction, the direct effect of wait time is not significant, but the effect is larger for donors who have made an appointment and who arrive on time or late. In particular, a one percent increase in wait time is estimated to reduce the likelihood that such a donor is 'practically certain' of return by 5.29 percent. The marginal effect for a donor who arrives early to her appointment is not significantly different from zero.

In contrast to the satisfaction regressions, the interactions between wait time and the two reference variables are not significant, although the marginal effects are still negative. Furthermore, wait time is found to more negatively affect the likelihood of return of new donors, compared to repeat donors. This interaction was not found to be important in the earlier models.

5.2.4 Likelihood of making an appointment

This subsection examines the probability that a donor will make a commitment to return, in the form of an appointment for a subsequent donation. A Probit model is used, with a binary dependent variable to indicate whether a donor made a new appointment ($y_i = 1$) or not ($y_i = 0$):

$$Pr(y_i = 1|\boldsymbol{x}_i) = \Phi(\alpha + \boldsymbol{\beta}'\boldsymbol{x}_i)$$

where Φ is the cumulative distribution of a standard normal random variable and $\boldsymbol{x}_i$ is the vector of covariates.

The last three columns of Table 11 show the marginal effect of each variable on the likelihood of making a new appointment ($y_i = 1$). These estimates reveal a different dynamic from the preceding analyses. In particular, a one percent increase in wait time is estimated to *increase* the probability that a donor will make a new appointment by 9.63 percent, providing that she did not have an appointment on the day of the survey. No such effect is visible for donors who had an appointment for the current donation. The addition of a further interaction with early arrival does not change these results.

A potential explanation of this dynamic is that donors without appointments, who waited longer but are willing to return, may expect that having an appointment will reduce future wait time. In accordance with the findings here, this effect would not extend to donors who had an appointment on the day of the survey. To test this hypothesis, the sample was divided into two parts. The last two columns of Table 11 show that the effect is very strong for donors who state that they are 'practically certain' of return, but weak for other donors. This finding supports the theory that any negative effect of wait time on satisfaction is being overwhelmed by a separate positive effect from donors who are already likely to return.

The ARCBS will also be interested to learn that donors who are asked to make an appointment are much more likely to do so. If this commitment increases the likelihood of return, then this could be an important part of a strategy to increase donations.

5.2.5 Probability of actual return

The final part of the analysis uses two methods to examine observable behaviour. First, a Probit regression is used to model the probability that a donor will return within thirty days of eligibility ($y_i = 1$):

$$Pr(y_i = 1|\boldsymbol{x}_i) = \Phi(\alpha + \boldsymbol{\beta}'\boldsymbol{x}_i)$$

where Φ is the cumulative distribution of a standard normal random variable and $\boldsymbol{x}_i$ is the vector of covariates.

A Cox Proportional Hazard model is then used to analyse the duration between donations. This is a semi-parametric model, which assumes that the hazard rate is of the following form:

$$\lambda(t|\boldsymbol{x}_i, \boldsymbol{\beta}) = \lambda_0(t) exp(\boldsymbol{\beta}'\boldsymbol{x}_i)$$

where $\lambda(t|\boldsymbol{x}_i, \boldsymbol{\beta})$ is the conditional hazard rate, $\lambda_0(t)$ is the baseline hazard, $\boldsymbol{x}_i$ is the vector of covariates and t is the number of days from the date of eligibility to the donor's first repeat donation (if any).

These regressions are necessarily restricted to plasma donors, since whole blood donors are not yet eligible to return. Once sufficient time has passed (minimally 84 days), the analysis will be replicated for whole blood donors. These results will be more readily comparable to the preceding analyses, from which plasma donors are excluded.

Table 12 presents (1) the marginal effect of each variable on the probability that a donor will return within thirty days of eligibility and (2) the hazard ratio, which is the estimated effect of a unit change on the likelihood that a donor will return at any given duration. In anticipation that donors who intend to return sooner may be more likely to make an appointment, the regressions are replicated for donors who state that they are 'practically certain' of returning within six months. The difference between the estimates for the two samples are small, primarily because 98 percent of plasma donors are confident of return. This indicates that the estimates do not suffer from this particular selection problem.

The results of the Probit and survival regressions are not consistent with the models of satisfaction and self-reported likelihood of return. The interaction between appointments and wait time is not statistically significant for donors who are on time or late and is negative for those who are early. Part of this may be explained by the fact that only 11 of the plasma donors arrived without an appointment. However, this could not have generated the negative effect for those who arrived early.

A potential explanation of these results is that plasma donors are fundamentally different from whole blood donors[12]. This is a select group of the

[12] This hypothesis was tested. However, low variation in the appointment, wait time and satisfaction variables means that precise estimates cannot be obtained.

Table 12: Probability of Actual Return (Plasma Donors)[a]

	Probit Models[b] (Marginal Effect)		Survival Models[c] (Hazard Ratio)	
	Full Sample	Certain of Return[d]	Full Sample	Certain of Return[d]
Log(Wait1)	2.53%	3.21%	1.15	1.62
	(0.858)	(0.821)	(0.771)	(0.764)
Appointment (Today)	11.86%	15.37%	1.44	1.53
	(0.713)	(0.637)	(0.745)	(0.709)
ln(Wait1)*Appt	0.92%	–0.51%	0.90	0.88
	(0.950)	(0.973)	(0.835)	(0.810)
ln(Wait1)*Appt*Early	–6.24%*	–7.07%**	0.88	0.87
	(0.068)	(0.037)	(0.195)	(0.148)
New Appointment	11.93%*	11.26%*	1.31	1.30
	(0.056)	(0.068)	(0.173)	(0.181)
Time Pressure (Now)	–3.29%*	–3.75%**	0.92	0.91
	(0.071)	(0.038)	(0.166)	(0.141)
Age	1.35%***	1.45%***	1.04***	1.04***
	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Male	8.19%	5.77%	1.44	1.37
	(0.245)	(0.412)	(0.111)	(0.171)
Sample size	189	186	189	186
Misclassification[e]	24%	23%	–	–

[a] Centre intercepts not reported. * indicates significance at the 10% level, ** at the 5% level and *** at the 1% level. Plasma donors only. P-values in brackets.
[b] Average marginal effects from Probit regressions with the dependent variable equal to one if the donor returned within thirty days.
[c] Hazard ratios from Cox Proportional Hazard models, which measure the effect of each variable on the likelihood of return at any given duration.
[d] These regressions include only donors who are 'practically certain' of return.
[e] The percentage of incorrect predictions of the Probit models.

most regular donors, who elect to proceed with a more invasive and time-consuming donation process. It is plausible that these donors expect to be given priority in the wait queue, regardless of when they arrive. Once sufficient time has elapsed, equivalent regressions for whole blood donors may reveal a different set of dynamics.

The estimates in Table 12 suggest that a donor who makes a *new* appointment is likely to return sooner, *ceteris paribus*. In particular, the Probit model indicates that donors who make an appointment for a subsequent donation are 11.93 percent more likely to return within thirty days of eligibility.

This effect is statistically significant at the ten percent level. Similarly, the survival model predicts that the likelihood of return is 31 percent higher at any given duration, although this parameter is not significant.

There are several potential limitations of the regressions. First, other types of unobserved heterogeneity may have biased the results. In particular, the likelihood of making an appointment may be affected by the expected *duration* between donations. If this is true, then the estimates from the survival regressions will be upwardly biased, although the Probit analysis should be less affected. Moreover, the same bias could be caused by any unobserved characteristic that is positively correlated with both the probability of return and the likelihood of making an appointment. This uncertainty could potentially be resolved by using aggregate donation data to estimate a panel regression with fixed effects. However, this would entail the abandonment of the control variables from the survey[13].

[13] An alternative solution is to create an instrument for appointments using two-stage least squares (2SLS). However, it has been shown by Terza, Basu and Rathouz (2008) that the 2SLS estimator is not consistent for this type of model.

6 Discussion

The estimated effect of compulsory appointments depends on the time period that is examined. The analysis of the Pre ⇒ Post group suggests an initially negative effect of the policy. For this cohort, the transition occurred between the initial and repeat donations, which implies that donors were only affected by the requirement to make an appointment and not by an altered perception of the donation experience. This essentially rules out the possibility that the effect is caused by the interaction of appointments with wait time. At the same time, the sign of the change is not consistent with a reduction in procrastination due to a commitment effect.

There are several potential explanations of this result. First, many donors were initially unaware of the policy change. A significant fraction will therefore have arrived without appointments and may have been turned away. Secondly, the reduction in flexibility from compulsory appointments may have contributed to permanently lower post-transition donation levels. However, the magnitudes of these long term changes seem too large to have been caused by the appointment policy alone. An additional possibility is that the dynamics were caused by an unobserved simultaneous policy change, such as a state-specific modification to eligibility requirements. While no such event has been found, this possibility cannot be ruled out entirely.

The results for the Post ⇒ Post group show that, conditional on having donated after the transition, donors are more likely to return than previously. This is consistent with the theory that compulsory appointments could help donors circumvent time-inconsistent preferences. However, there are other explanations. In particular, an untestable possibility is that an increase in the percentage of donors with appointments led to improved efficiency and lower wait times[14]. Satisfaction may therefore have increased, leading to a higher propensity to return. As before, the results may also have been affected by an unobserved simultaneous policy change.

The aggregate results provide useful conclusions for an assessment of the new policy. However, the individual mechanisms that generate these results can only be separated using the survey data. The first step in the survey analysis showed that the adoption of an appointment is associated with a significant decrease in expected wait time and no equivalent reduction in the perceived wait. For donors who arrive early, the effect on expectations is weaker, but this difference is matched by a relative increase in perceived wait time. These findings are important, as they suggest that the adoption of an appointment changes the reference point of an average donor, without changing the perceived experience.

As predicted in Section 2.2.1, the change in expectations from an appointment leads to more negative perception of wait time. Furthermore, the effect of wait time on satisfaction is weaker for donors who arrive early, which is consistent with the earlier observation that expectations change by less for these donors. These findings could be explained by a more negative slope of the utility function for losses than for gains, as suggested by Kahneman and Tversky's (1979) theory of loss aversion. However, they are also compatible with reference dependence without loss aversion. It is interesting to observe that no strong results are produced by more explicit tests of the hypothesis that a change in slope occurs at the point where perceptions equal expectations. This could indicate either that donors are not loss averse or that the reference point is not defined exclusively by expectations.

Another possibility is that donors' reference points are defined in comparison

[14]This theory cannot be tested, as wait time data are not available for these periods.

to peers and past experience. More specifically, the satisfaction regressions suggest that wait time has a significantly more negative effect if it is perceived to be longer than usual or longer compared to other donors. In neither case is there evidence to suggest that there is an equivalent effect for shorter wait times, and the effects do seem to be caused by binary interactions. These results suggest a kink in the utility function at each reference point, which is compatible with loss aversion, but not with a simpler version of reference dependence.

The next step was to analyse self-reported likelihood of return, to test whether donors intend to act on changes in utility. As before, the interaction between appointments and wait time has a strongly negative effect, which is an indication that intended behaviour is indeed affected by the change in expectations associated with an appointment. Similarly, a more negative effect is still observed for wait times that are long compared to peers and past experience, although the coefficients are smaller than before and are not significant.

The first step in the analysis of observable behaviour was to examine the probability that a donor will make a commitment to return in the form of a new appointment. A donor who arrives without an appointment was found to be more likely to make this commitment if wait time is longer. No such effect was found for those who had an appointment on the day of the survey. One explanation for this is that donors attribute long wait time to the fact they did not have an appointment. This effect is strong enough to overwhelm any negative effect through satisfaction.

The analysis of subsequent donation behaviour also produced results that are inconsistent with the findings for satisfaction and self-reported likelihood of return. However, this may be because these tests are currently restricted to *plasma donors*, whereas all previous analyses considered only *whole blood donors*. It is possible that plasma donors are fundamentally different from other donors, since they have self-selected to endure a more invasive and time-consuming donation process. Furthermore, only eleven of the plasma donors did not have an appointment and variation in wait time is low. In an already small sample, this makes it difficult to get a reliable estimate. Once it becomes possible to replicate these regressions for whole blood donors, it is anticipated that the dynamics may be quite different.

The evidence from donation behaviour also supports the hypothesis that the adoption of a commitment mechanism directly increases the probability that a donor will return. More specifically, both the Probit and survival models suggest that the likelihood of return within a given time period is higher for donors who make an appointment for their next donation. Furthermore, this effect is unchanged by the truncation of the sample to include only donors who are 'practically certain' that they will return. This indicates that the result is unlikely to be driven by reverse causality. These findings are compatible with the theory that some donors' preferences are time-inconsistent and that appointments therefore help to avoid procrastination. However, this still does not necessarily imply that appointments should be made compulsory. A direct test of the role of *compulsory* appointments may only be achievable if a method is found to create a consistent instrument for the appointment variable that is not affected by voluntary adoption. At this stage, no such instrument has been found.

7 Conclusion

This thesis examined the effect on blood donation of an ARCBS policy of compulsory appointments. The first empirical contribution was to measure the overall effect of the policy transition in Western Australia and Queensland, using aggregate data. In the very short term, the policy was found to have a negative effect, possibly because donors were unwilling to make an appointment or because those who arrived without appointments were turned away. However, conditional on having donated at least once after the transition, donors were found to be more likely to return. This is consistent with a role for appointments as a commitment device, but could also be due to shorter wait times from improved efficiency.

In order to isolate individual mechanisms that contributed to these dynamics, a survey of blood donors was conducted. The first theory to be examined was Maister's (1985) hitherto untested hypothesis that appointments could lead to lower expectations of wait time and to lower satisfaction, if not accompanied by a perceived improvement. The findings presented here support this theory. Donors with appointments were found to expect shorter wait time, and a unit increase in wait time has a greater negative effect on satisfaction for these donors, compared to those without appointments. Furthermore, the same dynamics affect intended actions. No strong evidence was found to suggest a change in subsequent donation behaviour, but this may be because the analysis was necessarily restricted to plasma donors.

Overall, the results suggest that donors are loss averse, but that the reference point is not simply located at the point of equality between expectations and perceptions. The change in expectations from having an appointment does seem to shift the reference point, but donors only appear to be loss averse with respect to peers and past experience. This does not support Parasuraman et al.'s (1988) proposition that satisfaction should be defined as the difference between perceived and expected service levels, but is compatible with the finding of Boulding et al. (1993) that expectations affect utility.

The second major finding is that appointments are associated with an increase in the likelihood of return. This supports the theoretical prediction from behavioural economics that a commitment mechanism can make a donor more likely to go through with a planned donation, by circumventing a problem of time-inconsistent preferences. It is also in line with experimental and field evidence in other contexts (Ariely and Wertenbroch 2002, Wertenbroch 1998, Schelling 1984).

There are several limitations of these results. First, the aggregate analysis was limited by the fact that only two states' transitions could be analysed. It is therefore impossible to be sure that the observed effects were truly caused by the appointment policy. This is especially important because an unexplained bubble in the donation rate was observed in Queensland in the six months prior to transition. Once additional data become available from earlier years, it will be possible to analyse a larger number of transitions. This will allow a more robust conclusion to be drawn.

The primary limitation of the survey analysis was that changes in subsequent donation behaviour could only be analysed for plasma donors, since whole blood donors are not yet eligible to return. It is difficult to obtain a reliable estimate for plasma donors, since variation in wait time is low and because almost all of these donors had appointments. It is therefore not surprising that the interaction between appointments and wait time was not found to have a significant effect on future donations. Once sufficient time has passed, the regressions will be replicated for whole blood donors. This will produce estimates that are more directly comparable to the findings for satisfaction and intended behaviour.

Due to the limitations of the aggregate regressions, it is not yet possible to provide the ARCBS with a normative assessment of the policy as a whole. However, specific recommendations can be made. First, there appears to be a strong effect of being asked to make an appointment on the likelihood that a donor will do so. In turn, making an appointment was found to increase the likelihood of return. Combined, these two observations indicate that staff should ask as many donors as possible to make an appointment for their next donation.

Second, the fact that wait time is more negatively perceived by donors with appointments suggests that these donors should be given at least some priority. As indicated by the regressions with perceived wait time, this does not seem to occur at present. Finally, new donors appear to be more negatively affected by wait time than others, which suggests that they too should be given a degree of priority. However, it is important to bear in mind that wait time has a more negative effect if other donors are perceived to wait less. Therefore, if some donors are given higher priority, then the ARCBS should ensure that this decision is justified in the eyes of other donors.

There are several ways in which the analyses in this thesis could be extended. First, the precision of the aggregate regressions could be improved by the inclusion of more control variables. For example, the donor's postcode could be used to add further demographic information. Aggregate economic variables could also be tested. Secondly, the robustness of the results would be significantly improved by a better understanding of the bubble in donations before the Queensland transition and by the analysis of additional transitions, if earlier data become available. The analysis of the survey data could be enhanced by the development of a consistent instrument for the appointment variable. Not only would this eliminate any remaining selection problems, but it could potentially be used to directly test the effect of *compulsory* appointments.

Finally, future research could investigate how strongly the effects observed in this thesis extend to other contexts. It would be particularly interesting to assess the wider applicability of the finding that appointments can shift agents' expectations and cause more negative perception of wait time. If found to apply to other areas of pro-social behaviour or to service interactions more generally, this result could be practically very significant.

A Appendix: Descriptive Statistics

This appendix contains summary statistics for selected variables. The top part of Table 13 provides the mean and standard deviation for each of the important linear regressors. The lower part of the table provides the percentage of donors for which each of the key dummy variables are equal to one. Finally, Table 14 contains response frequencies for the three dependent variables used in Section 5.2. The information is stratified by the type of donation and the donor's appointment status.

Table 13: Summary Statistics for Selected Variables

Linear Variables[a]	Whole Blood Donors		Plasma Donors	
	Without Appointment	With Appointment	Without Appointment	With Appointment
Wait 1 (Actual)	11.84	10.52	9.20	7.76
	(13.57)	(11.50)	(7.50)	(8.52)
Wait 1 (Expected)	13.07	11.19	12.44	8.28
	(10.34)	(7.76)	(7.99)	(5.42)
Wait 2 (Actual)	11.55	11.22	8.55	8.46
	(16.91)	(45.57)	(9.66)	(7.93)
Wait 2 (Expected)	14.65	10.30	12.94	9.34
	(14.43)	(7.31)	(8.39)	(7.16)
Age	43.30	43.93	49.00	53.42
	(15.71)	(15.60)	(17.09)	(14.04)
# Others Waiting	4.79	4.50	2.95	3.59
	(4.14)	(3.32)	(2.74)	(3.54)
# Donations (Year)	2.19	2.56	12.27	10.53
	(1.20)	(1.33)	(8.79)	(7.60)
Dummy Variables[b]	**Whole Blood Donors**		**Plasma Donors**	
	Without Appointment	With Appointment	Without Appointment	With Appointment
Actual Return	2.16%	4.80%	54.55%	63.73%
Asked to Make Appt	41.01%	41.28%	36.36%	58.33%
Came With Others	21.58%	24.73%	18.18%	20.10%
Early	–	53.74%	–	56.65%
Male	72.66%	51.96%	90.91%	71.08%
New Donor	16.55%	8.36%	–	–
Unusually Long Wait	34.53%	35.59%	36.36%	24.02%
Long Versus Peer	10.79%	6.76%	0.00%	6.37%

[a] The mean and standard deviation (in brackets) for each linear variable.
[b] The percentage of donors for which each dummy variable is equal to one.

Table 14: Dependent Variables (Frequency Table)

Acceptability of wait time[a]		Whole Blood Donors		Plasma Donors	
		Without Appointment	With Appointment	Without Appointment	With Appointment
Not at all –	1	1	3	0	0
acceptable	2	0	3	0	2
	3	0	29	0	7
	4	6	35	0	15
	5	13	50	0	16
Completely	6	35	122	4	35
acceptable –	7	78	309	6	129

Overall Experience[b]		Whole Blood Donors		Plasma Donors	
		Without Appointment	With Appointment	Without Appointment	With Appointment
Not at all –	1	0	1	0	0
satisfied	2	0	0	0	0
	3	1	5	0	2
	4	1	12	0	5
	5	12	52	0	20
Completely	6	29	117	3	45
satisfied –	7	93	371	8	132

Likelihood of Return[c]		Whole Blood Donors		Plasma Donors	
		Without Appointment	With Appointment	Without Appointment	With Appointment
No Chance –	0	2	0	0	0
	1	0	0	0	0
	2	1	2	0	1
	3	1	7	0	0
	4	1	0	0	0
	5	3	5	0	0
	6	3	6	0	0
	7	5	17	0	0
	8	17	38	0	3
Practically	9	17	54	1	0
Certain –	10	89	431	9	200

[a] Exact question: How acceptable was the total wait time you experienced today?
[b] Exact question: How satisfied were you with the overall experience today?
[c] Exact question: What is the likelihood that you will donate again in the next 6 months?

B Appendix: Results

This appendix contains additional information regarding the aggregate regressions discussed in Section 5.1. Tables 15 and 16 provide the full set of estimates for the regressions reported in Table 7. Similarly, Tables 17 and 18 contain the full set of estimates for the regressions in Table 8. In both cases, the tables in Section 5.1 show only the marginal effects of the interaction between the policy variable and a dummy for the transition state.

Table 15: Policy Transition in Queensland[a]

Pre ⇒ Post versus Pre ⇒ Pre

Compared to all other states	All Donors (No Controls)	All Donors (With Controls)	New Donors	Zero Donations[b]	One Donation[b]	Two Donations[b]
Western Australia	3.32%***	–5.16%***	–8.00%***	–2.26%**	0.80%	–4.15%***
Victoria	4.16%***	0.21%	0.10%	0.61%	0.42%	–2.04%**
Tasmania	–4.92%***	–9.48%***	–7.12%***	–11.29%***	–6.55%***	–6.46%***
ACT	–8.45%***	–6.96%***	–0.57%	–5.31%***	–3.74%**	–7.60%***
South Australia	5.92%***	0.96%**	7.79%***	1.88%**	1.81%**	–1.77%*
Northern Territory	11.07%***	3.63%***	6.44%**	4.20%**	5.24%***	1.29%
New South Wales	–5.12%***	–2.30%***	1.32%	–1.08%	–1.59%**	–3.18%***
Policy Transition	–1.17%***	–1.02%***	–3.58%***	–0.42%	–0.27%	2.42%
Queensland*Policy	–8.65%***	–8.84%***	–8.63%***	–8.46%***	–8.72%***	–11.89%
Mobile	–	–14.21%***	–11.89%***	–8.43%***	–10.12%***	–11.97%***
Male	–	4.95%***	–0.13%	1.99%***	5.06%***	6.73%***
Age	–	0.68%***	0.48%***	0.48%***	0.54%***	0.35%***
Sample size	192185	192185	29701	53414	81220	27855
Misclassification[c]	45%	39%	31%	36%	40%	26%

[a] Average marginal effects on the probability that a donor returns within 50 days of becoming eligible, from Probit difference-in-difference regressions. Whole blood only. * indicates significance at the 10% level, ** at the 5% level and *** at 1%.
[b] Count of donations in the six months before the initial 50 day window.
[c] The percentage of incorrect predictions of the models.

Table 16: Policy Transition in Queensland[a]

Post ⇒ Post versus Pre ⇒ Pre

Compared to all other states	All Donors (No Controls)	All Donors (With Controls)	New Donors	Zero Donations[b]	One Donation[b]	Two Donations[b]
Western Australia	4.93%***	–3.05%***	–5.36%***	–0.81%	3.15%***	–2.88%***
Victoria	3.64%***	–0.06%	1.68%	0.75%	0.43%	–1.52%**
Tasmania	–0.82%	–4.99%***	–1.46%	–5.38%***	–2.25%	–2.41%
ACT	–11.85%***	–9.54%***	–5.02%***	–4.63%***	–3.90%**	–7.26%***
South Australia	6.66%***	1.82%***	9.67%***	1.45%*	4.07%***	–1.89%**
Northern Territory	7.46%***	0.85%	2.96%	0.84%	–0.65%	3.61%*
New South Wales	–5.46%***	–2.80%***	1.03%	–0.83%	–1.34%**	–1.88%**
Policy Transition	–0.91%**	–1.15%***	–4.63%***	–19.42%***	2.02%***	11.29%***
Queensland*Policy	3.94%***	3.32%***	6.98%***	–0.68%	4.22%***	3.17%***
Mobile	–	–13.45%***	–10.43%***	–6.33%***	–6.46%***	–8.43%***
Male	–	5.08%***	–0.10%	2.84%***	4.72%***	4.57%***
Age	–	0.66%***	0.44%***	0.42%***	0.47%***	0.27%***
Sample size	181038	181038	25519	45978	79234	30307
Misclassification[c]	46%	39%	32%	29%	39%	19%

[a] Average marginal effects on the probability that a donor returns within 50 days of becoming eligible, from Probit difference-in-difference regressions. Whole blood only. * indicates significance at the 10% level, ** at the 5% level and *** at 1%.

[b] Count of donations in the six months before the initial 50 day window.

[c] The percentage of incorrect predictions of the models.

Table 17: Policy Transition in Western Australia[a]

Pre ⇒ Post versus Pre ⇒ Pre

Compared to Queensland	All Donors (No Controls)	All Donors (With Controls)	New Donors	Zero Donations[b]	One Donation[b]	Two Donations[b]
West. Australia	–3.40%***	–11.83%***	–12.15%***	–10.57%***	–9.18%***	–9.35%***
Policy Transition	0.45%	1.04%**	–2.67%***	1.54%*	4.64%***	3.53%***
West.Aust.*Policy	–1.17%	–1.65%*	–2.35%	–0.17%	–5.53%***	–9.98%***
Mobile	–	–14.84%***	–13.43%***	–9.97%***	–10.95%***	–15.12%***
Male	–	5.08%***	0.79%	0.93%	5.71%***	6.27%***
Age	–	0.73%***	0.49%***	0.51%***	0.55%***	0.40%***
Sample size	65573	65573	9242	18835	27604	9897
Misclassification[c]	48%	39%	28%	35%	40%	28%

Compared to VIC, ACT, TAS & SA	All Donors (No Controls)	All Donors (With Controls)	New Donors	Zero Donations[b]	One Donation[b]	Two Donations[b]
Queensland	3.39%***	12.21%***	11.85%***	11.97%***	9.95%***	8.98%***
Victoria	6.78%***	11.74%***	11.37%***	22.25%***	14.94%***	18.90%***
ACT	–10.14%***	1.85%*	5.39%***	15.51%***	7.01%***	12.18%
Tasmania	–0.25%	3.46%***	4.21%**	20.83%***	9.19%***	16.76%**
South Australia	7.03%***	10.08%***	13.16%***	20.95%***	12.18%***	16.73%**
Policy Transition	1.44%***	1.49%***	–5.24%***	–8.26%***	–1.83%***	–8.31%
West.Aust.*Policy	–2.16%***	–2.10%**	0.07%***	9.64%***	0.98%	2.25%
Queensland*Policy	–0.99%*	0.45%	2.47%*	9.85%***	6.36%***	11.73%*
Mobile	–	–15.59%***	–12.75%***	–11.92%***	–12.48%***	–14.49%***
Male	–	5.04%***	0.72%	3.19%***	5.39%***	5.74%***
Age	–	0.72%***	0.48%***	0.57%***	0.57%***	0.39%***
Sample size	140897	140897	18495	52129	54707	15585
Misclassification[c]	47%	39%	29%	38%	39%	26%

[a] Average marginal effects on the probability that a donor returns within 50 days of becoming eligible, from Probit difference-in-difference regressions. Whole blood only. * indicates significance at the 10% level, ** at the 5% level and *** at 1%.
[b] Count of donations in the six months before the initial 50 day window.
[c] The percentage of incorrect predictions of the models.

Table 18: Policy Transition in Western Australia[a]

Post ⇒ Post versus Pre ⇒ Pre

Compared to Queensland	All Donors (No Controls)	All Donors (With Controls)	New Donors	Zero Donations[b]	One Donation[b]	Two Donations[b]
West. Australia	–3.39%***	–10.29%***	–11.05%***	–8.85%***	–7.64%***	–8.70%***
Policy Transition	4.85%***	3.80%***	3.17%***	3.44%***	6.80%***	3.04%***
West.Aust.*Policy	7.60%***	7.78%***	3.62%	10.94%***	6.06%***	2.67%
Mobile	–	–11.89%***	–11.10%***	–6.40%***	–8.07%***	–13.74%***
Male	–	4.84%***	0.10%	–0.11%	6.00%***	5.42%***
Age	–	0.68%***	0.48%***	0.48%***	0.53%***	0.34%***
Sample size	64555	64555	8168	18873	27720	9794
Misclassification[c]	47%	40%	31%	37%	39%	26%

Compared to VIC, ACT, TAS & SA	All Donors (No Controls)	All Donors (With Controls)	New Donors	Zero Donations[b]	One Donation[b]	Two Donations[b]
Queensland	0.16%	6.45%***	4.79%***	1.59%*	1.66%**	8.54%***
Victoria	2.17%***	4.78%***	4.19%***	10.94%***	4.21%***	2.11%***
ACT	–12.90%***	–3.88%***	–3.68%*	4.10%***	1.08%	–6.24%*
Tasmania	–3.38%	–1.41%	–2.72%	10.39%***	1.42%	2.02%
South Australia	3.82%***	5.00%***	6.97%***	12.02%***	2.77%**	1.87%
Policy Transition	3.72%***	3.91%***	1.58%	–5.68%***	0.37%	0.08%***
West.Aust.*Policy	5.50%***	3.22%***	–0.26%	11.43%***	5.70%***	–2.65%
Queensland*Policy	1.13%*	–0.12%	1.66%	9.13%***	6.33%***	–5.08%***
Mobile	–	13.07%***	–9.67%***	–9.11%***	–9.50%***	–14.12%***
Male	–	5.26%***	–0.32%	3.13%***	6.00%***	5.32%***
Age	–	0.69%***	0.48%***	0.55%***	0.56%***	0.38%***
Sample size	140189	140189	16708	52555	54570	16357
Misclassification[c]	46%	39%	32%	39%	38%	25%

[a] Average marginal effects on the probability that a donor returns within 50 days of becoming eligible, from Probit difference-in-difference regressions. Whole blood only. * indicates significance at the 10% level, ** at the 5% level and *** at 1%.
[b] Count of donations in the six months before the initial 50 day window.
[c] The percentage of incorrect predictions of the models.

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