Modelling Decisions to Volunteer at a Household Level

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Abstract

Volunteering is widespread in Australia and within households it is common to observe couples making similar decisions on whether to volunteer or not. Using a sample from the HILDA survey our models of interactions between couples indicate that the positive correlation between the decisions of partners can be attributed to a large endogenous effect of volunteering. In addition, it is found that volunteers are generally more educated, have children, are aged around 50 and attend religious services. The models used can be broadly classified as assuming cooperative and non-cooperative behaviour within couples and are based on equilibrium concepts from game theory.

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1 Introduction

Volunteering refers to individuals supplying labour without monetary reward. The ABS 2006 Voluntary Work Survey (ABS, 2007) estimates that 34% of the Australian population aged 18 years and over participated in voluntary work, contributing some 713 million hours to the community. Volunteering Australia (2009) values the contribution of volunteering as $70 billion in 2008. Despite volunteering being an activity of substantial economic and social value to Australian society, volunteering and the non-profit sector in general have received little attention from economists. Using Australian data from HILDA, this paper focuses on modelling volunteering decisions at the level of heterosexual couples with the primary objective being to better understand the interactions between partners in making volunteering decisions. Freeman (1997) comments on the fact there is a positive association in volunteering among spouses, which is also evident in HILDA. This paper explores the possible explanations for this positive association by considering several models which capture alternative explanations of the observed correlation in volunteering decisions in Australian couples.

From a policy perspective, it is useful to know the source of this observed correlation. If it is in fact attributable to an individual's partner volunteering directly impacting on their own probability of volunteering, then this implies a multiplier effect. That is, policies which successfully encourage a group of individuals to volunteer will have the added bonus of also encouraging their spouses to volunteer. Empirical evidence in this paper suggests that this is the case.

In order to develop a model which is reasonably complete in its ability to capture different sources of the observed correlation in a couple's volunteering decisions, it is necessary to make some assumptions regarding how couples interact. Since it is difficult a priori to determine whether such assumptions are valid or what their impact is on the results, this paper will utilise a variety of models which draw on equilibrium concepts from game theory and can be broadly classified as cooperative or non-cooperative. In particular, the non-cooperative models will use the concept of a Nash equilibrium in pure strategies (Bjorn and Vuong, 1984) and a Stackelberg-leader equilibrium (Bjorn and Vuong, 1985). The equilibrium concept used in the cooperative model is developed from the Nash equilibrium in pure strategies by imposing Pareto optimality on the observed decisions (Kooreman, 1994). The key findings in this paper are found to be robust across these models.

None of the current literature has attempted to explicitly account for the interactions within couples in making volunteering decisisons, making the current econometric approach novel and potentially of wider interest for those modelling household decision-making. The economic literature on volunteering in Australia is thin with Polidano, et. al. (2009) being a recent exception. While the current results are similar to Polidano, et. al. (2009) in terms of isolating some of the key drivers of volunteering, they concentrate on individual behaviour. Here we show the importance of modelling interactions within couples. Our estimates indicate that the impact of the partner's volunteering decision on their spouse's probability of volunteering is substantial with a male whose partner volunteers being around 15 percentage points more likely to volunteer and a female whose partner volunteers being around 20 percentage points more likely to volunteer.

2 Modelling approach

2.1 Modelling Volunteering Behaviour

The models in the literature for volunteering behaviour are broadly based on the consumption and investment models of volunteering proposed by Menchik and Weisbrod (1987). The consumption model assumes that the giving of time is a normal utility bearing good while the investment model assumes that volunteering is an activity that raises one's future earning power. The mechanism for the investment model is the work experience and potentially valuable contacts gained through volunteering. This paper will focus on the consumption motive for volunteering rather than the investment motive due to the fact estimated wage premiums for volunteers are small and as a result evidence for the investment model is limited (see Day and Devlin (1998) and Prouteau and Wolff (2006)). Under the consumption model, utility is assumed to depend directly or indirectly on hours volunteered. As a result, following Freeman (1997) individuals are assumed to maximize utility dependent on goods (G), leisure (L) and charity (C) subject to a budget constraint, where volunteer time (T_v) and donations (D) are the two inputs used to produce charity. More formally, individuals solve the following problem:

$$\max \ U(G, L, C)$$

$$\text{subject to} \quad \begin{aligned} C &= C(T_v, D) \\ G + D &= WT_w + Y \text{ (income constraint)} \\ T_w + T_v + L &= 1 \text{ (time constraint)} \end{aligned}$$

where W is wages, T_w is time worked, Y is non-wage income and D is charitable donations. In this problem the exogenous variables are W and Y and as such, the solution to this problem will yield a derived demand for volunteer time as a function of W and Y:

$$T_v = f(W, Y).$$

This solution will depend on the functional forms chosen for U and C. In addition, the functional form of the utility function may differ across individuals depending on characteristics such as culture, education and family characteristics. This provides a justification for adding these characteristics to the previous equation. Although substantially more structure must be imposed in the previous problem to obtain the regression models that will be used in this paper, it is intended to provide some justification for the form of the regressions being used.

Also, while this model predicts that higher wage workers should volunteer less since the productivity of volunteer time is the same for all workers, and that there should be substitution of donations for volunteering as wages rise, these predictions are a result of the charitable production function. Freeman (1997) points out that by using $C = C(WT_v, D)$ instead, the increased productivity in volunteering for higher wage workers can offset the increased opportunity cost of time as measured through the wage rate.

Finally, it may be the case that seemingly endogenous variables in the maximization problem should be included in the equation for volunteer time. As Brown and Lankford (1992) discuss, whether W measures the worker's opportunity cost of time depends on whether hours of work are fully flexible. If in the previous maximization problem, workers are forced to solve it sequentially by committing to a paid job with fixed hours before allocating time to volunteering, the wage rate will not measure the opportunity cost of time. Instead, hours worked becomes the theoretically relevant control variable and should be included in the model instead.

2.2 Discussion of Econometric Approach

This paper focuses solely on the decision to volunteer rather than the number of hours volunteered. The decision to volunteer is clearly important in its own right, while Day and Devlin (1996) and Polidano, et. al. (2009) provide further motivation for focusing on the decision to volunteer.

In formulating a model to capture the interactions within couples, we consider the possible sources of the observed correlation between male and female partners volunteering. Manski

(1993) notes that there are three main sources, which motivates the following latent variable framework (Equation (2-1)):

1. Exogenous (contextual) effects - Volunteering is correlated with observable factors which are in turn correlated with whether or not couples form.
2. Correlated effects - Volunteering is correlated with unobservable factors which are correlated between couples, which is accounted for by allowing correlation in the error terms (ε_1 and ε_2).
3. Endogenous effects - An individual's partner's volunteering decision directly affects their own volunteering decision.

$$\begin{cases} y_1^* = x'_1\beta_1 + \gamma_1 y_2 + \varepsilon_1 \\ y_2^* = x'_2\beta_2 + \gamma_2 y_1 + \varepsilon_2 \\ y_i = 1 \; if \; y_i^* > 0, 0 \; otherwise \end{cases} \tag{2-1}$$

In the framework given in Equation (2-1), y_1^* represents the male's propensity to volunteer, y_2^* represents the female's propensity to volunteer, y_1 is a binary outcome variable for the male's decision to volunteer, y_2 is a binary outcome variable for the female's decision to volunteer and x_1 and x_2 contain observable factors we wish to control for.

To estimate this model we may assume a bivariate normal distribution for the errors which results in the simultaneous probit model. However, a well known difficulty with this model is that it is incoherent without a suitable restriction being placed on the parameters (that is it produces total probabilities in excess of one). The relevant coherency condition for the model in this case is $\gamma_1\gamma_2 = 0$ (Heckman, 1978). This makes the resulting system triangular restricting the simultaneity in the model. This is problematic since any resulting model specification would assume that the male makes their decision independently of the female and then the female makes their decision conditional on the male's decision or vice-versa. This does not allow us to fully capture the endogenous effects and as such seems to be an overly restrictive class of models. It should be noted that the bivariate probit model with $\gamma_1 = \gamma_2 = 0$ accommodates exogenous and correlated effects but not endogenous effects.

With this restriction in mind, this paper focuses on alternative ways to link the latent variables (y_1^* and y_2^*) with the observed outcomes (y_1 and y_2) which do not result in a need to impose restrictive coherency conditions. An approach is provided by Bjorn and Vuong (1984, 1985) who develop two models based on equilibrium concepts from game theory in which both endogenous variables can be included without coherency restrictions. Bjorn and Vuong (1984) assume that the observed outcome is the Nash equilibrium in pure strategies of a two player game with payoffs given by the latent variables (referred to as the Nash model in Section 2.3). Bjorn and Vuong (1985) assume that the observed outcome is the Stackelberg equilibrium of a Stackelberg leader game played between the partners with payoffs given by the latent variables (referred to as the Stackelberg model in Section 2.3).

While this approach has not been applied in the context of volunteering decisions in the literature previously, it has been applied to several other decisions where there is the possibility of interdependence between partners' decisions. These include husband/wife labour force participation (Bjorn and Vuong (1984, 1985), Bresnahan and Reiss (1991) and Kooreman (1994)), contraceptive choice (Chao (2002)) and retirement decisions (Jia (2005)).

In addition to these non-cooperative approaches to modelling household decisions, there is also a substantial literature on modelling household decisions cooperatively (see Vermeulen (2002)) that provides a useful alternative way to view interactions within the household. Due to the fact many of the models in this literature are not appropriate for modelling discrete choices of each of the partners there is a somewhat limited selection of cooperative models which could be applied. Kooreman (1994) provides a possible cooperative model which adjusts the Nash equilibrium concept used by Bjorn and Vuong (1984) to ensure that the outcome is always Pareto optimal (this is clearly necessary for a cooperative model), which is described as the Pareto Nash model. While further details of the equilibrium concept are explained in Section 2.4, to provide some insight we consider the case where the payoffs defined by the latent variables result in the couple facing a prisoners' dilemma game. The Pareto Nash equilibrium concept would choose the "cooperative" outcome where both players are not playing their best response to the other's strategy rather than the Nash equilibrium in pure strategies.

While this approach provides a reasonable method for relaxing the coherency condition associated with the bivariate probit model, there are other popular alternatives in the literature for modelling couple decision making. In particular, there is a third approach which assumes that couples are a unitary decision making unit. Such an approach was used by Jia (2005), which adopts a simplistic cooperative model that is equivalent to the unitary model of the household and estimates it using a conditional logit regression. Adopting this approach is problematic for several reasons. Firstly, the available data is not appropriate for a conditional logit regression since the independent variables do not vary over choices, only individuals. Secondly, a conditional logit regression assumes independent and identically distributed error terms. This means we are unable to capture correlated effects which are a potentially significant source of the observed correlation in volunteering decisions.

This leads to two possible approaches to implementing a unitary model for volunteering decisions. Initially, both approaches involve generating an outcome variable for whether neither volunteers, only the female volunteers, only the male volunteers or both volunteer. Then, using multinomial logit or multinomial probit with this outcome variable implies there is a single decision maker within the household and as such is in line with a unitary model. Unfortunately, using multinomial probit in this situation is difficult due to the fact there are no clearly appropriate exclusion restrictions on the regressors. As discussed by Keane (1992), identification is fragile without appropriate exclusion restrictions on the regressors.

Finally, while a multinomial logit model could be estimated, it suffers from the same problem as a conditional logit regression. That is, it assumes independent and identically distributed error terms implying that it is unable to capture correlated effects which are a potentially important source of the observed correlation in volunteering decisions. In addition, as a result of assuming independent and identically distributed error terms it assumes independence of irrelevant alternatives (IIA). This seems unlikely to hold in this case since for instance if a couple where both partners are volunteering changed status, it appears substantially more likely that they would change to a situation where one partner volunteered rather than neither volunteering. While some initial exploratory work was carried out using a multinomial logit model, due to these significant limitations it was not seen as an appropriate model for volunteering decisions.

2.3 Non-cooperative choice models

This section provides some discussion of how assuming the observed outcomes are generated by a Nash or Stackelberg leader game played between the partners can be used to link the latent variables to the observed outcomes. Equation (2-2) defines the utilities which will be used throughout this section.

$$\begin{aligned} U^m(1, y_f) &= x_m'\beta_1^m + \alpha_1^m y_f + \varepsilon_1^m \\ U^m(0, y_f) &= x_m'\beta_0^m + \alpha_0^m y_f + \varepsilon_0^m \\ U^f(y_m, 1) &= x_f'\beta_1^f + \alpha_1^f y_m + \varepsilon_1^f \\ U^f(y_m, 0) &= x_f'\beta_0^f + \alpha_0^f y_m + \varepsilon_0^f \end{aligned} \tag{2-2}$$

2.3.1 *Stackelberg leader model – Definition and Estimation*

The Stackelberg leader model assumes that the observed outcome is the Stackelberg equilibrium of a Stackelberg leader game played between the partners with payoffs given by the latent variables. Bjorn and Vuong (1985) discuss in detail how the Stackelberg leader model is implemented. In brief, we take the male to be the Stackelberg leader and the female to be the follower and as such index the players by i=m,f (corresponding to the male and female respectively) rather than i=1,2.

In making a decision whether to take action 0 or 1, player m takes into account player f's reaction function. The possible reaction functions for player f along with the conditions for them to hold are given in Table 2-1 (note that $U^f(y_m, y_f)$ denotes the female's utility when the male takes action y_m and the female takes action y_f).

Table 2-1 - Player f's reaction functions

F_1	Always take action 1	$U^f(y_m, 1) - U^f(y_m, 0) \geq 0$ for $y_m = 0$ or 1
F_2	Always take the same action as player m	$U^f(y_m, 1) - U^f(y_m, 0) \geq 0$ for $y_m = 1$ & $U^f(y_m, 1) - U^f(y_m, 0) < 0$ for $y_m = 0$
F_3	Always take action 0	$U^f(y_m, 1) - U^f(y_m, 0) < 0$ for $y_m = 0$ or 1
F_4	Always take the opposite action to player m	$U^f(y_m, 1) - U^f(y_m, 0) < 0$ for $y_m = 1$ & $U^f(y_m, 1) - U^f(y_m, 0) \geq 0$ for $y_m = 0$

The utility comparison player m makes in determining their action depends on the reaction function of player f. The conditions arising from these comparisons (or outcomes of these comparisons) are detailed in Table 2-2. Note that we let $\overline{M_i}$ denote the negation of M_i and $U^m(y_m, y_f)$ refers to the male's utility when the male takes action y_m and the female takes action y_f.

Table 2-2 - Player m's utility comparisons

Reaction function	Utility Condition for player m	Condition Label
F_1	$U^m(1,1) \geq U^m(0,1)$	M_1
F_2	$U^m(1,1) \geq U^m(0,0)$	M_2
F_3	$U^m(1,0) \geq U^m(0,0)$	M_3
F_4	$U^m(1,0) \geq U^m(0,1)$	M_4

By finding the Stackelberg equilibria of the game in terms of the reaction functions and utility conditions, we obtain the results in Equation (2-3).

$$
\begin{aligned}
\Pr(0,0) &= \Pr(F_2 \text{ } and \text{ } \overline{M_2}) + \Pr(F_3 \text{ } and \text{ } \overline{M_3}) \\
\Pr(1,0) &= \Pr(F_3 \text{ } and \text{ } M_3) + \Pr(F_4 \text{ } and \text{ } M_4) \\
\Pr(0,1) &= \Pr(F_1 \text{ } and \text{ } \overline{M_1}) + \Pr(F_4 \text{ } and \text{ } \overline{M_4}) \\
\Pr(1,1) &= \Pr(F_1 \text{ } and \text{ } M_1) + \Pr(F_2 \text{ } and \text{ } M_2)
\end{aligned} \tag{2-3}
$$

Using Table 2-1 and replacing the utilities with the results in Equation (2-2) we can derive conditions on the error terms (random component) for each of player f's reaction functions to hold. Similarly, using Table 2-2 and replacing the utilities with the results in Equation (2-2) we can derive conditions on the error term for each of player m's utility conditions to hold.

From this, combined with Equation (2-3), we can derive probability statements for each outcome in terms of the parameters. Using these, we can use maximum likelihood estimation to estimate the parameters of the model. We note that only the differences in some parameters can be identified since only their differences are relevant in determining which reaction function or utility condition applies and therefore we define $\beta^m = (\beta_1^m - \beta_0^m)$, $\beta^f = (\beta_1^f - \beta_0^f)$, $\alpha^f = (\alpha_1^f - \alpha_0^f)$. The complete likelihood function along with the relevant *Stata* code is available from the author on request.

2.3.2 Nash game – Definition and Estimation

The Nash game assumes that the observed outcome is the Nash equilibrium in pure strategies of a two player game with payoffs given by the latent variables. Bjorn and Vuong (1984) discuss in detail how this is implemented by considering the reaction functions of the relevant players. In summary, we begin by considering the four possible reaction functions for each player, which are given for player f in Table 2-3.

Table 2-3 – Player f's reaction functions

Label	Description	Condition
F_1	Always take action 1	$U^f(y_m,1) - U^f(y_m,0) \geq 0 \; for \; y_m = 0 \; or \; 1$
F_2	Always take the same action as player m	$U^f(y_m,1) - U^f(y_m,0) \geq 0 \; for \; y_m = 1$ & $U^f(y_m,1) - U^f(y_m,0) < 0 \; for \; y_m = 0$
F_3	Always take action 0	$U^f(y_m,1) - U^f(y_m,0) < 0 \; for \; y_m = 0 \; or \; 1$
F_4	Always take the opposite action to player m	$U^f(y_m,1) - U^f(y_m,0) < 0 \; for \; y_m = 1$ & $U^f(y_m,1) - U^f(y_m,0) \geq 0 \; for \; y_m = 0$

We now use the assumption that the observed outcomes are Nash Equilibrium outcomes of a game played by the two agents to relate the latent variables to the observed outcomes. This is insufficient to define how the observed outcomes are generated without additional assumptions due to the fact a Nash Equilibrium in pure strategies may not exist or multiple Nash Equilibria in pure strategies may arise. This is because each pair of reaction functions does not necessarily imply a unique Nash equilibrium. As a result, some additional assumptions have been introduced to relate the probability of each pair of outcomes to the probability of pairs of reaction functions occurring. The following equilibrium selection rule has been used to deal with this problem in producing the estimation results (this approach was adopted by Bjorn and Vuong (1984), Kooreman (1994) and Chao (2002)):

- In the case of multiple Nash equilibria, the probability of occurrence is equally distributed over the two possible outcomes.
- In the case of non-existence of a Nash equilibrium, the probability of occurrence is equally distributed over all four outcomes.

Then, by finding the possible Nash Equilibria in pure strategies of the game given the two player's reaction functions, the probability of each observed outcome in terms of the probability of each pair of reaction functions occurring can be derived. These are given in Equation (2-4).

$$\begin{aligned}
\Pr(0,0) &= \Pr(F_2 \; and \; M_3) + \Pr(F_3 \; and \; M_2) + \Pr(F_3 \; and \; M_3) \\
&\quad +0.5\Pr(F_2 \; and \; M_2) + 0.25\Pr(F_4 \; and \; M_2) + 0.25\Pr(F_2 \; and \; M_4) \\
\Pr(1,0) &= \Pr(F_3 \; and \; M_1) + \Pr(F_3 \; and \; M_4) + \Pr(F_4 \; and \; M_1) \\
&\quad +0.5\Pr(F_4 \; and \; M_4) + 0.25\Pr(F_4 \; and \; M_2) + 0.25\Pr(F_2 \; and \; M_4) \\
\Pr(0,1) &= \Pr(F_1 \; and \; M_3) + \Pr(F_1 \; and \; M_4) + \Pr(F_4 \; and \; M_3) \\
&\quad +0.5\Pr(F_4 \; and \; M_4) + 0.25\Pr(F_4 \; and \; M_2) + 0.25\Pr(F_2 \; and \; M_4) \\
\Pr(1,1) &= \Pr(F_1 \; and \; M_1) + \Pr(F_1 \; and \; M_2) + \Pr(F_2 \; and \; M_1) \\
&\quad +0.5\Pr(F_2 \; and \; M_2) + 0.25\Pr(F_4 \; and \; M_2) + 0.25\Pr(F_2 \; and \; M_4)
\end{aligned} \tag{2-4}$$

By replacing $U^i(y_m, y_f)$ with the results in Equation (2-2), we can define conditions on the error terms (random components) for each of the reaction functions to hold. Since only differences in the utilities are relevant in determining which reaction function holds, it follows that we can only identify differences in some of the parameters. These differences are $\alpha^i = \alpha_1^i - \alpha_0^i, \beta^i = \beta_1^i - \beta_0^i$ for i=m,f. Combining this with Equation (2-4), we can derive probability statements for each outcome in terms of the model parameters. The likelihood function along with the relevant *Stata* code is available from the author on request.

While previously we have explicitly assumed an equal probability distribution, we can make the approach more general by introducing additional parameters into the model which specify the probability each equilibrium is picked in the case of multiple equilibria or non-existence of equilibrium. More recent literature has focused on approaches which do not require the use of an equilibrium selection rule (see Berry and Reiss (2006)). To provide some guidance regarding the likely effects of incorrectly imposing an equilibrium selection rule a sensitivity analysis was undertaken. It was found that varying the weights used has little impact on the estimated conditional probabilities of volunteering for the male and female, since there is very little variation in the estimates across runs. In addition, there is a small amount of variation in the estimated coefficients on the explanatory variables implying little change in the inferences associated with the explanatory variables. The main impact of varying the weights is on the separation of the endogenous effects in the model as measured by α^f and α^m and the correlation in the error terms. It was found that decreases in the correlation in the error terms are associated with increases in α^f and α^m. This implies that as the estimated size of the positive endogenous effect increases, the magnitude of the negative correlation between the unobservables increases to offset this change. Due to this, the final estimation results were produced with equal probability weights.

2.4 A cooperative choice model – Mixed Pareto Optimality/Nash

The equilibrium concept used in this model is a modification of that used in the Nash game. To define how the observed outcome is generated from the latent variables we follow the approach of Kooreman (1994) by dividing the possible situations into three cases as follows. In each case the same general approach of attempting to find the Nash equilibrium first and comparing it to the Pareto optimal allocations is followed. The payoffs in the game are given by the utilities specified in Equation (2-2).

1. Unique Nash equilibrium
    a. If the Nash equilibrium is also Pareto optimal then this is assumed to be the observed outcome.
    b. If the Nash equilibrium is not Pareto optimal there exists exactly one outcome at which both the male and the female are better off when compared to the Nash equilibrium. The players are assumed to choose this Pareto efficient allocation.
2. Two Nash equilibria (at least one of these will be Pareto optimal)
    a. If only one is Pareto optimal, this is assumed to be the observed outcome.
    b. If both Nash equilibria are Pareto optimal, the players are assumed to choose one of them with equal probability.
3. No Nash equilibrium – in this case the game may have two, three or four Pareto optimal allocations. The players are assumed to randomly choose one of these Pareto optimal allocations with equal probabilities.

Using this equilibrium concept, given the rankings of the four possible utilities each player may receive it is possible to find the observed outcome. After imposing an assumption for the distribution of the differences in the error terms in Equation (2-2) it is possible to find the probability of a particular utility ranking occurring as a function of the model parameters. This makes it possible to find the probability of each of the four observed outcomes as a function of the model parameters. Note that it is only possible to identify the differences of some of the parameters in Equation (2-2) and as such we define $\beta^i = \beta_1^i - \beta_0^i$ for i=m,f. Further details regarding the likelihood function along with the relevant *Stata* code are available from the author on request.

Since there are 4! or 24 possible rankings of the utilities for each partner meaning there are 24^2 possible combinations of utility rankings for both partners, this approach becomes cumbersome without imposing some assumptions to reduce the number of possible utility rankings each partner may have. In using the model in this paper, we will assume that $\alpha_1^m > 0, \alpha_0^m > 0, \alpha_1^f > 0$ and $\alpha_0^f > 0$ in order to reduce the number of possible cases. This is equivalent to assuming that an individual's partner volunteering has a positive effect on their own utility regardless of whether they volunteer or not. It is also distinct from assuming the direction or existence of an endogenous effect in volunteering (i.e. that an individual's partner volunteering directly affects their own probability of volunteering) since this depends on the differences $\alpha_1^m - \alpha_0^m$ and $\alpha_1^f - \alpha_0^f$.

While it may not be clear that such an assumption is valid and further investigation may be required, at this stage it is necessary to reduce the number of possible cases and it is also possible to provide some justification for it. In particular, if there is some spill-over benefit of volunteering between partners then this would imply that the structural parameters are all positive. A spill-over benefit may occur because the individual's partner volunteering makes the household appear charitable which in turn makes the individual appear more charitable gaining them social approval. This fits with the characterisation of volunteering as a conscience good or activity by Freeman (1997).

2.5 Possible endogeneity of hours worked and income

There is a possibility that some of the explanatory variables being used are not exogenous to the volunteering decision. The variables which are most likely to cause concern in this regard are income and hours worked. While this endogeneity will not be accounted for in the models used in this paper, the purpose of this section is to highlight the likely severity of this issue along with drawing attention to it as a possible issue with the estimation results.

Under the investment model of volunteering, income will clearly be endogenous since volunteering increases income. Given the limited evidence for the investment model, this in itself is not a major cause for concern. In addition, few papers in the literature have attempted to control for the endogeneity of income (Day and Devlin (1996) is one exception where determinants of income were included in the regression rather than income itself).

Whether hours worked is endogenous essentially depends on how free an individual is to set their hours worked. As Brown and Lankford (1992) discuss there are a variety of theoretical models which imply that hours are constrained. In the context of volunteering, a worker may have to commit to a remunerative job with fixed hours before committing time to volunteering which implies that hours worked is exogenous to the volunteering decision. If on the other hand hours are unconstrained then the time allocated to working may be decided jointly with time allocated to volunteering, implying that hours worked is endogenous. Anecdotal evidence suggests the nature of most employment contracts in Australia is such that the prior situation is more likely to be appropriate. In addition, there is some evidence in HILDA to suggest that volunteering has little impact on hours worked since very few individuals indicated they are not looking for work because they do voluntary/unpaid work. As discussed in Section 3.2, these observations were removed from the sample. Also, one question within HILDA asks respondents to rate their satisfaction with the hours they work on a scale from 0 (totally dissatisfied) to 10 (totally satisfied). While a large majority of males and females in the sample gave responses of 5 or higher, only 23.8% of males and 34.1% of females responding to this question gave a value of 9 or 10. This provides some evidence that individuals are constrained in the hours they work.

3 Data

3.1 The HILDA Survey

The data used in this study was obtained from Wave 6 of the Household, Income and Labour Dynamics in Australia (HILDA) Survey. A summary of the relevant information on HILDA provided by Watson (2008) follows. The HILDA Survey began with Wave 1 in 2001 which contained a large national probability sample of Australian households occupying private dwellings. In total, 19 914 individuals from 7682 households were interviewed in Wave 1.

Each subsequent wave attempts to interview all members of the households providing at least one interview in Wave 1 and as such HILDA is a panel data set. In addition, the sample includes any new household members resulting from changes in the composition of the original households. The survey is conducted at yearly intervals with most of the fieldwork being completed in spring of each year. The data for Wave 6 was collected in 2006.

The key characteristic of HILDA which is relevant for the analysis in this study is that HILDA uses the household as the sampling unit, attempts to interview all members of the household and records the relationships within the household. As such for all those individuals in the dataset who have a partner, it is possible to identify their partner within the dataset and obtain their partner's survey responses. This differentiates the dataset from other datasets containing information on volunteering such as the Australian Bureau of Statistics' Voluntary Work Survey, 2000, (only the 2000 release is available as a Confidentialised Unit Record File) which only contains data on a representative individual from the household (ABS, 2001).

The analysis presented here focuses on a single cross-section. This represents an obvious and non-trivial first stage of modelling volunteering that will inform the development of models that exploit the panel structure of HILDA. These developments are left for further research. Although data on volunteering behaviour is available in all waves of HILDA, Wave 6 of HILDA will be used for the analysis for several reasons. Firstly, Wave 6 of HILDA provides an additional question on volunteering behaviour which is not provided in previous waves. Given the apparent sensitivity of responses to questions on volunteering to the way the question is asked, this will be used for comparison with the other data on volunteering behaviour.

In addition, Waves 5 through 7 provide data on who within the household is responsible for a variety of decisions. Similar data is used in the context of monetary donations. Andreoni, et. al. (2003) considers the relationship between who within the household is primarily responsible for giving decisions and donations by the household. While the data in HILDA is not identical, it may still be useful for further work which considers differences between couples where both individuals make the same volunteering decision (i.e. both don't volunteer/both volunteer) and make the opposite volunteering decision (i.e. one volunteers while the other doesn't).

Finally, within the special topics section, Wave 6 of HILDA contains questions on wealth which a priori would seem to be an important determinant of volunteering choices. For these reasons and the fact Wave 6 is one of the most recent available, the analysis will be undertaken using Wave 6 of HILDA.

3.2 Sample selection

Wave 6 of HILDA contains data on 12 905 responding individuals from 6538 fully responding households and 601 partially responding households. This sample was obtained by approaching a total of 9351 households. The final sample of 3255 couples used for estimating the models consists of all heterosexual couples where both individuals completed the PQ and SCQ, which are not part of multi-family households. In addition, both individuals must have given a plausible value for hours volunteered and hours worked, must not have been required by Centrelink of a Job Network provider to do volunteer work and mustn't be not looking for work because they do volunteer work. Finally, couples who are living with their spouse less than half the time or either of them stated they are separated or never married and not de facto were removed. Complete details regarding number of observations removed are available from the author on request.

3.3 Treatment of missing data

As detailed in Section 3.2, only two observations were removed from the dataset due to missing data in the explanatory variables. In the other cases the missing data was handled as follows:

- For the income and wealth variables the imputed values were used.
- If the missing data occurred in a continuous variable, the continuous variable was set to zero and a dummy variable was generated which was 1 if the variable was missing and 0 otherwise. Information on these variables is available in the Appendix, with the frequencies of missing observations being available in Table 3-2 and Table 3-3.
- If the missing data occurred in a discrete variable with more than two values which was used to generate a set of dummy variables, a dummy variable was generated which was 1 if the variable was missing and 0 otherwise. Information on these variables is available in the Appendix.
- If the missing data occurred in a variable which was used to generate a dummy variable, the dummy variable was set to zero when the data was missing. The number

of observations affected is small (less than 100 for each variable). Complete details on the number of observations affected are available from the author on request.

3.4 Dependent variable

The dependent variable is derived from the time-use question (B25) in the Self Completion Questionnaire component of HILDA. This question asks individuals how much time they spend on a variety of activities in a typical week with part h) being "Volunteer or charity work (for example, canteen work at the local school, unpaid work for a community club or organisation)". To obtain a dummy variable for whether each partner volunteers, this was recoded to 1 if the individual undertakes one or more hours of volunteer or charity work and 0 otherwise. Table 3-1 shows a cross-tabulation of the dependent variable for the 3255 couples in the sample which illustrates the correlation between each couple's volunteering decisions noted by Freeman (1997). We can see that there are substantially more couples where both volunteer (i.e. (1,1) outcomes) than would be expected under independence. In particular, the relative frequency of (1,1) is $\frac{301}{3255}=0.092$ compared with an expected relative frequency under independence of $\frac{628}{3255}\times\frac{793}{3255}=0.047$.

Table 3-1 - Volunteering outcomes for males/females

Male \ Female	0	1	Total
0	2135	492	2627
1	327	301	628
Total	2462	793	3255

The second question on volunteering behaviour in Wave 6 asks "In general, how often do you do the following things: i) Volunteer your spare time to work on boards or organising committees of clubs, community groups or other non-profit organizations?" with the responses being never, rarely, occasionally, sometimes, often and very often. Given the sensitivity of responses to questions on volunteering to the way the question is asked noted by Freeman (1997), the responses to this question and to the dependent variable derived previously were compared. In comparing the variables, it was clear that there is a strong correlation between the two variables and that the two measures are relatively consistent after considering differences in what they are measuring.

3.5 Key explanatory variables

Given the nature of the study, there are a wide variety of plausible explanatory variables available in HILDA which could be included as controls, many of which have been identified in previous studies. There is only one major exception in terms of variables which have previously been identified in the literature as important but are not available. This is that no data is available on whether an individual was asked to volunteer which Freeman (1997) identifies as an important determinant of volunteering behaviour.

The Appendix details the variables that will be used in the study and their definitions. Since many variables relate to an individual rather than a couple, prefixes are used to distinguish between the male and female's characteristics. The prefix "part_" is placed in front of the variable name to indicate it refers to the female partner's characteristics. If the variable does not have a prefix it refers to the male partner's characteristics or a household characteristic. The base category for each set of dummy variables is provided in the table.

While the rationale for using many of these variables such as age, demographic characteristics, education level, health, hours worked and number of children is clear, the motivation for including a small number of them may not be clear. The variables arrived_less_than_10y, yr_curr_addr, owns_home and likely_to_move are intended to aid in capturing an individual's level of integration with their local community which is likely to have an impact on whether or not they volunteer. The variables fixedterm_casual, irregular_hours, more_than_one_job, office_worker, satisfied_balance_work and worried_about_job are intended to capture characteristics of an individual's employment which may be relevant in determining whether or not they volunteer (e.g. if their hours are irregular they may have difficulty committing to a volunteering activity). Some of these are motivated by Polidano, et. al. (2009) who find a positive relationship between volunteering and being in labour market transition. Finally, pressed_for_time is included since it may have an impact on an individual's ability to commit to a volunteering activity and retire_in_5y is included on the basis that being close to retirement may mean an individual takes on additional voluntary activities as they transition into retirement.

3.6 Summary statistics

Means for the dummy explanatory variables are provided in Table 3-2 (these are all measured at the individual level), while the mean, standard deviation, minimum and maximum are reported for the continuous explanatory variables in Table 3-3. The results in Table 3-2 indicate that a substantial proportion of the sample is born overseas (around 20%), however very few are recent arrivals (around 2-3% arrived in the 10 years prior to the survey). In addition, the majority of couples live in major urban areas and around 25% of individuals have a postgraduate or bachelors level qualification with slightly more females having one of the two qualifications than males. Finally, a large proportion of the sample owns their own home (over 80%) and has self-assessed health status of good, very good or excellent.

The results in Table 3-3 indicate that the males in the sample are on average slightly older than the females and work substantially more hours than females (the average for males is close to double that for females). In addition, males have higher individual disposable incomes than females in the sample.

Table 3-2 – Summary statistics for dummy explanatory variables

Variable	Male Mean	Female Mean	Variable	Male Mean	Female Mean
overseasborn_english	0.1263	0.1054	irregular_hours	0.1551	0.1244
overseasborn_other	0.1084	0.1177	fixedterm_casual	0.1143	0.1677
arrived_less_than_10y	0.0206	0.0283	satisfied_balance_work	0.6003	0.5020
aboriginal_torres	0.0123	0.0123	retire_in_5y	0.0578	0.0535
state_vic	0.2498	0.2498	office_worker	0.4737	0.5475
state_qld	0.2123	0.2123	unemployed	0.0172	0.0181
state_sa	0.0965	0.0965	retired	0.2089	0.2452
state_wa	0.1011	0.1011	worried_about_job	0.1579	0.0989
state_tas	0.0326	0.0326	child_under_10	0.2876	0.2866
state_nt	0.0061	0.0061	long_term_hlth_cond	0.1828	0.1662
state_act	0.0197	0.0197	health_excellent	0.0952	0.1041
other_urban	0.2335	0.2335	health_verygood	0.3318	0.3733
bounded_locality	0.0316	0.0316	health_good	0.3662	0.3389
rural_balance	0.1515	0.1515	health_fair	0.1413	0.1186
postgrad	0.1051	0.0992	health_poor	0.0326	0.0289
bachelor	0.1339	0.1521	owns_home	0.8575	0.8154
post_school	0.4181	0.2544	pressed_for_time	0.3539	0.4452
yr12	0.0962	0.1398	likely_to_move	0.1195	0.1183
hours_vary	0.0243	0.0200	religion	0.1330	0.1579
more_than_one_job	0.0513	0.0562			

Finally, comparing the mean and standard deviation for different explanatory variables across four groups of observations (both volunteer, male volunteers while female doesn't, female volunteers while male doesn't, both don't volunteer) suggests a number of relationships in the data (this comparison is not included in the tables). In particular, volunteers are generally older and more highly educated with a greater proportion of volunteers holding postgraduate degrees. As would be expected, hours worked appears to have a negative relationship with volunteering with volunteers generally working fewer hours than non-volunteers.

Table 3-3 – Summary statistics for continuous variables

Variable	Mean	Std Dev	Min	Max
age	49.15	15.55	16	93
part_age	46.68	15.20	17	93
hours_worked	32.01	22.84	0	100
part_hours_worked	18.59	18.89	0	112
ind_disp_income	44.18	37.64	-86.9	375.639
part_ind_disp_income	26.47	23.76	-61	375.639
num_child	0.9447	1.1728	0	8
part_num_child	1.0277	1.2127	0	8
yr_curr_addr	10.55	11.82	0	80.35
part_yr_curr_addr	10.25	11.40	0	70.56
yr_curr_addr_missing	0.0061			
part_yr_curr_addr_missing	0.0065			
hh_gross_inc	92.84	76.15	-86.9	842.344
hh_home_equity	302.51	417.94	-450	4426.46
hh_net_worth	806.33	1369.06	-918.7	12798.92

In addition, volunteering couples (those where both volunteer) have a greater proportion of the males being office workers than non-volunteering couples (the opposite is true for the females). Volunteers are more likely to be retired, more likely to attend religious services and less likely to have young children (defined as under 10). Finally, volunteers generally have higher net worth.

4 Estimation Results

4.1 Selected parameter estimates from bivariate probit and game theoretic models

Table 4-1 includes some key parameter estimates from the game theoretic models. The set of explanatory variables included in each of these models is identical. For the game theoretic models, the parameters are defined in Section 2.3, in particular see Equation (2-2). The parameter ρ is the correlation between the error terms. In some cases it is not possible to individually identify α_1^m and α_0^m or α_1^f and α_0^f but only their differences. In these cases, the two cells are merged and the difference is reported.

Table 4-1 - Key parameter estimates

Model	ρ	Log-likelihood	α_1^m	α_0^m	α_1^f	α_0^f
Nash game	-0.9298 (0.0520)	-2934.85	1.4537 ** (0.1364)		1.2357 ** (0.1351)	
Stackelberg male leader	-0.4250 (0.1809)	-2932.90	1.1221 ** (0.3815)	0.3591 (0.3134)	0.5043 * (0.2040)	
Stackelberg female leader	-0.4101 (0.1720)	-2932.29	0.8055 ** (0.2297)		0.7839 ** (0.2812)	0.4813 (0.3048)
Pareto Nash game	-0.4101 (0.1720)	-2932.29	0.8055 ** (0.2297)	0.00000	0.7840 ** (0.2813)	0.4813 (0.3048)
Number of observations used in all models: 3255						

Note: Standard errors in round brackets, *, ** denote significance at 5%, 1% level

In addition to the results in Table 4-1, some selected estimates of the parameters on the explanatory variables in the game theoretic models are reported in Table 4-2. While a number of additional variables were controlled for in all the models, the estimated coefficients were generally insignificant and as such only some key parameter estimates are reported in Table 4-2. The additional variables that were controlled for are overseasborn_english, arrived_less_than_10y, aboriginal_torres, state dummy variables, yr_curr_addr, yr_curr_addr_missing, likely_to_move, irregular_hours, fixedterm_casual, retire_in_5y, worried_about_job, long_term_hlth_cond, self-assessed health dummy variables, pressed_for_time, hh_gross_inc, hh_home_equity, hh_net_worth, ind_disp_income and owns_home. The definitions for these variables are provided in the Appendix.

Table 4-2 – Selected coefficient estimates

	Stackelberg male leader	**Stackelberg female leader**	**Nash game**	**Pareto Nash game**
Male equation				
overseasborn_other	-0.3234 *** (0.1029)	-0.3102 *** (0.0995)	-0.1946 ** (0.0835)	-0.3103 *** (0.0995)
age	0.0246 * (0.0145)	0.0231 (0.0141)	0.0150 (0.0120)	0.0231 (0.0141)
age_sq	-0.0002 (0.0001)	-0.0002 (0.0001)	-0.0001 (0.0001)	-0.0002 (0.0001)
religion	0.4960 *** (0.0936)	0.4776 *** (0.0897)	0.3701 *** (0.0671)	0.4776 *** (0.0897)
other_urban	0.1172 (0.0732)	0.1139 (0.0713)	0.0867 (0.0666)	0.1139 (0.0713)
bounded_locality	0.1020 (0.1568)	0.1013 (0.1531)	0.0855 (0.1455)	0.1013 (0.1531)
rural_balance	0.1286 (0.0842)	0.1235 (0.0816)	0.0639 (0.0765)	0.1235 (0.0816)
postgrad	0.5329 *** (0.1079)	0.5201 *** (0.1045)	0.4297 *** (0.0867)	0.5201 *** (0.1045)

bachelor	0.3276 *** (0.1006)	0.3204 *** (0.0976)	0.2827 *** (0.0803)	0.3204 *** (0.0976)
yr12	0.1458 (0.1124)	0.1449 (0.1094)	0.1599 * (0.0878)	0.1449 (0.1094)
hours_worked	-0.0073 *** (0.0023)	-0.0071 *** (0.0023)	-0.0051 *** (0.0018)	-0.0071 *** (0.0023)
hours_vary	-0.4522 ** (0.1990)	-0.4382 ** (0.1945)	-0.4144 ** (0.1649)	-0.4382 ** (0.1945)
more_than_one_job	0.2782 ** (0.1141)	0.2669 ** (0.1115)	0.2160 ** (0.0957)	0.2669 ** (0.1115)
satisfied_balance_work	0.1768 ** (0.0802)	0.1721 ** (0.0780)	0.1152 * (0.0652)	0.1721 ** (0.0780)
office_worker	0.1967 *** (0.0743)	0.1905 *** (0.0726)	0.1454 ** (0.0609)	0.1905 *** (0.0726)
unemployed	0.1425 (0.2389)	0.1440 (0.2334)	0.0999 (0.1935)	0.1440 (0.2334)
retired	0.3533 ** (0.1470)	0.3452 ** (0.1431)	0.2640 ** (0.1182)	0.3452 ** (0.1431)
child_under_10	-0.2187 *** (0.0813)	-0.2124 *** (0.0795)	-0.2113 *** (0.0743)	-0.2124 *** (0.0795)
num_child	0.1341 *** (0.0339)	0.1296 *** (0.0329)	0.0932 *** (0.0284)	0.1296 *** (0.0329)
Constant	-2.4949 *** (0.4034)	-2.4608 *** (0.3946)	-2.1612 *** (0.3400)	-2.4608 *** (0.3946)
Female equation				
part_overseasborn_other	-0.3079 *** (0.0883)	-0.3173 *** (0.0904)	-0.2532 *** (0.0756)	-0.3173 *** (0.0904)
part_age	0.0894 *** (0.0138)	0.0912 *** (0.0142)	0.0734 *** (0.0128)	0.0912 *** (0.0142)
part_age_sq	-0.0009 *** (0.0001)	-0.0009 *** (0.0001)	-0.0007 *** (0.0001)	-0.0009 *** (0.0001)
part_religion	0.5731 *** (0.0821)	0.5921 *** (0.0863)	0.4537 *** (0.0626)	0.5921 *** (0.0863)
part_other_urban	0.1345 ** (0.0662)	0.1385 ** (0.0680)	0.1168 * (0.0631)	0.1385 ** (0.0680)
part_bounded_locality	-0.0019 (0.1481)	-0.0079 (0.1521)	-0.0066 (0.1412)	-0.0079 (0.1521)
part_rural_balance	0.2003 *** (0.0744)	0.2096 *** (0.0765)	0.1662 ** (0.0721)	0.2096 *** (0.0765)
part_postgrad	0.2199 ** (0.0974)	0.2305 ** (0.1001)	0.1600 ** (0.0811)	0.2305 ** (0.1001)
part_bachelor	0.1898 ** (0.0861)	0.1924 ** (0.0878)	0.1263 * (0.0698)	0.1924 ** (0.0878)
part_yr12	0.1010 (0.0828)	0.1081 (0.0850)	0.0650 (0.0700)	0.1081 (0.0850)
part_hours_worked	-0.0140 *** (0.0024)	-0.0142 *** (0.0025)	-0.0111 *** (0.0021)	-0.0142 *** (0.0025)
part_hours_vary	-0.2586 (0.1784)	-0.2739 (0.1835)	-0.1814 (0.1490)	-0.2739 (0.1835)
part_more_than_one_job	0.3767 *** (0.1055)	0.3871 *** (0.1077)	0.3125 *** (0.0880)	0.3871 *** (0.1077)

part_satisfied_balance_work	0.0189 (0.0774)	0.0227 (0.0792)	0.0232 (0.0648)	0.0227 (0.0792)
part_office_worker	0.0972 (0.0956)	0.0965 (0.0976)	0.0855 (0.0805)	0.0965 (0.0976)
part_unemployed	0.1688 (0.1924)	0.1635 (0.1963)	0.1609 (0.1557)	0.1635 (0.1964)
part_retired	0.0206 (0.1027)	0.0191 (0.1052)	0.0277 (0.0858)	0.0191 (0.1052)
part_child_under_10	-0.0467 (0.0811)	-0.048 (0.0832)	-0.0028 (0.0739)	-0.0480 (0.0832)
part_num_child	0.0719 ** (0.0299)	0.0771 ** (0.0311)	0.0582 ** (0.0274)	0.0771 ** (0.0311)
Constant	-3.5438 *** (0.3609)	-3.6014 *** (0.3717)	-3.1924 *** (0.3315)	-3.6014 *** (0.3717)

Standard errors in round brackets, *, **, *** denote significance at the 10%, 5%, 1% levels

4.2 Average partial effects of selected explanatory variables

To assist in interpreting the parameter estimates, for each of the game theoretic models a selection of average partial effects on the male and female probabilities of volunteering were calculated. These have been reported in Table 4-3. Due to the nature of the models, a change in the male or female characteristics will have an impact on both the male and female probabilities of volunteering. These probabilities were calculated as follows:

1. Calculate the predicted probabilities of the four possible observed outcomes for the base group, which consists of all couples in the sample where the relevant individual (male or female) has the initial value for the variable we wish to calculate the effect of, i.e. if we wish to calculate the effect of the male retiring, the base group would consist of all couples where the male is not retired.
2. Depending on whether we wish to calculate the effect for a change in a male or female characteristic, adjust the male or female index by the change in the index caused by the change in the variable. i.e. to calculate the effect of the male's education increasing from year 12 to a bachelors degree we adjust the male index by the difference between the coefficients on the bachelors degree and year 12 dummy variables.
3. Recalculate the predicted probabilities of the four outcomes for the base group.
4. Calculate the change in the male probability of volunteering (defined as $P(Male\ volunteering) = P(1,1) + P(1,0)$) and the female probability of volunteering (defined as $P(Female\ volunteering) = P(1,1) + P(0,1)$) for each observation in the base group and average these changes over the base group to obtain the average partial effects.

It is clear that the number of observations used to calculate the average partial effects will vary with the size of the appropriate base group. In addition, the effect of an explanatory variable on the predicted probabilities will depend on the values of all the other explanatory variables. By using the method proposed here, the values of these other explanatory variables will be determined by the sample, thus ensuring appropriate values are used.

Table 4-3 – Average partial effects of selected explanatory variables

	Stackelberg male		**Stackelberg female**		**Nash**		**Pareto Nash**	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Male variables								
Yr 12 to Post school	0.034 (0.020)	0.007 (0.006)	0.033 (0.020)	0.007 (0.006)	0.021 (0.020)	0.008 (0.006)	0.033 (0.020)	0.007 (0.006)
Bachelor to Post grad	0.058 (0.030)	0.011 (0.009)	0.058 (0.031)	0.010 (0.009)	0.050 (0.031)	0.018 (0.009)	0.058 (0.030)	0.010 (0.008)
Age from 20 to 30	0.017 (0.011)	0.002 (0.002)	0.016 (0.012)	0.002 (0.003)	0.012 (0.011)	0.002 (0.002)	0.016 (0.011)	0.002 (0.002)
Hrs. worked from 30 to 40	-0.019 (0.007)	-0.004 (0.003)	-0.018 (0.007)	-0.004 (0.002)	-0.015 (0.007)	-0.006 (0.003)	-0.018 (0.007)	-0.004 (0.002)
Retired	0.095 (0.046)	0.019 (0.015)	0.095 (0.047)	0.018 (0.017)	0.085 (0.046)	0.032 (0.017)	0.095 (0.046)	0.018 (0.015)
Religion	0.138 (0.029)	0.027 (0.018)	0.136 (0.031)	0.025 (0.022)	0.123 (0.030)	0.046 (0.019)	0.136 (0.030)	0.025 (0.017)
Female variables								
Yr 12 to Post school	0.001 (0.006)	0.004 (0.024)	0.001 (0.005)	0.003 (0.024)	0.002 (0.005)	0.006 (0.023)	0.001 (0.006)	0.003 (0.024)
Bachelor to Post grad	0.002 (0.007)	0.009 (0.029)	0.003 (0.007)	0.011 (0.029)	0.004 (0.008)	0.011 (0.031)	0.003 (0.008)	0.011 (0.030)
Age from 20 to 30	0.014 (0.007)	0.073 (0.012)	0.015 (0.007)	0.073 (0.012)	0.018 (0.006)	0.067 (0.011)	0.015 (0.006)	0.073 (0.011)
Hrs. worked from 30 to 40	-0.009 (0.004)	-0.037 (0.006)	-0.009 (0.005)	-0.037 (0.006)	-0.013 (0.004)	-0.035 (0.006)	-0.009 (0.004)	-0.037 (0.006)
Retired	0.001 (0.007)	0.006 (0.030)	0.001 (0.007)	0.005 (0.030)	0.003 (0.008)	0.009 (0.029)	0.001 (0.007)	0.005 (0.029)
Religion	0.043 (0.020)	0.185 (0.031)	0.044 (0.023)	0.187 (0.032)	0.063 (0.021)	0.169 (0.031)	0.044 (0.021)	0.187 (0.030)
Replications	403		461		307		400	

The standard errors for the average partial effects are reported in brackets in Table 4-3, which were calculated using the bootstrap command in *Stata.* The bootstrap results were obtained by resampling with replacement the 3255 couple level observations (note that in the new sample each individual still has the same partner). While this process was repeated 500 times for each model, the actual number of bootstrap replications used to calculate each standard error is reported in Table 4-3. The discrepancy arises because the estimation procedure appears to be somewhat fragile and as a result while the estimation procedure was repeated 500 times, it sometimes failed to converge. In addition, the maximum number of iterations was restricted to 500 rather than the default 16 000 in *Stata* since otherwise a small number of replications consumed a large proportion of the processing time. As a result, in a small number of cases the optimisation algorithm terminated and the results were reported before the usual convergence criteria were satisfied (details of these cases are available on request). These results were still used to compute the statistics in Table 4-3. For some of the models the estimated average partial effects are missing for a large number of replications, which may have a substantial impact on the estimated standard errors. While it is difficult to confirm whether or not this is the case, some reassurance is provided by comparing the estimated standard errors across models. The estimated standard errors are very similar across models (which is expected due to the comparable coefficient estimates and standard errors, and average partial effects) despite the number of successful replications varying considerably.

4.3 Conditional probabilities of volunteering

Table 4-4 – Conditional probabilities of volunteering

Model & Probability	Mean	Std. Dev.	Min	Max
$P(y^m = 1 \vert y^f = 1)$				
Stackelberg male leader	0.3196	0.1465	0.0006	0.8714
Stackelberg female leader	0.3239	0.1436	0.0007	0.8583
Nash	0.3014	0.1746	0.0000	0.9140
Pareto Nash	0.3239	0.1436	0.0007	0.8583
$P(y^m = 1 \vert y^f = 0)$				
Stackelberg male leader	0.1499	0.1161	0.0004	0.8596
Stackelberg female leader	0.1510	0.1205	0.0004	0.8973
Nash	0.1483	0.1067	0.0013	0.8211
Pareto Nash	0.1510	0.1205	0.0004	0.8973
$P(y^f = 1 \vert y^m = 1)$				
Stackelberg male leader	0.4097	0.1698	0.0095	0.9509
Stackelberg female leader	0.4124	0.1622	0.0090	0.9429
Nash	0.3834	0.2044	0.0000	0.9746
Pareto Nash	0.4124	0.1622	0.0090	0.9429
$P(y^f = 1 \vert y^m = 0)$				
Stackelberg male leader	0.2047	0.1422	0.0059	0.9608
Stackelberg female leader	0.2053	0.1453	0.0054	0.9698
Nash	0.2034	0.1324	0.0106	0.9682
Pareto Nash	0.2053	0.1453	0.0054	0.9698

These conditional probabilities have been calculated as $P(y^m = 1|y^f = 1) = \frac{P(1,1)}{P(1,1)+P(0,1)}$, $P(y^m = 1|y^f = 0) = \frac{P(1,0)}{P(1,0)+P(0,0)}$, $P(y^f = 1|y^m = 1) = \frac{P(1,1)}{P(1,1)+P(1,0)}$ and $P(y^f = 1|y^m = 0) = \frac{P(0,1)}{P(0,1)+P(0,0)}$. The values in Table 4-4 were obtained by finding the predicted probabilities for each observation of the four observed outcomes, calculating the conditional probabilities for each observation and reporting the summary statistics for these conditional probabilities in the table.

5 Discussion

5.1 Estimated impacts of explanatory variables

The coefficient estimates and significance levels are generally comparable across all the models that have been considered, with the main exception being the magnitude of the coefficient estimates is often smaller in the Nash model. In addition, the coefficient estimates are largely in line with our expectations. As such, while the following discussion focuses on the coefficient estimates reported in Table 4-2 for the Stackelberg female leader model, the comments are generally the same for the other models. The average partial effects reported in Table 4-3 are also referenced to provide some information regarding the economic significance of the estimates.

The estimated impact of being overseas born is negative for both the male and the female and is statistically significant at the 1% level in the case of being overseas born in a non-English speaking country. This can be attributed to the fact an individual born overseas may feel less integrated with their local community and as such is less likely to volunteer. In addition, age enters the model in a quadratic form and as such has a positive effect until a turning point at around 58 years for males and 51 years for females and thereafter has a negative effect. Both age and age squared are individually statistically significant in the female equation at the 1% level and are jointly statistically significant at the 1% level in the female equation. The average partial effect for a change in the female's age on the female's probability is also statistically significant at the 1% level. This matches findings by Freeman (1997) that volunteering peaks in the 35-54 age range. When considering the average partial effects of age in Table 4-3, it can be seen that changes in age have a much larger effect for females than males and as such while age has an economically significant effect for females (when taking into account the relatively low rates of volunteering in the sample), it does not for males. In fact, the effect of a change in the female's age on the male's probability of volunteering as reported in Table 4-3 (this effect is due to the impact of the female's volunteering decision on the males) is around the same as the effect of a similar change in the male's age on the male's probability of volunteering.

Number of children has a positive and statistically significant effect (1% level in male equation, 5% level in female equation) on an individual's probability of volunteering, which is similar to findings by Carlin (2001). Having a young child has a negative effect on volunteering which may be attributable to difficulties in finding appropriate care for children while volunteering. Attendance at religious services has a large positive and statistically significant effect on an individual's probability of volunteering which is in line with results from Gomez and Gunderson (2003). When considering the average partial effects reported in Table 4-3, the effect is economically significant with an increase in the male probability of volunteering of around 0.14 and a larger increase of around 0.19 for the female (both of these effects are statistically significant at the 1% level). Gomez and Gunderson (2003) suggest that this is due to traits within individuals which motivate them to engage in socially oriented activities and the fact many religions encourage such selfless behaviour.

There is some evidence that the size of the area an individual lives in has an effect on volunteering with living in an area classified as rural balance having a positive and statistically significant (1% level in female equation) effect on an individual's probability of volunteering, relative to the base category which is Major Urban. This is likely to be attributable to stronger communities in these areas. There is limited evidence for state effects since none of the state dummy variables are significant at the 5% level and are generally small in magnitude.

In addition, the coefficients on the education dummy variables indicate that the more highly educated are more likely to volunteer since all of these coefficients are positive and several are statistically significant at the 1% level (note that the base group is those who did not complete Year 12). This is in line with many previous studies on volunteering, for example Freeman (1997) finds that the more highly educated are more likely to volunteer. Table 4-3 indicates that while economically the effect of education is significant for the male, it is not for the female (in most of the models the average partial effect of Bachelor to Post grad for the male is statistically significant at the 5% level).

In regard to the employment variables, hours worked has a negative and statistically significant effect (1% level) on both the male and female's probability of volunteering. Table 4-3 indicates that the effect is larger for females than males, with the effect being economically quite small for males and around twice the size for females (the estimated average partial effect is statistically significant at the 1% level in all the models excluding the Nash model where it is significant at the 5% level). While this is expected when considering the budget constraint in Section 2.1 since working additional hours reduces the amount of time available for volunteering, in a previous study Freeman (1997) finds that the data does not support this simple substitution story. Interestingly, whether an individual has more than one job has a positive and statistically significant (5% - male equation; 1% - female equation) effect on their probability of volunteering. This may be attributable to factors such as those who work multiple jobs are better able to manage time commitments and therefore fit in volunteering activities. Of the other employment variables, only satisfied_balance_work, office_worker and retired are positive and statistically significant (only in the male equation at the 5% level, 1% level and 5% level respectively). The effect of being retired is not economically significant for the female but is for the male with Table 4-3 indicating an increase in the male's probability of volunteering of around 0.1 (the average partial effect for the male is statistically significant at the 5% level in all the models except the Nash model where it is significant at the 10% level). It is expected that satisfied_balance_work and retired have a positive effect since those who feel they are better able to balance work and non-work commitments would be more likely to volunteer and retired people are more likely to volunteer due to greater availability of time. In regard to office_worker it is difficult to form any strong expectations of the direction of the effect.

Finally, the wealth and income variables do not appear to play a substantial role in determining volunteering behaviour (coefficients are not reported). Brown and Lankford (1992) provide some discussion as to whether hours worked or income is the relevant control variable and given the nature of many employment contracts in the Australian labour market it is not surprising that income has a limited effect on volunteering behaviour.

5.2 Estimated endogenous effects of volunteering

Each of the models considered provides support for there being endogenous effects in volunteering behaviour. All the models provide a substantial improvement in the log-likelihood over the bivariate probit with no endogenous effects (-2942.00), which is nested in each of the other models. Formally testing the difference using a likelihood ratio test we find that the improvement is statistically significant at the 1% level in all models. In addition, the structural parameters reported in Table 4-1 are often statistically significant and reasonably large in comparison to other coefficient estimates reported in Table 4-2.

Further evidence of the presence of endogenous effects in volunteering behaviour is provided by comparing the correlation parameter ρ across models. In the bivariate probit model with no endogenous effects the correlation parameter is positive and statistically significant (0.359), however in all the other models it is negative and statistically significant. This indicates that the bivariate probit with no endogenous effects is incorrectly specified and as a result the endogenous effects are being picked up by the correlation parameter.

To provide some guidance as to the impact of each partner's volunteering decision on the others, the conditional probabilities of volunteering reported in Table 4-4 can be used. It should be noted that the differences in these probabilities (i.e. $P(y^m = 1 | y^f = 1) - P(y^m = 1 | y^f = 0)$ and $P(y^f = 1 | y^m = 1) - P(y^f = 1 | y^m = 0)$) are affected not only by the magnitudes of the structural parameters but also by the magnitude of the correlation parameter. However, since the correlation parameter is negative in all the game theoretic models (and therefore acts to reduce the size of these differences), the impact of the endogenous effect is at least as large as these differences.

Table 4-4 indicates that the conditional probabilities of volunteering are similar across the four game theoretic models. In addition, it appears that the impact of the partner's volunteering decision on their spouse's probability of volunteering is substantial with a male whose partner volunteers being around 15 percentage points more likely to volunteer and a female whose partner volunteers being around 20 percentage points more likely to volunteer. While volunteering has been modelled as a discrete decision, this suggests that volunteering (when modelled in terms of hours volunteered) is a strategic complement and therefore the individual's reaction functions are upward sloping. This indicates that policies which encourage individuals to volunteer are likely to have substantial multiplier effects since an individual choosing to volunteer has a substantial positive impact on their partner's probability of volunteering.

5.3 Model selection

Each of the models considered in this paper implies a different structure for couple decision making and as such if it is possible to differentiate between them and choose a preferred model this will provide some insights into the nature of decision making within couples. A possible approach to this is to use the likelihood dominance criterion (LDC) (Pollak and Wales, 1991).

To apply the LDC we note that the Nash model has 103 parameters, both of the Stackelberg leader models have 104 parameters and the Pareto Nash model has 105 parameters. The log-likelihood values for each model are reported in Table 4-1 while the relevant critical values (at the 1% level) for the LDC are reported in Table 5-1. Since the difference in the log-likelihood between the Nash model and the two Stackelberg leader models (1.95 and 2.56) exceeds the critical value of 1.2877 in both cases, we conclude that the LDC prefers the Stackelberg leader models to the Nash model.

Table 5-1 – Critical values for likelihood dominance criterion

$n_2 \setminus n_1$	**103**	**104**
104	0.5805, 1.2877	
105	1.1607, 2.3550	0.5802, 1.2877

Clearly there is little difference between the Pareto Nash model and the two Stackelberg leader models in terms of fit. In particular, the log-likelihood values for the Stackelberg female leader model and the Pareto Nash model are identical to two decimal places. This similarity is not restricted to the log-likelihood values as can be seen by comparing the estimates of the other parameters in Table 4-1 and Table 4-2. The reason for this is that given the restrictions placed on the structural parameters in order to estimate the Pareto Nash model and the differences between the structural parameters, the Pareto Nash model generally predicts the same outcomes as the Stackelberg leader models. It is possible for the Pareto Nash model to also "mimic" the Stackelberg male leader model, however it has tended towards the Stackelberg female leader model due to the lower log-likelihood value for this model.

As such, on the basis of this it may be possible to claim that the Stackelberg female leader model is the preferred model, however it is not clear that this is an appropriate conclusion. This is because the log-likelihood value for the Nash model is somewhat sensitive to the weights that are used in the estimation procedure. If we were to vary the weights in maximizing the log-likelihood value the difference between it and the Stackelberg female leader model is very close to being in the region where the likelihood dominance criterion is indecisive.

In addition, it is possible that the fact the Pareto Nash model mimics the Stackelberg female leader model is a result of the restrictions imposed in order to estimate the model. Further research is required in order to estimate the model without these restrictions and determine whether this is the case. Also, the similarity in fit between the two Stackelberg leader models could be interpreted as meaning that some households have the female acting as leader while others have the male acting as leader which provides some motivation for considering a mixture model rather than concluding the female leader model is preferred.

Finally, it is difficult to differentiate between the models in terms of the substantive inferences. This is due to the similarities between the models discussed in Sections 5.1 and 5.2. In terms of the key research question which relates to the correlation in volunteering decisions, it does not appear to make a great deal of difference which model is used. As a result given the data available on volunteering decisions, it seems difficult to determine what is the underlying decision making structure.

5.4 Implications for volunteering behaviour

As mentioned in Section 5.2, it appears that there are substantial multiplier effects in volunteering behaviour. This is because the observed correlation in volunteering decisions does not seem to be solely due to exogenous or observable characteristics, but can also be attributed to the presence of endogenous effects. There are a variety of possible rationalisations for the presence of these endogenous effects. While it is not possible to distinguish between them on the basis of the available data, we may consider the explanations and corresponding situations given below:

- There is likely to be a strong tendency for couples to be involved in the same organisation and it may be possible that one has encouraged the other to join. For instance a father may begin coaching a team at a local sports club and as a result finds out they are in need of help in the canteen so asks his wife to assist. This fits with Freeman's (1997) findings that being asked to volunteer is an important determinant of volunteering behaviour.

- An individual may be more familiar with the benefits of volunteering if their partner volunteers. For instance, consider a household where the wife decides to join a group of volunteers that look after a local park. After visiting the park and hearing from his wife about the scope of the volunteers' work, the husband then decides to join a similar volunteer organisation.
- Partners may wish to share the social aspect of volunteering. For instance suppose a male retires and as a result decides to join a volunteer organisation to meet new people other than old work colleagues. He may then encourage his partner to join the same organisation so that she also meets the same people.

6 Conclusion

Volunteering is rapidly becoming an area of substantial research interest. This is hardly surprising given recent comments by the Productivity Commission (2009), 'If you count the contribution of 4.6 million volunteers, with an imputed value of $15 billion, this would make it a similar contribution to the retail industry.' Given the retail industry is one of the largest employers in Australia, this highlights the value of volunteering to the Australian community.

This paper explicitly models interactions between couples in making volunteering decisions, allowing the reasons for the observed correlation in couple's volunteering decisions to be uncovered. It was found that there is strong evidence for the presence of a substantial endogenous effect of volunteering. That is, an individual's partner choosing to volunteer has a direct positive impact on their own likelihood of volunteering. This positive impact is estimated to be a 0.15 increase in probability for males whose partners volunteer and a 0.20 increase for females whose partners volunteer.

This is particularly useful from a policy perspective since it indicates that a strong multiplier effect is present. This arises because successful policies which target specific groups of people and encourage them to volunteer will have the added benefit of encouraging their partners to volunteer. This may substantially enhance the benefit of any Government policies to increase volunteering. In addition, the relationship between volunteering and observable factors is similar to that found in overseas studies. The key results are robust to varying the assumption regarding the nature of interactions between couples indicating that they are either not affected by these assumptions or all the models are providing a reasonable approximation to reality.

Nevertheless, volunteering is clearly a fertile area for further research and there are many avenues for extending this work. Firstly, while this cross-sectional study is an obvious starting point, exploiting the panel structure of the HILDA data on volunteering is likely to provide significant information gain by controlling for couple/individual specific effects. In addition, assumptions were made to estimate the Pareto Nash model and Nash model which may have an impact on the estimation results. As such, it may be worthwhile exploring the effects of relaxing these assumptions.

Overall, volunteering is clearly an important activity for the Australian community. This paper has provided an empirical investigation of volunteering while highlighting the importance of interactions between couples in determining behaviour.

Appendix – Variable Definitions

Variable	Definition
aboriginal_torres	1 if individual is of Aboriginal or Torres Strait Islander origin, 0 otherwise
arrived_less_than_10y	1 if individual first came to Australia to live less than 10 years ago (defined as (fanyoa-1996)>0), 0 otherwise
other_urban	1 if individual's Section of State is other urban, 0 otherwise
rural_balance	1 if individual's Section of State is rural balance, 0 otherwise
bounded_locality	1 if individual's Section of State is bounded locality, 0 otherwise
Base category for above dummy variables is individual's Section of State is Major Urban	
bachelor	1 if individual's highest level of education is a bachelors degree, 0 otherwise
post_school	1 if individual's highest level of education is an Advanced Diploma, Diploma or Certificate, 0 otherwise
postgrad	1 if individual's highest level of education is a masters, doctorate, graduate diploma or graduate certificate, 0 otherwise
yr12	1 if individual's highest level of education is Year 12, 0 otherwise
Base category for above dummy variables is individual's highest level of education is below Year 12	
child_under_10	1 if age of individual's youngest own child is less than 10, 0 otherwise
health_excellent	1 if individual's Self-assessed health is excellent, 0 otherwise
health_fair	1 if individual's Self-assessed health is fair, 0 otherwise
health_good	1 if individual's Self-assessed health is good, 0 otherwise
health_poor	1 if individual's Self-assessed health is poor, 0 otherwise
health_verygood	1 if individual's Self-assessed health is very good, 0 otherwise
Base category for self-assessed health dummy variables is individual refused/not stated	
long_term_hlth_cond	1 if individual has a long-term health condition which means they can't work or limits the type or amount of work they can do, 0 otherwise
age	Inidivdual's age last birthday at date of interview
age_sq	Individual's age last birthday at date of interview squared

hh_gross_inc	Household financial year gross income (excluding windfall) in thousands (missing values are imputed and variable is top-coded)
yr_curr_addr	Years at current address
yr_curr_addr_missing	1 if years at current address is missing (in this case yr_curr_addr=0), 0 otherwise
hh_home_equity	Household Home Equity in thousands (missing values are imputed and variable is top-coded)
hh_net_worth	Household Net Worth in thousands (missing values are imputed and variable is top-coded)
fixedterm_casual	1 if individual is employed on a fixed-term contract or casual basis, 0 otherwise
hours_worked	Hours individual usually works per week in all jobs
owns_home	1 if individual owns or is buying own home or any other residential property, 0 otherwise
num_child	Number of own resident children
ind_disp_income	Individual's financial year disposable income in thousands (missing values are imputed and the variable is top-coded)
hours_vary	1 if individual's hours vary (in this case hours_worked=0), 0 otherwise
irregular_hours	1 if individual works a rotating shift, split shift, is on call, has an irregular schedule or some other irregular schedule, 0 otherwise
likely_to_move	1 if individual is likely or very likely to move in the next 12 months, 0 otherwise
more_than_one_job	1 if individual currently has more than one job, 0 otherwise
office_worker	1 if individual is currently employed as an office worker (derived from fjbmocc1), 0 otherwise
overseasborn_english	1 if individual is born outside Australia in Main English speaking country, 0 otherwise
overseasborn_other	1 if individual is born outside Australia in a country which is not Main English speaking, 0 otherwise
Base category for above two dummy variables is Australian born	
pressed_for_time	1 if individual often/almost always feels pushed for time (flsrush equals 1 or 2), 0 otherwise
religion	1 if individual often or very often makes time to attend services at a place of worship, 0 otherwise
retire_in_5y	1 if individual plans to retire within the next 5 years (defined as frtiage1-age<5 & frtiage1-age>=0), 0 otherwise
retired	1 if individual has completely retired from paid work or was never in paid work but considers themselves retired, 0 otherwise
satisfied_balance_work	1 if individual is satisfied with the flexibility to balance work and non-work commitments (fjbmsflx>5), 0 otherwise
state_act	1 if individual lives in Australian Capital Territory, 0 otherwise
state_nt	1 if individual lives in Northern Territory, 0 otherwise
state_qld	1 if individual lives in Queensland, 0 otherwise
state_sa	1 if individual lives in South Australia, 0 otherwise
state_tas	1 if individual lives in Tasmania, 0 otherwise
state_vic	1 if individual lives in Victoria, 0 otherwise
state_wa	1 if individual lives in Western Australia, 0 otherwise
Base category for above state dummy variables is individual lives in New South Wales	
unemployed	1 if individual is unemployed and looking for full time or part time work, 0 otherwise

volunteer	1 if individual undertakes 1 or more hours of volunteer or charity work, 0 otherwise
worried_about_job	1 in individual worries about the future of their job (defined as fjomwf>4), 0 otherwise

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