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Super-sizing renewable energy investment: Examining the portfolio preferences of superannuation fund members*

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Abstract

We use a discrete choice experiment to quantify whether superannuation fund members value higher allocations of funds to renewable energy investments in their portfolios. Mixed logit modelling provides evidence that this valuation is driven by a fund member's environmental sentiment. Latent class modelling suggests that two classes of superannuation fund members exist: those whose preferences align with a renewable energy transition and those who are focused on financial returns. Our results suggest that the understanding of fiduciary duties, to act in the best interests of members, should be broader than a singular focus on financial returns.

Key words: discrete choice experiment, renewable energy transition, socially responsible investment, superannuation.
JEL classifications: D14, Q40

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1 Introduction

Restricting temperatures to within two degrees of the pre-industrial revolution baseline requires a global capital expenditure of approximately US$120 trillion in energy systems before 2050, primarily in renewable energy and energy efficiency (IRENA, 2018). Private sector finance is expected to play a large role given such factors as high government debt in many countries (Kaminker and Stewart, 2012). There are promising signs that private investment is increasing, albeit from a small base. In Australia, which forms the basis of this study, renewable energy investment has increased considerably over recent years. Since 2014, 25 percent of a cumulative AU$15.6 million in green bond issuances has been allocated to the energy sector (Climate Bonds Initiative, 2019). Companies such as AGL (Australia's largest producer of coal-fired electricity) are also making commitments to increase renewable electricity output (Nabtrade, 2020).

A key question arises regarding the types of channels through which further private investment can occur. In Australia and other countries with established pension fund systems, calls have been made to channel funds to renewable energy projects through the pension system (Della Croce et al., 2011). Pension funds are responsible for large amounts of assets, with approximately AU$3 trillion under management in the Australian superannuation industry alone (APRA, 2020a). These channels could therefore enable a more rapid transition towards renewable energy as relevant infrastructure is extremely capital-intensive (Best, 2017).

This article therefore poses the question: *Do Australians value using their superannuation to help fund a renewable energy transition?* This question departs from existing research, which typically discusses the perspectives of institutions towards using private funds for renewable energy investments rather than those of households (Salm, 2018). To answer the question, the article explores the values that Australian superannuation fund members place on higher proportions of both renewable energy and fossil fuel investments by their super funds. As limited market data exists in this context, we present a stated-preference discrete choice experiment (DCE) that asks survey respondents to repeatedly decide between different superannuation fund options with varying proportions of both fossil fuel and renewable energy investments alongside other characteristics. We choose a DCE framework rather than asking respondents directly for their willingness to pay for clean energy both to understand how they value different attributes of pension funds and to ascertain whether reallocations of assets by pension funds could be a potential way to finance renewable energy transitions through private sector funds. By making trade-offs between the superannuation funds, the respondents implicitly reveal the values they place on the inclusion of different types of energy assets in their pension fund portfolios.

There are likely considerable differences between Australian superannuation fund members in their preferences for investing their funds in the renewable energy transition. Increased understanding of these varied preferences is necessary to assist policymakers to find a balance between creating attractive investment environments and preventing over-incentivising renewable energy investments, resulting in overcapacity and high monetary costs (Salm, 2018). Using a latent class analysis of the survey data, we therefore also answer: *What are the characteristics of superannuation fund members who value using their holdings to help finance the renewable energy transition versus those who do not, or value it to a lesser extent?*

The study makes three contributions. First, it provides evidence as to whether demand-side issues constrain the ability of pension funds to invest in renewable energy projects. Direct allocations of large pension funds to sustainable infrastructure were only a fraction of one percent of their investments in 2017 at a global level (OECD, 2018). While supply-side barriers certainly constrain further investment by pension funds in renewable energy, including regulations such as minimum liquidity requirements (OECD, 2015), less is known about the demand-side aspect. Second, the study identifies the characteristics of superannuation fund members who value using private funds for the renewable energy transition. Finally, this study contributes towards the literature on household participation in financing renewable energy investments. While several studies explore the willingness to pay by households for renewable electricity (Murakami et al., 2015) and for smart energy technologies (Pepermans, 2014), the literature on financing low-carbon developments such as renewable energy is somewhat underdeveloped (Curtin et al., 2017; Salm et al., 2016). It is possible that investors would be willing to pay more for renewable energy investments using their superannuation funds, which cannot typically be accessed until retirement, than if they must face the financial costs of their investments immediately.

The article commences by describing the Australian superannuation system and the preferences of households for renewable energy investments. We then provide an overview of the DCE methodology before presenting our results, including a discussion of the implications for policymakers and superannuation funds.

2 Background

2.1 Australian superannuation system

Australia has a ‘three pillar’ system for providing retirement income: compulsory superannuation, the age pension, and voluntary retirement savings. This article focuses on the superannuation component, which became compulsory in 1992 under the Superannuation Guarantee (APRA, 2020a). As of 2019, the pooled value of funds as well as the proportion of the population with superannuation had become amongst the highest in the world (APRA, 2020a). Employers are currently required to contribute 9.5 percent above an employee’s wages and salaries into one of many different types of superannuation funds, as nominated by the beneficiary or a default option. Kingston and Thorp (2019) provide a comprehensive survey of the literature on superannuation in Australia.

The superannuation framework is well-suited to individual choice elicitation because, although institutions play an important role in framing individual decisions by setting default allocations and choosing investments for their beneficiaries, individuals can select their super fund for their contributions. For example, they can choose a self-management option that offers total investment control or a socially responsible option that excludes such investment categories as tobacco, alcohol and gambling, but whose assets are selected by the superannuation fund.

2.2 Preferences for renewable energy investments

To the best of our knowledge, this study is the first to investigate preferences by pension fund holders for energy investments that are managed by institutional superannuation funds. This section draws on insights from the literature on retail investors who participate in community renewable energy projects, and socially responsible investors more broadly. Socially responsible investment (SRI) is characterised as the integration of personal values and social concerns into investment decisions, and focuses on such aspects as environmental protection, human rights, and production of harmful goods (Nilsson, 2008). Although both classes of investors differ from superannuation fund members, an investigation of this literature provides insights into the motivations for citizens to invest in renewable energy.

Individual investors may choose to participate in community renewable energy projects in an attempt to reduce transaction costs and risks associated with household investments, cut energy costs and for the financial returns (Dóci and Vasileiadou, 2015; Salm et al., 2016). If households perceive investing in the renewable energy sector to be risky, perhaps due to regulatory risk from changing political incentives, they are less likely to provide funds to the sector (Chassot et al., 2014). This risk-return trade-off therefore plays a large role in determining investment decisions by households in community renewable energy projects.

However, research also shows that investment outcomes cannot be explained purely by understanding the risk-return trade-off. Normative motivations, such as environmental protection, are also likely to be important for some investors (Dóci and Vasileiadou, 2015; Salm et al., 2016). People may participate in community renewable energy projects to ensure the wellbeing of future generations or to obtain independence from large energy companies (Dóci and Vasileiadou, 2015).

The SRI literature also demonstrates the importance of non-monetary factors for some investors. SRI investors likely base their investment decisions on what is 'right' alongside what is most profitable and are influenced by both altruistic and profit-oriented considerations (Nilsson, 2008). Socially responsible investors may even expect lower returns and higher management fees for SRI funds than for conventional funds, suggesting they are willing to prioritise their social preferences over the financial performance of their portfolios (Riedl and Smeets, 2017).

Recent literature confirms the need to better understand the composition of investors likely to provide funds for renewable energy investment. However, existing energy policies and research often fails to consider the heterogeneity of the actors involved. Bergek et al. (2013), for example, find that rather than being a homogeneous group, investors in community renewable energy projects come from different groups, from traditional investors to non-traditional small-scale investors including individuals and farmers. To classify the types of people who are likely to invest in community renewable energy projects, the literature considers both their attitudes and motivations, and their socio-demographic characteristics.

Characterisation of these investors reveals several insights, which may have implications for the types of superannuation fund members that would prioritise using their funds for renewable energy projects. Renewable energy investors typically hold strong pro-environmental values (Dóci and Vasileiadou, 2015; Gamel et al., 2016; Kalkbrenner and Roosen, 2016) and perceive that their communities exhibit strong social norms related to renewable energy, energy saving and community energy (Kalkbrenner and Roosen, 2016). These attitudes are also reflected in the SRI literature, which distinguishes between two types of SRI investors: value-driven investors who emphasise return on investment less than other attributes and profit-driven investors who find return on investment to be the most important factor when making investment decisions (Derwall et al., 2011). Studies also find that SRI investors are likely to perceive that their social environment expects them to invest in SRI (Apostolakis et al., 2018). These studies therefore suggest that superannuation fund members who value investing in renewable energy more favourably are likely to hold pro-environmental values and believe their communities support such investments.

Studies also discuss the likely sociodemographic characteristics of retail renewable energy investors. While results differ between studies, based on differences in methodologies and geographical contexts, general findings are that younger people, those with higher household incomes and/or greater access to financial resources, those with higher education levels, and males are more willing to invest in community renewable energy projects (Gamel et al., 2016). The SRI literature finds that ethical investors are typically female and more highly educated with higher incomes than the general population (Rosen et al., 1991; Pérez-Gladish et al., 2012).

3 The discrete choice experiment

3.1 Modelling approach

To examine how individuals value different superannuation fund attributes, we develop a stated-preference DCE. Such experiments are underpinned by random utility theory: the notion that a representative individual's utility is derived from the attributes of the choice that they are faced with, subject to some unobserved error term. Further, we assume that individuals follow a utility maximising decision rule when it comes to making their super fund choices. In the case of a superannuation fund, for individual i, the utility derived from a given fund j can be expressed as follows:

$$U_{ij} = \beta' X_j + \varepsilon_{ij} \tag{1}$$

where β' is the parameter vector associated with the vector of fund attributes X_j and ε_{ij} is a random error term that captures unobservable contributions to utility.[1]

Assuming ε_{ij} follows an extreme value type 1 (EV1) distribution, the multinomial logit model (MNL) choice probability that individual i chooses fund j from the available set of K funds, can be expressed as:

$$P_{ij} = \frac{\exp(\beta' X_j)}{\sum_{k=1}^{K} \exp(\beta' X_k)}. \tag{2}$$

[1] As respondents are presented with an array of generic (unlabelled) super fund alternatives (e.g. option A, B, C or D), alternative specific constants are omitted from our specifications.

The MNL model is useful for making preliminary inferences about our attributes of interest, and for evaluating the overall quality of our experimental design. However, its usefulness is limited due to the fact that it exhibits the independence from irrelevant alternatives (IIA) property and assumes that the estimated parameters are fixed amongst the population. This is akin to assuming that there are no differences in individuals' preferences. While a convenient form, this assumption of homogeneous preferences across all super fund holders places obvious limitations on the usefulness of the MNL model in certain choice settings.

The mixed multinomial logit (MMNL) model relaxes this assumption, allowing for preferences to vary across individuals by specifying parameters that are randomly distributed. In this case, utility can now be defined as:

$$U_{ij} = \beta_i' X_j + \varepsilon_{ij} \tag{3}$$

where $\beta_i = \bar{\beta} + \eta z_i$ and z_i is a random draw from an underlying (multivariate) distribution. The (expected) probability of individual i selecting fund j can be defined as:

$$E[P_{ij}] = \int_{\beta_i} \frac{\exp \beta'_i X_j}{\sum_{k=1}^{K} \exp \beta'_i X_k} f(\beta_i) d\beta_i. \tag{4}$$

where $f(\beta_i)$ is the probability of having parameter vector β_i based on the sampled population. Unlike standard logit models, this choice probability cannot be solved analytically and is therefore approximated using simulation methods (Train, 2009).

Another model that relaxes the assumption of IIA and permits the examination of heterogeneity amongst individuals is the latent class model (LCM). The LCM offers an extension to the standard MNL model by assuming that there exists a finite number of classes of investors that account for the heterogeneity regarding preferences for superannuation funds. The LCM algorithm examines the distribution of responses to each choice set and creates latent classes containing individuals who have similar preferences. Membership of a particular class is therefore probabilistic, based on a respondent's desire for particular attributes of the super fund on offer, socio-demographic characteristics or a combination of both.

The LCM estimates Equation 2 for S classes and predicts the probability M_{is} of investor i belonging in class s. The unconditional probability of choosing fund j now becomes:

$$P_{ij} = \sum_{s=1}^{S} P_{ij|s} M_{is} \tag{5}$$

where

$$P_{ij|s} = \frac{\exp(\beta_s' X_j)}{\sum_{k=1}^{K} \exp(\beta_s' X_k)} \quad s = 1, ..., S \tag{6}$$

and

$$M_{is} = \frac{\exp(\gamma_s' Z_i)}{\sum_{s=1}^{S} \exp(\gamma_s' Z_i)} \tag{7}$$

where γ_s is the parameter vector associated with the vector of individual-level characteristics Z_i.

Determination of the appropriate number of latent classes requires the minimisation of a model selection index such as the Akaike Information Criterion (AIC) or the Bayesian Information Criterion (BIC). The formulas for these indices are as follows:

$$AIC = -2LL + 2P \tag{8}$$

$$BIC = -2LL + (ln(N))P \tag{9}$$

where LL is the value of the log-likelihood function at convergence, P is the number of parameters in the model and N is the total sample size. The researcher must also ensure that the parameters of the attributes for each class are behaviourally valid (that is, they make logical sense). Once the appropriate number of classes is determined, the LCM indicates the fraction of respondents whose preferences align with each class.

3.2 Attribute selection

In order to elicit preferences for superannuation fund attributes, we create a series of hypothetical fund structures and ask individuals to choose between alternative funds. The selection by a respondent of their most preferred (utility maximising) fund over a series of choice sets permits insights into how individuals make trade-offs between the attributes presented to them. Table 1 provides an overview of the attributes and levels chosen for our DCE. These were selected based on a review of the relevant literature, discussions with the manager of a superannuation fund comparison service, and an examination of the Australian Prudential Regulation Authority website. The selection of attributes and their associated levels requires careful consideration. For the analysis to yield valid parameter estimates, the DCE should incorporate the key attributes that drive super fund choice, whilst ensuring that respondents are not cognitively overburdened by the options presented to them. While an array of additional attributes could have conceivably been incorporated into the DCE, the following five were chosen in order to keep the choice presented to respondents manageable, while ensuring we are still able to make inferences regarding our key research questions.

Expected net rate of return: The levels of this attribute (2 to 8 percent) are aligned with return expectations over the long-term. Superannuation fund options typically communicate their expectations regarding financial returns as the CPI + x%.[2] In recent years, the CPI has been around 2 percent in Australia and the 'x' component is typically around 3 on average. For low growth/conservative options, the value of 'x' could be zero, whereas it could be between 5 percent and 6 percent for high growth options.[3]

While the inclusion of a separate attribute for risk was considered, we ultimately decided against this and to proceed with the use of 'expected' returns for several reasons. First, to accurately estimate the effect of expected net rate of return on fund choice, we need to ensure that there is no conceptual overlap between any of the attributes, known as inter-attribute correlation, which may bias parameter estimates. However, evidence suggests a high correlation between risk and returns. Typically, if the level of risk is higher, the expected returns are also correspondingly higher (Bateman et al., 2014). The high correlation between risk and returns is evident in the pre-mixed options from Australia's largest superannuation fund: AustralianSuper. The correlation between the expected return and the minimum time frame (as a measure of risk) is 0.99 (AustralianSuper, 2020b). Second, there are many ways to present risk and presentation can affect choices more than the underlying changes in risk, even for individuals with higher financial literacy (Bateman et al., 2014). If a risk attribute were to be included in the choice experiment, it would be unknown whether individuals are responding to the attribute itself or to its presentation in the experiment. Finally, evidence suggests that many individuals do not understand risk, as financial literacy in the population is generally quite low, and they may therefore violate expected utility axioms (Bateman et al., 2016).

A setup based solely on expected returns is at odds with the theory of financial decisions, which suggests that risk is important. However, in practice, most people do not incorporate risk into their decisions in any systematic way due to a lack of understanding of risk. In the survey, we make reference to risk by labelling returns as 'expected' to indicate that the returns are not guaranteed ex-ante. We do not inform respondents that higher returns necessarily imply higher risk. Respondents likely have different attitudes towards risk and different levels of financial literacy, potentially introducing noise into the collected data. However, the

[2] See, for example: `https://www.hesta.com.au/members/investments/super-investment-options`.

[3] We include expected net rate of return instead of gross returns and fees separately. The expected net rate of return can be viewed as the appropriate payment vehicle, as fees for investors are subtracted from gross returns to give net returns.

inclusion of a separate risk attribute may only serve to complicate the experimental design if the purpose is to study the influences of attributes other than risk on a respondent's utility.

Renewable energy investments: Our main attributes of interest are the proportions of renewable energy and fossil fuel investments in the superannuation fund options. According to the Institute for Sustainable Futures, Australia could achieve 100 percent renewable energy (for stationary power) by 2030 by investing 7.7 percent of total superannuation holdings in the sector (Corbell et al., 2018). Levels for this attribute therefore range from zero to 15 percent.

Fossil fuel investments: To enable comparison with the renewable energy investments attribute, the fossil fuel investments attribute has the same range of levels. Sustainable superannuation funds would target zero percent fossil fuel investment.

Super fund governance structure: Two distinct types of governance structure have evolved in the Australian superannuation industry. These structures can be differentiated based on their representation, business and distribution models. In the for-profit (appointed trustee) model, funds are managed by financial institutions with high sales and distribution. The fund boards consist of appointed trustee directors and fund members can obtain financial advice for a fee. Contrastingly, the not-for-profit (representative governance) model involves distribution through the workplace and fund boards are comprised of both member and employer representation. The Royal Commission into Misconduct in the Banking, Superannuation and Financial Services Industry (2017-2019) highlighted important variations in conduct between the different types of super fund governance structures in Australia, potentially influencing public opinions.

Super fund size: In selecting between possible super fund options, people may consider the size of the super fund as a representation of its ability to diversify its assets. Smaller superannuation funds have fewer asset holdings and therefore less chance to diversify the range of assets, as compared to larger funds. The size categories of small, medium and large are based on the annual fund-level superannuation statistics for June 2019 provided by the Australian Prudential Regulation Authority (APRA, 2020b).

3.3 Experimental design

An experimental design governs the specific combinations of attributes and levels that individuals evaluate in the choice sets, with the goal to present choice tasks to respondents in the most efficient manner (i.e. to generate parameter estimates with the smallest possible standard errors). In order to achieve this, we adopt a D-efficient experimental design (Rose and Bliemer, 2008).

Efficient designs predict the standard errors by determining the asymptotic variance-covariance matrix (AVC) of the underlying experiment, based on some prior information about the parameter estimates. Formally, the AVC matrix Ω_N is defined as follows:

$$\Omega_N(X, Y, \tilde{\beta}) = -[\ E(I_N(X, Y, \beta))]^{-1} \ = - \left[\frac{\partial^2 L_N(X, Y, \tilde{\beta})}{\partial\beta\partial\beta'} \right]^{-1} \tag{10}$$

where X represents the experimental design, Y the outcomes of the choice tasks and β the associated parameter values. $I_N(X, Y, \beta)$ is the Fisher information matrix with N respondents, while $L_N(X, Y, \tilde{\beta})$ is the log-likelihood function for N respondents.

The efficiency of a design is determined by the minimisation of some 'efficiency error.' A common efficiency measure is the D-error, which calculates the determinant of the AVC matrix Ω_1 (that is to say, Ω_N is calculated for a single respondent). As noted in Equation 10, efficient designs require some prior estimates of β. These priors were obtained using a pilot survey of 25 respondents, which permitted the estimation of an initial MNL. The β parameters from this model were then used as the priors for the D-efficient experimental design.

3.4 Survey administration

The DCE was conducted online in May 2020, using a panel of respondents provided by a leading multinational market research company. In each choice set, respondents were asked to choose between one of four hypothetical superannuation fund options or a no-choice option.[4] Figure 1 presents an example of one of the choice sets presented to the respondents during the study.

The survey was open to Australian residents aged 18 and over, and eligible respondents were remunerated by the market research company for their participation. The sample of respondents was collected to be representative of the wider population of Australian adults in terms of age, gender and income. Table 2 details the socio-demographic characteristics of the survey respondents, along with Australian Bureau of Statistics demographic information on our representative characteristics. On the whole, it is evident that the survey panel provided generally mirrors the wider Australian population in terms of age, gender and income.

[4]The modelling framework outlined in Section 3.1 permits the presence of a no-choice option. The inclusion of a no-choice option permits the study of unconditional demand for super fund attributes, as opposed to demand being conditioned upon the 'forced' selection of a super fund option that may not be deemed desirable by a respondent if the no-choice option was not offered (Hensher et al., 2015). As the no-choice alternative is not associated with any attribute levels (i.e. there is no expected rate of return, governance structure, etc.), it can simply be assigned a utility of zero.

After checking for quality (using both attention and timing filters), the survey yielded 208 complete responses. The experimental design software, NGENE, generates an 'S estimate', which is the minimum sample size (i.e. number of respondents) required for the estimation of significant parameters. The S estimate for this particular experimental design was 77. Therefore, the actual sample size collected in the survey (n=208) is sufficient. Each respondent completed 12 choice tasks, resulting in a total of 2496 observations.

To ensure that respondents had a good understanding of the choice sets being presented to them, the survey included detailed instructions as well as a sample choice task before the experiment began. The instructional information was also available through a 'pop up' window during every choice task. As most Australian adults have a superannuation fund, issues related to framing of unfamiliar choices (Rolfe et al., 2002) should not be a problem in this context.

In addition to the choice tasks, respondents also answered a series of questions related to their socio-demographic characteristics and sentiments towards environmental protection. Specifically, a series of ten statements (based on those used by Krovetz et al. (2017)) were shown to respondents. Figure 2 details each of the statements, along with a summary of the responses measured on a 5-point Likert scale, ranging from strongly agree to strongly disagree. Environmental sentiment scores for each respondent were calculated based on the average value of each of their responses. A respondent who strongly agreed with all ten statements received an environmental sentiment score of 5. Comparatively, a respondent that strongly disagreed with each statement received an environmental sentiment score of 1. Survey participants may interpret the categories of a Likert scale in different ways, thus impacting the estimated results of the analysis. Nevertheless, the inclusion of these environmental sentiment scores in the analysis enables us to understand how environmental values affect an individual's preference to use their superannuation to help fund the renewable energy transition.

4 Results

4.1 MNL & MMNL models

The results for the MNL and MMNL models are provided in Table 3.[5] Expected net rate of return, fossil fuel investments, renewable energy investments and environmental sentiment

[5] As noted, the MMNL model offers greater flexibility and explanatory power than the MNL model. Nevertheless, the MNL presented in Table 3 serves as a tool to check the reliability (in terms of parameter signs and significance) of the experimental design before including the socio-demographic and environmental sentiment variables in the more sophisticated models that follow (Hensher and Greene, 2002).

are modelled as continuous variables. Super fund governance structure, super fund size, age, income and gender are modelled as effects-coded dummy variables using the categories listed in Tables 1 and 2. The estimated parameters can be interpreted as the marginal utility from a change in attribute or socio-demographic characteristic as one moves from one level to another.

As discussed, the MMNL model allows for heterogeneity amongst respondents and enables the relaxation of the IIA assumption. As per Equation 4, the MMNL has to be approximated using simulation methods. Therefore, we use Halton draws with 500 replications for the maximum simulated likelihood estimation with NLOGIT's mixed logit command (see Greene, 2016).

To examine the influences of a respondent's socio-demographic characteristics and their sentiment towards the environment on their choice of superannuation fund, we estimate two separate MMNL models. The first model includes only the attributes, whereas the second model interacts income, age, gender and environmental sentiment with each of the attributes included in the experiment.[6] In both MMNL models, the quantitative attributes (expected net rate of return, fossil fuel investments and renewable energy investments) are modelled as random parameters with a normal distribution.[7]

For all three models, the coefficient for expected net rates of return is positive and statistically significant at the five percent level or lower. This finding is aligned with expectations and provides some basic evidence that the stated-preference DCE yields sensible results. The results of the MNL and the attributes only MMNL model are broadly consistent. The energy-type allocations show an overall preference for a clean energy transition. In both models, there is a negative coefficient for the fossil fuel investment variable and a positive coefficient for the renewable energy investment variable. The positive coefficients for the renewable energy investment variable suggest that a one-unit rise in the percentage of renewable energy investments increases a respondent's utility by around 0.063 or 0.072 units. Respondents prefer medium-size, not-for-profit super funds. The latter may relate to a belief that not-for-profit funds are more likely to work for their members, rather than distribute profits to the stakeholders of the super funds. It may also link to the negative portrayal of for-profit super funds in the 2019 Australian Royal Commission into Misconduct in the Banking, Superannuation and Financial Services Industry.

Caution should be taken in interpreting the results of the MMNL model with interactions. Each attribute enters the utility function five times, rather than only once as in the other

[6]The MMNL model with interaction effects provides a better overall fit than the attributes only model. The log-likelihood values improve from -2892.99 to -2823.39 when we include the interactions.

[7]Alternative distributions were also examined, however, these did not significantly alter our results.

models. The impact on utility of a change in each attribute therefore depends on the values of each of the socio-demographic and environmental sentiment variables and their corresponding parameter estimates.

Preferences for fossil fuel investment are driven by gender and environmental sentiment (as indicated by statistically significant interactions in the MMNL model). If we take a hypothetical female super fund holder with an environmental sentiment score of 4.5 while invoking the *ceteris paribus* assumption, we can see that increasing fossil fuel investment by one percentage point corresponds with an overall decrease in her utility of 0.075 (i.e. $0.104 + (0.028 \times 1) + (-0.046 \times 4.5)$). If we take a hypothetical male super fund holder with an environmental sentiment score of 2, we can see that increasing fossil fuel investment by one percentage point corresponds with an overall increase in his utility of 0.012 (i.e. $0.104 + (0.028 \times 0) + (-0.046 \times 2)$). Environmental sentiment is the only respondent characteristic that is statistically significant when interacted with renewable energy investment. Again, let us take a hypothetical super fund holder with an environmental sentiment score of 4.5 and invoke the *ceteris paribus* assumption. A one percentage point increase in investment in renewables corresponds with an increase in utility of 0.1365 (i.e. $-0.120 + (0.057 \times 4.5)$). However, the same increase in renewable energy investment for a hypothetical super fund holder with an environmental sentiment score of 2 would lead to a decrease in utility of 0.006 (i.e. $-0.120 + (0.057 \times 2)$). The examples of marginal utilities related to renewable energy for our two hypothetical respondents with differing environmental sentiment scores (0.1365 and -0.006) can be averaged to give a similar outcome to the coefficient from the MMNL model without interactions (0.072).

Inferences can also be drawn from the interaction effects associated with the other attributes. All else being equal, those with higher incomes derive a greater utility from for-profit funds. One interpretation is that higher income earners are attracted to the wider range of investment options and financial advice offered by for-profit super funds. Alternatively, they are more likely than lower income earners to invest in shares of financial services companies and to therefore benefit directly from the profits of for-profit funds. However, the opposite is true for older respondents who indicate a preference for not-for-profit funds when holding other factors constant. A possible mechanism to drive these results is that not-for-profit super funds generally keep fees relatively low. We find a positive and statistically significant impact on utility from the interaction of age and net rate of return. This suggests that, all else equal, older respondents are more sensitive to net rates of return than younger respondents. A possible reason for older respondents being more sensitive to returns is greater engagement with superannuation in contrast to younger individuals who will not access their superannuation for many years (other than in exceptional circumstances). Investment returns in retirement can provide up to 60 percent of total retirement income (Sunsuper, 2020), making continued high returns a priority for many retired individuals.

The addition of the various interaction effects in the MMNL model provides evidence that superannuation fund choice is heavily influenced by environmental sentiment scores and, to a lesser extent, certain socio-demographic characteristics. We therefore further investigate these issues by using a LCM, which enables us to explore heterogeneity in super fund choice in greater detail.

4.2 Latent class model

As discussed, the LCM offers additional flexibility and explanatory power. In the LCM, marginal coefficients are allowed to differ for subgroups of respondents. Socio-demographic and environmental sentiment variables can also be incorporated into the LCM as membership functions. The appropriate number of classes in the LCM is the number that corresponds with the minimum value of a selection criterion such as the Akaike Information Criterion (AIC) or the Bayesian Information Criterion (BIC). In our case, both the AIC and BIC decreased as we increased the number of latent classes from one to two. However, the selection criteria was not improved when we added more than two classes. Subsequent analysis is therefore based on the existence of two distinguishable groups of superannuation fund members. The results of the latent class model are presented in Table 4.

We refer to the two groups as 'return-focused savers' and 'social savers'. The parameters are estimated for each class and can be interpreted as the marginal utility from moving from one attribute level to another, within the same class. Our 'social savers' were used as a base (i.e. all membership function coefficients were normalised to zero for this class), and the estimates of socio-demographic and environmental sentiment variables for our 'return-focused savers' are interpreted as relative to the 'social savers'.

The only similarity between our two groups of savers is that they have positive and statistically significant associations between net returns and utility. For both groups, utility increases as expected net returns increase. All other significant coefficients differ in sign. A discussion of the characteristics of the two groups now follows:

Return-focused savers: The 'return-focused savers' group comprises 30 percent of the sample. Respondents in this group derive considerable utility from increases in the expected net rate of return. For this group, the coefficient on the fossil fuel investment attribute is positive, whereas it is negative for the renewable energy investment attribute. This finding suggests that this group does not prioritise using their superannuation funds to help finance a renewable energy transition. These respondents also favour large fund sizes.

Based on the estimates for the membership functions, this group of investors is older, earns higher incomes and is made up of more males than the 'social savers'. It contains individuals who are less concerned about the environment, meaning they were more likely to disagree or strongly disagree with the ten statements regarding environmental concern that were put to them.

Social savers: The 'social savers' group is the larger of the two classes, with 70 percent of the sample. This group derives their utility from a wider range of attributes than the 'return-focused savers'. This group has a positive and statistically significant coefficient for the renewable energy investment variable and a negative and statistically significant coefficient for the fossil fuel investment variable. These results could suggest that the group has social concerns, which are not satisfied by a singular focus on the financial returns from their superannuation funds. However, it could also mean that this class is more forward looking and expects the decline of fossil fuels in the future, resulting in a different model for maximising returns than the other class. The group also exhibits a strong preference against for-profit superannuation funds. One interpretation is that the class is concerned about the concentration of profits and wealth in the hands of the funds' shareholders. Dislike of large funds compared to small funds by this group could similarly reflect sentiments against profit concentration.

The 'social savers' class is younger, earns lower income, and contains more females than the 'return-focused savers'. The group also contains individuals who are generally more concerned about the environment.

4.3 Willingness to accept

In this DCE, we use willingness to accept reductions in expected net returns as a payment mechanism to understand how respondents value investment in renewable energy and other super fund attributes. We do not argue that super fund options with higher investments in renewable energy would necessarily imply lower returns. Some sustainable superannuation funds, such as the UniSuper sustainable options in Australia, perform better than average (UniSuper, 2020). Other sustainable options perform worse. For example, the AustralianSuper Socially Aware option has performed substantially worse than the Balanced option (which has the same target asset allocation) over five and ten year periods to 30 June 2020 (AustralianSuper, 2020a). Systematic comparisons in performance based on whether a superannuation fund is 'sustainable' are difficult due to differences in what constitutes a sustainable investment option across superannuation funds. Nevertheless, for the purposes of the DCE, we investigate the values respondents place on different superannuation fund attributes by using willingness to accept reductions in expected returns as a payment vehicle.

Table 5 reports willingness to accept (WTA) estimates for the two groups of savers identified by our LCM. Mean WTA values are simply the negative ratio of the estimated coefficient for attribute k to the estimated expected net rate of return coefficient:

$$WTA = -(\beta_k/\beta_{NRR}) \tag{11}$$

WTA values for each attribute are therefore expressed as a percentage point decrease in the expected net rate of return. Negative values can be understood as the willingness to accept a lower expected net rate of return for a given increase in, or move towards, an attribute that yields utility. Positive WTA values indicate the increase in expected net rate of return that respondents would have to receive in order to be compensated for a given increase in, or move towards, an attribute that yields a disutility. Standard errors and confidence intervals were calculated using the delta method (Hole, 2007; Bliemer and Rose, 2013). We refer to confidence intervals as these provide greater insights into the heterogeneity of individual responses within each class. The width of the confidence intervals provides some indication of the extent of the heterogeneity of individual preferences for the attributes. Wider confidence intervals suggest that preferences are more varied, while narrower confidence intervals indicate the opposite.

With regards to the WTA values associated with the LCM, our 'social savers' are willing to forego between 0.25 and 0.52 percentage points of investment returns for a one percentage point increase in renewable energy investment. Conversely, they need an increase in net investment returns of between 0.10 and 0.20 percentage points to be compensated for a one percentage point increase in fossil fuel investment. 'Social savers' would need to receive between 1.14 and 2.91 extra percentage points in expected net rate of return to be compensated for the decrease in utility associated with for-profit super funds. Likewise, expected net rate of return would have to increase by between 0.34 and 1.31 percentage points in order to entice 'social savers' to move to a large super fund, from a small one.

Due to their preference for fossil fuel investments and aversion to renewable energy investments, the WTA figures for our 'return-focused savers' tell the opposite story. These savers are willing to forego between 0.07 and 0.15 percentage points of investment returns for a one percentage point increase in fossil fuel investments. Conversely, they need between 0.08 and 0.15 extra percentage points of investment returns to be compensated for a one percentage point increase in renewable energy investments. 'Return-focused savers' would be willing to forego between 0.32 and 0.74 percentage points of investment returns to make the switch from a small superannuation fund to a large one.

Overall, it is worth noting that only the 'return-focused savers' (which make up just over 30 percent of our respondents) need to be incentivised to choose renewable investment options as their utility decreases as investment in renewable energy increases. Compared to this group, the 'social savers' group is both considerably larger and comprises more younger members. If the young 'social savers' retain their preferences for renewable energy investments over their lifetimes and following generations have similar preferences, it could be that super funds that invest in fossil fuels will become obsolete over time. More 'social savers' could power the transition to renewable energy by reducing overall demand for investment in fossil fuels by super funds.

5 Discussion

Given its capital-intensive nature, the success of the transition from high-carbon to low-carbon energy sources will depend on its capacity to attract investment, whether from public or private sources. Our paper considers one such channel for this investment by examining individual preferences for allocations of private retirement savings to different types of energy investments. The Australian superannuation system represents a large pool of private funds that can potentially contribute to socially beneficial investment. Limitations on the ability of individuals to access their retirement savings prior to the retirement age suggest the funds are suitable for investment in assets with long time horizons, such as renewable energy infrastructure. Investigation of private investment channels is particularly important given limits on public financing. Our study explores demand for renewable energy investments, and highlights some demand-side challenges for using superannuation to support the transition.

Our paper reveals that willingness to accept lower returns for higher allocation to renewable energy investments is largely driven by a respondent's environmental sentiment. Only those respondents with higher levels of sentiment towards the environment are likely to be willing to forego expected returns for increases in investments in renewable energy by their super funds. Contrastingly, respondents with lower environmental sentiment scores prefer super fund options with higher levels of investment in fossil fuels.

The latent class analysis reveals the existence of two distinct groups of super fund holders. The largest group of respondents exhibits preferences for not-for-profit super funds and higher allocations of funds to renewable energy investments. 'Social savers' do not value allocations to fossil fuel projects or being a member of large superannuation funds favourably. The group is more likely to be female and younger, and to have lower income and greater concern for environmental issues. In their study of Dutch citizens and pension plans, Borgers and Pownall (2014) also find that most (three-quarters) respondents are willing to forego pension income to ensure their investments are aligned with their environmental and social preferences. Our other group of fund holder places a much larger focus on expected net rates of return, and prefers large superannuation funds. 'Return-focused savers' would need to be compensated to place their investments in renewable energy projects, however, are willing to forego returns to invest in fossil fuels: a stark contrast from the preferences of 'social savers'. This group tends to be older, male, have higher incomes and be less concerned about environmental issues.

The identification of these two groups is similar to those recognised in previous literature. Glac (2009) distinguishes between investors with an expressive decision frame (those who extend their identity and social beliefs into their investment decisions) and those with a financial decision frame, while Nilsson (2009) reports the existence of 'primarily concerned about profit' and 'primarily concerned about social responsibility' groups of socially responsible investors.

Our study provides important implications for both superannuation funds and policymakers. It suggests that superannuation funds should carefully consider how best to re-allocate funds to renewable energy investments as there may be backlash from some members. One possibility to increase allocation in renewable energy while preserving customer support is to offer two default options: one that maintains the current low allocations to renewables and a second option that has higher allocations to renewables. The high-renewables default could be allocated to individuals whose observable characteristics align with the 'social savers' group. This assignment would be similar to the concept of 'lifecycle investing', whereby defaults are modified based on an individual's age. The setting of default allocations is particularly important given the commonly displayed inertia by superannuation fund members.

Australian regulations for the superannuation industry that require trustees to act in members' best interests are typically interpreted as referring to individual financial interests based on financial returns (Industry Super Australia, 2018). Our results instead suggest that socially beneficial investments may also be important for many members. Harnessing these preferences would provide policymakers an opportunity to reap the public good benefits of cleaner environments with less air pollution. Our results therefore highlight the potential to broaden the interpretation of trustee fiduciary duties beyond a singular focus on financial returns.

6 Conclusion

The results of our stated-preference discrete choice experiment suggest that many superannuation fund members would like to see their funds being used to support the clean energy transition. Our results identify preferences that may exist but that are not evident in observed superannuation behaviour due to a lack of engagement and understanding of most individuals with the system. Our quantification of investor willingness to accept provides an indication of the possible magnitudes of preferences for renewable energy investments as compared to fossil fuel investments. The results of the latent class modelling indicate that most people (around 70 percent in our study) may be amenable to higher renewable energy allocations.

One limitation of the present study may be that it does not consider how survey participants respond to risk. To ensure the experimental design was not biased by inter-attribute correlation, the study focuses on 'expected' returns rather than incorporating a specific measure of risk. However, it is possible that decisions made by our respondents could also reflect differences in how they perceive risk in energy industries. For example, the 'return-focused savers' might be more likely to perceive renewable energy investments to be risky based on their limited historical record. Alternatively, our 'social savers' might be more likely to view fossil fuel investments as more risky, due to stranded asset risk from early closure of fossil generators that are not appropriate in carbon-constrained contexts. Future research could consider the sensitivity of our estimates to different levels of risk and financial literacy.

Future studies could also investigate how regulations of the superannuation industry would need to be amended to enable higher allocations of funds to renewable energy investments. Currently, supply-side barriers constrain further investment by superannuation funds in renewable energy. These barriers include a lack of knowledge and appropriate investment vehicles, and regulations such as minimum liquidity requirements (OECD, 2015; Della Croce et al., 2011). Super funds might not have sustainable funds as their defaults due to market capitalisations, as renewable energy companies tend to be very small. Another reason may be peer risk based on competition between funds. If a fund implements a greater focus on sustainable investments in its default option, and short-term returns then happen to be lower than competitors, there may be adverse consequences for the managers of the superannuation fund. Finally, higher investment risk associated with constraining possibilities for diversification may prevent funds from offering sustainable options as their defaults. Given the demand for higher allocations of superannuation to renewable energy investments identified by our paper, future research should identify how the implied changes could be implemented.

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Table 1: Attributes and levels in the stated preference experiments

Attribute	Level
Expected net rate of return	2%
	3%
	4%
	5%
	6%
	7%
	8%
Super fund governance structure	Not-for-profit - base
	For-profit
Super fund size	Small (assets $<$ AU$2b) - base
	Medium (assets between AU$2b and AU$10b)
	Large (assets $>$ AU$10b)
Fossil fuel investments (% of total fund)	0%
	3%
	6%
	9%
	12%
	15%
Renewable energy investments (% of total fund)	0%
	3%
	6%
	9%
	12%
	15%

Notes: Qualitative variables (super fund governance structure and size) are introduced into the models as dummy variables. The base levels for these variables therefore represent the level expressed by default in the utility function.

Table 2: Socio-demographic characteristics of survey respondents

		Survey respondents	Australian population[a]
Age	18-24	13.5%	12.2%
	25-34	20.7%	19.3%
	35-44	17.8%	17.1%
	45-54	15.9%	16.5%
	55-64	14.4%	14.9%
	Older than 65	17.7%	20.0%
Gender	Male	46.7%	49.1%
	Female	53.3%	50.9%
Income (AU$)	Less than $299 per week	19.7%	22.8%
	$300-$649 per week	27.4%	26.5%
	$650-$1249 per week	27.9%	26.4%
	$1250-$1999 per week	15.4%	15.3%
	More than $2000 per week	9.6%	9.0%

[a]Age and gender figures are obtained from Australian Bureau of Statistics (2020), Income figures are obtained from Australian Bureau of Statistics (2016).

Table 3: Multinomial logit & mixed multinomial logit results

	MNL		MMNL - attributes only		MMNL - with interactions	
	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
Attributes						
NET RATE OF RETURN	0.404***	(0.012)	0.530***	(0.034)	0.351**	(0.179)
FOR PROFIT	-0.361***	(0.044)	-0.562***	(0.054)	0.235	(0.284)
SIZE - MEDIUM	0.055*	(0.031)	0.105***	(0.035)	0.291	(0.188)
SIZE - LARGE	-0.049	(0.030)	-0.022	(0.035)	0.157	(0.185)
FOSSIL FUEL INV	-0.062***	(0.005)	-0.056***	(0.008)	0.104**	(0.043)
RENEWABLE INV	0.063***	(0.004)	0.072***	(0.007)	-0.120***	(0.039)
Interactions						
INCOME · NET RATE OF RETURN					0.026	(0.027)
INCOME · FOR PROFIT					0.174***	(0.045)
INCOME · SIZE - MEDIUM					-0.006	(0.030)
INCOME · SIZE - LARGE					-0.028	(0.030)
INCOME · FOSSIL FUEL INV					0.006	(0.007)
INCOME · RENEWABLE INV					-0.009	(0.006)
AGE · NET RATE OF RETURN					0.065***	(0.021)
AGE · FOR PROFIT					-0.154***	(0.033)
AGE · SIZE - MEDIUM					0.038*	(0.022)
AGE · SIZE - LARGE					0.012	(0.021)
AGE · FOSSIL FUEL INV					-0.001	(0.005)
AGE · RENEWABLE INV					-0.002	(0.004)
FEMALE · NET RATE OF RETURN					-0.069	(0.070)
FEMALE · FOR PROFIT					-0.314***	(0.111)
FEMALE · SIZE - MEDIUM					0.013	(0.074)
FEMALE · SIZE - LARGE					-0.157**	(0.073)
FEMALE · FOSSIL FUEL INV					0.028*	(0.016)
FEMALE · RENEWABLE INV					-0.004	(0.015)
ENV SENT · NET RATE OF RETURN					0.008	(0.044)
ENV SENT · FOR PROFIT					-0.147**	(0.070)
ENV SENT · SIZE - MEDIUM					-0.070	(0.046)
ENV SENT · SIZE - LARGE					-0.020	(0.045)
ENV SENT · FOSSIL FUEL INV					-0.046***	(0.011)
ENV SENT · RENEWABLE INV					0.057***	(0.009)
Log likelihood	-3199.56		-2892.99		-2823.38	
AIC/N	2.569		2.325		2.289	
Observations	2496		2496		2496	

Notes: Dependent variable is binary (1 = preferred fund in a given choice task, 0 = otherwise); * $p < 0.10$, ** $p < 0.05$, ***$p < 0.01$.

Table 4: Latent class model results

	Return-focused savers		Social savers	
	Coef.	S.E.	Coef.	S.E.
Attributes				
NET RATE OF RETURN	4.247*	(2.176)	0.242***	(0.031)
FOR PROFIT	-6.647	(4.329)	-0.491***	(0.071)
SIZE - MEDIUM	0.063	(0.817)	0.087**	(0.043)
SIZE - LARGE	2.251**	(0.913)	-0.200***	(0.049)
FOSSIL FUEL INV	0.470*	(0.285)	-0.036***	(0.009)
RENEWABLE INV	-0.479*	(0.282)	0.093***	(0.007)
Membership functions				
AGE	0.248***	(0.050)		
FEMALE	-0.417***	(0.157)		
INCOME	0.193***	(0.063)		
ENV SENTIMENT	-0.352***	(0.094)		
Class size	30.1%		69.9%	
Log likelihood	-3124.87			
AIC/N	2.518			
Pseudo R2	0.222			
Observations	2496			

Notes: Dependent variable is binary (1 = preferred fund in a given choice task, 0 = otherwise); * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 5: Latent class model willingness to accept calculations

	Return-focused savers			Social savers		
	Mean	S.E.	95% confidence interval	Mean	S.E.	95% confidence interval
FOR PROFIT	1.57***	0.26	1.05 to 2.08	2.03***	0.45	1.14 to 2.91
SIZE - MEDIUM	-0.01	0.19	-0.40 to 0.37	-0.36*	0.19	-0.72 to 0.01
SIZE - LARGE	-0.53***	0.11	-0.74 to -0.32	0.83***	0.24	0.34 to 1.31
FOSSIL FUEL INV	-0.11***	0.02	-0.15 to -0.07	0.15***	0.03	0.10 to 0.20
RENEWABLE INV	0.11***	0.02	0.08 to 0.15	-0.38***	0.07	-0.52 to -0.25

Notes: Willingness to accept is measured as the percentage point change in the expected net rate of return (for the superannuation fund account); confidence intervals calculated using the delta method; * $p < 0.10$, ** $p < 0.05$, ***$p < 0.01$.

Figure 1: Choice task example

Task 5 of 12

Which super fund option would you prefer?

	Option A	Option B	Option C	Option D
Super fund governance structure	Not-for-profit	Not-for-profit	For-profit	For-profit
Size of the super fund: total assets	Small	Large	Small	Medium
Fossil fuel investments (% of total assets)	12%	0%	12%	15%
Renewable energy investments (% of total assets)	6%	0%	6%	15%
Expected net rate of return	3%	6%	3%	6%

If required, a reminder of descriptions for each of the characteristics can be found by clicking here.

Option A

Option B

Option C

Option D

Other super fund option

Figure 2: Environmental sentiment