Contribution Rate and Investment Choices in a Large Defined Contribution Pension Plan

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Abstract

In this paper we use a unique administrative dataset to examine the contribution and investment decisions made by members of a large UK-based defined contribution pension plan. We find that the members' contribution rates are positively related to their age and level of income, which is broadly consistent with lifecycle saving theory. We also find that male plan members save more than females, and that individuals who have made an active choice of investment fund save more than those who have accepted the default fund. Investors choosing equity-dominated investment funds save more than investors choosing fixed-income-dominated-funds. In terms of investment choice, we find that use of the default fund declines with both employment tenure and income. Default fund use increases with age. After controlling for whether or not the plan member has made an active choice of investment fund, we find that equity allocation decreases with age, is higher for males than females and increases with income. There is some evidence of home bias in members' asset allocation, but this is less marked than documented elsewhere. Members do not appear to allocate their contributions equally across all investment options (the naïve 1/n diversification strategy), but a sizeable minority do appear to allocate evenly across the funds they have chosen (the *conditional* 1/n diversification strategy). We provide tentative evidence on the link between member decision making and investment return. After controlling for the decision about how much equity to hold, we find weak evidence that male plan members outperform female members and that higher paid plan members actually *underperform* lower paid members. A notable finding is that the members who make fund switches earn lower returns than more passive investors, by approximately 100 basis points.

Keywords: Pensions; Defined Contribution; Contribution Rates; Investment Choice; Behavioural Biases.

JEL Codes: G11; G23.

1. Introduction

Defined contribution (DC) pension plans are becoming increasingly common in many countries including the US and the UK. DC plans typically give individual plan members responsibility for deciding how much to contribute to the plan and how to invest these contributions. The growing literature on behavioural economics examines how members make these decisions. Byrne (2004) and Mitchell and Utkus (2004) provide reviews of this literature. The evidence to date indicates that there are wide divergences from the behaviour expected if plan members were fully rational and made optimal savings and investment decisions over their life cycle (see, e.g., Campbell and Viceira, 2002, and Gomes and Michaelides, 2005).

In this paper we use a unique administrative dataset to examine the contribution and investment decisions made by members of one large UK-based DC plan which is sponsored by a FTSE-100 company.[1] The company is committed to providing good pension benefits for its employees and actively communicates with its workforce on pension issues. The data allow us to test key rational and behavioural economic theories that relate to retirement saving.

We find that the members' contribution rates are positively related to their age and level of income, which, contrary to much of the recent evidence from behavioural studies, is broadly consistent with lifecycle saving theory. We also find that male plan members save more than females, and that individuals who have made an active choice of investment fund save more than those who have accepted the default fund. The latter finding might be consistent with the idea that more financially sophisticated members save at higher rates, since they are more aware of the consequences of inadequate pension savings for consumption in old age. Contrary to the proposition that conservative investors who adopt lower risk / lower expected return investment strategies need to save more to reach a given level of retirement income, we find that investors choosing equity-dominated investment funds actually save *more* than investors choosing fixed-income-dominated-funds. This might be because equity-dominated investors are more financially sophisticated investors and hence have a better understanding of their lifecycle needs.

[1] The company wishes to remain anonymous.

In terms of investment choice, one particular contribution we are able to make is to assess member decision making in the absence of the complication of members being able to invest their contributions in the employer's own stock (see Agnew, 2006), as this is not an option in this plan. This is important because own employer stock is not a common investment choice in DC pension plans outside of the US. We find that use of the default fund declines with both employment tenure and income. Default fund use increases with age, which may be because the default in this case comprises largely fixed-income investments. After controlling for whether or not the plan member has made an active choice of investment fund, we find that equity allocation decreases with age (by 8 percentage points for every 10-year increase in age), is higher for males than females (by approximately 5 percentage points) and increases with income (by approximately 0.6 percentage points for every 10% increase in income). There is some evidence of home bias in members' asset allocation, but this is less marked than documented elsewhere and is lower amongst investors with complex portfolios. Very few plan members appear to follow the naïve 1/n diversification approach documented by Benartzi and Thaler (2001) whereby members invest equally across all available investment funds. However, there is evidence of members following a *conditional* 1/n diversification strategy (Huberman and Jiang, 2006) whereby contributions are invested equally across the subset of funds chosen by the member.

We provide tentative evidence on the link between member decision making and investment return. The return data we have relates to the period of 12 months ending in May 2006, which is obviously too short a period to fully assess a long-term investment such as a pension fund. This particular period was characterised by strong equity market performance and hence the highest returns were earned by those investors with high allocations to equities. Investors in the fixed-income–based default fund did relatively poorly. After controlling for the decision about how much equity to hold, we find weak evidence that male plan members outperform female members and that higher paid plan members actually *underperform* lower paid members. One notable finding is that the members who make fund switches earn lower returns than more passive investors, by approximately 100 basis points, consistent with the idea of an overconfidence bias leading some investors to trade too much (Barber and Odean, 1999). This provides some evidence against the efficient management of investment portfolios.

The remainder of this paper is organised as follows. Section 2 discusses the previous academic literature on contribution and investment decisions in DC pension plans, including relevant literature from the field of behavioural economics. Section 3 describes the dataset we use in our analysis, while Section 4 outlines the method of analysis. Section 5 presents our results, and Section 6 concludes.

2. Literature

2.1 Contribution Decisions

Standard economic theory provides an explanation for the savings rates that individuals should choose throughout their working life if they were behaving optimally. The lifecycle saving theory of Ando, Brumberg and Modigliani (Modigliani and Brumberg, 1954; Ando and Modigliani, 1957), and Friedman's permanent income hypothesis (1957) both imply that individuals attempt to smooth consumption over their lifetime in order to maximise expected lifetime utility. In essence, in each period an individual can consume up to the annuity value of his or her expected total (i.e., financial and human) wealth, and saving will take place only when current income exceeds this annuity value.

Behavioural economics provides an alternative view that suggests saving decisions may be driven by behavioural biases and thus may not be consistent with optimal behaviour. Previous research shows that a large proportion, and often the majority, of employees are inclined to take the 'path of least resistance' and passively adopt the default arrangements that exist in their pension plan. For example, Choi et al. (2002) review US evidence on the tendency for members to accept plan defaults for key features such as the contribution rate and the investment fund. Even though employees are free to opt out of default arrangements, relatively few actually do. In the plans Choi et al. studied, between 42% and 71% of participants accept the default contribution rate, even though it is typically too low to generate a reasonable replacement rate for retirement income.

2.2 Investment Decisions

A similar analysis applies for members' investment choices: standard theory offers rational optimising explanations of choice, while behavioural finance offers alternative explanations driven by the existence of behavioural biases. Standard theory suggests that members choose an investment strategy to maximise their expected lifetime utility. This, in essence, involves

maximising expected risk-adjusted portfolio returns, where the risk adjustment factor is the ratio of the volatility (i.e., standard deviation) of the portfolio returns to the investor's degree of risk tolerance.[2] While risk tolerance is essentially unobservable, psychometric questionnaires have been designed to attempt to measure it. Hallahan et al. (2004) use one such measure and find that risk tolerance is higher amongst males than females and generally increases with income and decreases with age. These results would suggest that portfolio allocations, e.g. to equities rather than bonds, should similarly be linked to these demographic and income variables.

Lifecycle investment theory (e.g. Bodie, 2003) holds that asset allocation should change through the individual's lifetime, with high weightings in risky assets during the earlier years and lower risk assets used as retirement approaches. Various justifications have been given for this based on the (possibly erroneous) notion that equities are less risky over long periods of time than over short periods, and hence that the equity weighting should decline in the period leading up to retirement. However, a more satisfactory justification is that younger investors have a substantial amount of their wealth tied up in human capital and generally a low weight in financial capital. If this human capital is relatively low risk it can allow greater risk to be taken in the individual's financial portfolio.

Choi et al.'s (2002) finding of default bias applies to investment choice as well as to choices of contribution rates. In the US plans Choi et al. studied, between 48% and 81% of plan assets are invested in the default fund, which is typically a money market fund. Cronqvist and Thaler (2004) also document widespread acceptance of the default fund in the Swedish state-wide Premium Pension System. Use of the default fund was relatively low at the initial launch of the plan when members were encouraged to make an active choice, but increases markedly for subsequent waves of new entrants. Cronqvist and Thaler find that the average initial entrant who made an active choice of investment portfolio earns lower returns than the average investor in the default fund over the period from October 2000 to October 2003.

A number of other studies document potentially non-rational approaches to portfolio strategy amongst DC pension plan members. For example, Benartzi and Thaler (2001) find DC members use a 1/n naïve diversification heuristic, whereby they split their pension

[2] In the presence of time-varying investment opportunities, there are additional intertemporal hedging demands as first emphasised by Merton (1971, 1973).

contributions equally amongst the funds on offer. Huberman and Jiang (2006) counter argue that many members equally weight across the subset of funds they have chosen, but do not necessarily equally weight over all available choices, especially where ‘n’ is large.

Some studies of retail investor behaviour show evidence of overconfidence leading to excessive trading and low investment returns. Barber and Odean (1999) analyse the trading behaviour of investors with discount retail brokerage accounts and find that trading activity typically subtracts from portfolio return, with stocks bought performing less well than stocks sold. The most active traders earn the lowest returns.

3. Data

The dataset we use is generated from the records of the DC pension plan of a FTSE-100 listed company. The data relate to the period of 12 months up to May 2006 and include information on 3629 plan members. This represents all of the DC plan members with more than one year’s service and who are not in addition accruing benefits under the company’s defined benefit pension plan.

The dataset contains details on the contribution and investment decisions made by the pension plan members, including their chosen contribution rate, investment fund choice, and any fund switches they have made. The company runs a flexible benefits (”flex”) plan whereby employees can choose the benefits most appropriate to them. The flex plan allows members to choose pension contributions of between 4% and 12% of salary that will be made out of the member’s flex allowance. The amount of allowance not spent on pension contributions can be used to purchase non-pension benefits or be taken as additional cash salary. Plan members allocating 12% from their flex allowance to pension contributions can contribute up to an additional 6% of pre-tax salary to the plan and this attracts one-for-one matching from the company.

In terms of investment, members have a choice of 11 funds (four active equity funds; four passive equity funds; two bond funds; one cash fund). The plan operates a default fund for members who are reluctant to make their own choice of investment fund. The default asset allocation for members contributing 10% of salary or less to the plan is 100% index-linked bonds. Where a member is contributing more than 10% of salary to the plan, the default allocation is 100% index-linked bonds for the first 10% of salary and 100% equities for the

remainder.[3] We have data on both the allocation of contributions chosen by members and the asset allocation of the portfolio, with the latter being the result of the allocation of contributions and the relative performance of the various funds over the period of investment.

One particularly attractive feature of the dataset is the inclusion of the investment return for each member's account. While this is only available for a short period (12 months ending May 2006), it provides indicative information on the impact of the members' investment choices on portfolio performance.

In addition, the dataset includes demographic variables (age and sex) and employment variables (tenure and salary). These variables allow us to analyse cross-sectional differences in contribution and investment decisions across plan members. Table 1 provides the definitions of the variables used in this study.

[Table 1 about here]

Table 2 provides descriptive statistics for the data. The average member is contributing 9.3% of salary, which includes the contributions made on behalf of the member by the employer. Sixty-nine percent of members have made an active choice of how to invest their contributions, which is relatively high by comparison to evidence available on other plans (e.g. Choi et al., 2002). However, members are relatively inactive, with the average number of fund switches made in the 12-month period being 0.37. In fact, only 4.7% of members made any switches during the period. The average member has chosen a contribution asset allocation of approximately 60% equities and 40% bonds, although there is a wide range and some members have an allocation of 100% bonds, while others have an allocation of 100% equities. The average 12 month portfolio return is 16.1% reflecting a period when equity markets did well. The average member is 35 years old, is paid £33,000 per annum and has been in the DC plan for 3.6 years. Forty six percent of plan members are males.

[Table 2 about here]

[3] For example, a member contributing 15% of salary to the plan and accepting the default investment would have an asset allocation of contributions of 66.7% index linked gilts (first 10% of salary) and 33.3% equities (the additional 5% of salary.) This is a relatively unusual default fund structure in the UK.

4. Method

4.1 Hypotheses concerning contribution rates

Older employees will likely have paid off (mortgage) debt and face reducing costs of bringing up their families, implying increased income available for saving for retirement. Equally, higher-paid members should have greater amounts available for saving. We thus hypothesise, in line with lifecycle theory, that the saving rate of plan members will be a positive function of both age and income. The main weakness in our ability to test this is that we know only what the member is contributing to their pension plan and cannot track non-pension saving. However, given the tax advantages of pension saving and the presence of employer matching it makes sense for employees who have already built up some precautionary savings to take full advantage of pension saving before saving more through other channels.

The likely relationship between the member's sex and pension contribution rate is somewhat ambiguous. Females typically have longer life expectancy than males and often also have interrupted labour market participation patterns. These factors would suggest the need for females to save more than males. However, to the extent that males occupy 'breadwinner' roles in household, males may feel a greater need to provide for their family in retirement.

Choi et al. (2002) document a default bias in the choices of DC pension plan members as regards contribution levels and investment choice. It is likely that engaged, active members who take an interest in their retirement savings are likely to choose an optimal contribution rate – rather than default or minimal levels – *and* to choose an optimal investment strategy rather than accept the default fund. It follows from this that there should be a positive relationship between the contribution rate and making an active fund choice.

Finally, the amount each member saves should be related to their desired level of pension in retirement. Plan members vary in the asset allocation chosen for their contributions. Given that equities have a higher expected return than bonds, it follows that, other things being equal, equity investors need to save less, on average, than bond investors. We thus expect a negative relationship between the contribution rate and the allocation of contributions to equities.

Putting these conjectures together leads to us to test the following regression:

$$(1)\ ContribRate = Constant + b_A Age + b_{MD} MaleDummy + b_{LP} Log(Pay) + b_{CD} ChoiceDummy + b_{EF} EquitiesFlow$$

The variable definitions are as given in Table 1. We estimate the regression by using Ordinary Least Squares.[4]

4.2 Hypotheses concerning investment choice

Choi et al.'s (2002) default bias implies that many members will passively accept the plan's default investment fund rather than make an active investment choice of their own. Some members will make an active choice and it seems plausible that default fund use should be negatively related to tenure (as people eventually make a positive choice), income (as a proxy for education) and age (as a proxy for engagement, with older employees typically more interested in pensions than younger employees). Active fund choice may also be related to sex, e.g. due to higher levels of overconfidence amongst males (Barber and Odean, 1999).

To test this we run the following Logit regression:

$$(2)\ ChoiceDummy = Constant + b_A Age + b_{MD} MaleDummy + b_T Tenure + b_{LP} Log(Pay)$$

For members who make an active choice of investment, the asset allocation chosen should reflect the member's attitude to risk. Hallahan et al. (2004) find subjective risk tolerance to be higher amongst males, positively related to income and negatively related to age. This implies that members' equity allocations should be similarly related. Furthermore, the lifecycle investment approach of Bodie (2003) implies lower allocations to equities at older ages.

To test this we run the following regression:

[4] ***ChoiceDummy*** and ***EquitiesFlow*** are potentially endogenous regressors in equation (1) given that they are decisions made by the plan member at the same point in time as the decision on ***SaveRate***. However, in practice the correlations between Choice Dummy and Equities Flow and the residuals from the OLS estimation of equation (1) are practically zero. Furthermore, our attempts to produce instruments for ***ChoiceDummy and EquitiesFlow*** using a matched pair approach failed to find a suitable highly correlated instrument for either variable. Hence, we estimate equation (1) using OLS.

$$(3)\ EquitiesFlow = Constant + b_A\ Age + b_{MD}MaleDummy + b_{LP}Log(Pay)$$

We estimate this model in two forms. In Model A we estimate for all members in our sample, but include ***ChoiceDummy*** as a control variable because for most members the default fund is 100% fixed income. Model B is estimated for only those members who have made an active choice of investment fund and hence there is no need for the ***ChoiceDummy*** control variable. There are a total of 2499 plan members who have made an active investment choice. We use the allocation of contributions (i.e. "Flow") rather than allocations of account balances because, as Huberman and Jiang note (2006, p769), account balances reflect cumulative returns as well as past choices and there is evidence that few members rebalance portfolios to achieve target allocations.

Portfolio diversification represents another dimension on which members must make a choice. Members can diversify internationally as well as across asset classes. The funds on offer in the plan are diversified equity portfolios mostly with a regional focus, together with domestic fixed income and cash funds. A large literature exists showing that many investors display a home bias and maintain a surprising high proportion – often 80% or more - of their investments in securities listed in their own country, e.g. French and Poterba (1991) and Kang and Stultz (1997). There have been attempts at rational explanations of this bias, for example due to information costs, but there are also behavioural explanations, such as familiarity bias (Huberman, 2001). We examine the degree of home bias in both the plan members' equity allocations and in their total portfolio allocations. The latter is a somewhat imperfect measure, because members seeking cash or fixed income exposure only have access to UK-domiciled investments. We further seek to understand whether certain groups of employees are more or less prone to home bias than others, for example because of their degree of financial sophistication.

We test the following regression:

$$(4)\ HomeEquity\ = Constant + b_A Age + b_{MD}MaleDummy\ + b_{LP}Log(Pay)$$

HomeEquity is defined as the percentage of the member's equity exposure accounted for by domestic equity. We also estimate the equation for HomeAssets, which is defined as the percentage of the overall portfolio comprised domestic assets (equities, bonds and cash.)

Again, we estimate this only for those scheme members who have made an active choice of funds.

An additional consideration in terms of investment choice is that while members of the plan can choose their own asset allocation, they must do so from a set of 11 funds offered in the plan. An important question is how members diversify across the key asset classes (especially equities and bonds) using the funds offered and the influence the fund menu has on their decisions. Our data allow us to test for plan members using the naïve 1/n or conditional 1/n approaches to diversification. Testing for 1/n is simply a matter of examining what proportion of members invest in all 11 funds and how many of those do so in equal proportions.

To test for the conditional 1/n approach, we follow the approach of Huberman and Jiang (2006). They sort plan members by the number of funds they have chosen and then assess what proportion of members in each category is following a conditional 1/n strategy. To do so, they calculate the Herfindahl concentration index for each member's portfolio allocation, which is defined as the sum of the squared fractions of contributions to each fund. For example, the Herfindahl index for an investor who chooses two funds and puts 50% in each is 0.5 (i.e., $0.5^2 + 0.5^2$). The Herfindahl index can range from 1/n through to 1. Huberman and Jiang argue that an investor is "close" to following a 1/n strategy if the total deviation of their fund allocation from a pure 1/n strategy is no more than 20%. (In the two fund case this equates to a 55:45 allocation.) This allows them to calculate an upper bound for the Herfindahl index than can be interpreted as being consistent with the plan member following a conditional 1/n strategy. We adopt this approach in our analysis.

4.3 Hypotheses concerning investment return

We wish to test the relationship between portfolio return and age, sex and income to see if any particular group does better than the others. Again financial sophistication is the most likely underlying reason for the difference. In addition, following Barber and Odean (1999), we wish to test the hypothesis that switchers will earn lower returns than other members. Most plan members in our database do not switch their fund choice through the course of the year, but a minority are fairly frequent switchers.

These hypotheses can be tested using the following regression:

$$(5)\ 12Rtn = Constant + b_{ES}EquitiesStock + b_{A}Age + b_{MD}MaleDummy + b_{LP}Log\ (Pay) + b_{SD}SwitchDummy$$

EquitiesStock serves as a control variable given that over the period the main determinant of portfolio return is the allocation to equities and we have already sought to explain that via equation (3). ***SwitchDummy*** is a 0/1 variable that flags members who have made any switches in the period. We also run an alternative specification of the model where we use the number of switches ("***Switches***") instead of ***SwitchDummy***. We estimate this equation using OLS and use only data on members who have made an active choice of investment fund.

5. Results

5.1 Results concerning contribution rates

Table 3 shows the regression models that we use to attempt to explain members' contribution rates. It is clear from both specifications of the model that contributions are positively related to age and income, which is broadly consistent with lifecycle saving theory. Other things being equal, the contribution rate is 1% higher for every ten year increase in member age and rises by 0.1% for every 10% increase in salary. On average, males have a 1% higher contribution rate than females, controlling for age and income.

[Table 3 about here]

There is evidence that higher contribution rates are chosen by more 'engaged' members who also make an active choice of investment fund. These members save an additional two percentage points of salary compared with members who have not made an active investment choice. Our final contribution rate hypothesis was that members who take a conservative, fixed-income–based investment strategy would save more to compensate for the lower expected return on their portfolio. Panel B of Table 3 shows that the opposite appears to be the case, with fixed-income investors saving less than equity investors.[5] Other things being equal, a member 100% invested in equities saves an additional 3% of salary relative to a member 100% invested in bonds. This might imply that both contribution rate and equity allocation are related to some measure of financial sophistication.

[5] We drop the ChoiceDummy variable from Model B as it is highly correlated with EquitiesFlow.

5.2 Results concerning investment choice

Our first analysis of investment choice seeks to understand the characteristics of members who make an active choice of investment strategy rather than accept the default fund. Table 4 shows the results of a Logit regression where the dependent variable is ***ChoiceDummy***, which takes the value one if the member has made an active fund choice and zero otherwise.

[Table 4 about here]

The results show that higher-paid members are more likely to make an investment choice, which may mean pay is acting as a proxy for education and financial sophistication. The probability of making a choice also increases with employment tenure, suggesting that some members initially accept the default but eventually get around to making an active choice. This is consistent with the findings of Choi et al. (2002). Older members are more likely to use the default than younger members. Given that for most members (contributing less than 10% of salary), the default is 100% bonds, it may be that older members are more likely to regard this asset allocation as suitable for their needs than younger members who may desire higher return investments. The sex variable in the equation is insignificant. We re-estimate the equation excluding the sex variable and find that the coefficients for the other variables are largely unchanged.

The most significant investment choice plan members have to make is the proportion of their contributions to invest in equity funds. Table 5 shows the analysis of this decision. Model A shows the results for the full sample using ***ChoiceDummy*** as a control to account for the default fund being 100% fixed income for most members. Model B is estimated for only those members who have made an active choice of investment fund.

[Table 5 about here]

The coefficients for both models are qualitatively similar. Both models show that older members invest less in equities than younger members, consistent with lifecycle asset allocation. Taking Model B, for every ten year increase in member age, the equity allocation is 8 percentage points lower. The coefficient is lower for Model A. Other things being equal, equity allocation is higher for males than females (by 5 percentage points) and higher for

those on higher incomes. The equity allocation is approximately 0.6 percentage points higher for every 10% increase in salary. These results are consistent with Hallahan et al.'s (2004) analysis of subjective risk tolerance scores.

In addition to choosing an allocation to equity, members may choose the international diversification of their portfolio. Across the whole sample, members allocate an average of 63% of their portfolios to domestic assets, and an average of 40% of their equity portfolios to domestic equity funds. While this is an indication of home bias, it appears to be less extreme than found in many previous studies. Taking only those members who have made an active choice of investment funds, the corresponding domestic weights are 48% of total assets and 38% of equity assets.

[Table 6 about here]

Table 6 shows the results of a regression equation attempting to explain which members are most prone to home bias. Panel A examines the domestic share of the equity portfolio, while Panel B examines the share of total assets. The main point to note is that in both cases the explanatory power of the model is low. However, both specifications show that older members are inclined to hold more home biased portfolios (for example two percentage points more domestic equity for every 10 years of age), while males hold less home biased portfolios. Care should be taken in interpreting the model in Panel B in that the only fixed income and cash funds in the plan are domestic funds. Hence, any investor desiring a conservative portfolio allocation must, by default, accept a degree of home bias.

One question that arises from the foregoing analysis of equity allocation and home bias is the extent to which both are determined by the level of financial sophistication of the investor. The data shown in Table 7 suggest this is the case. The table shows data ranked into quintiles by number of funds held in each member's portfolio. High numbers of funds are more likely to be complex portfolios held by relatively sophisticated investors. The Table provides some support for this by showing that the more complex portfolios have higher equity weightings (by approximately 5%, taking quintile 5 vs. quintile 1) and lower home bias (by approximately 13% on the same basis.)

[Table 7 about here]

To continue the analysis of diversification, Table 8 shows the distribution of number of fund choices. The table shows a maximum of 10 funds. Members have 11 funds to choose from, but in our data the index-linked bond fund and corporate bond fund data are aggregated. The mean number of funds chosen is 4.2, while the median is 4. Panel A shows that over 60% of members choose 3, 4 or 5 funds. These figures are broadly consistent with Huberman and Jiang's findings. The table also shows that only 0.5% of members (or 12 in number) are invested across all 10 funds, suggesting that Benartzi and Thaler's 1/n rule is not a valid description of the members' behaviour.

[Table 8 about here]

Panel A shows the percentage of members with allocations to a particular number of funds and the percentage in each category whose allocations are consistent with them following a conditional 1/n strategy. For example, members choosing two funds are following a conditional 1/n approach if they invest 50% in each of the two funds. The Herfindahl index measures the degree of dispersion in the allocations. Following Huberman and Jiang we allow 20% deviation from the pure conditional 1/n strategy while still classifying the member as following that approach. The table shows the 1/n Herfindahl index values (H) and the conditional 1/n upper bound Herfindahl index values (H_U). The final column of the table shows the percentage of members in that category of fund choice who have a Herfindahl index value within the range from H to H_U. The table shows that more than half of members who choose two funds opt for a 50:50 allocation, or something close to it. A conditional 1/n strategy is less common amongst members who have chosen more than two funds, although there is an interesting spike in the proportion of members who follow the conditional 1/n approach amongst those who have chosen 4 or 5 funds. The conditional 1/n approach appears to be most popular where the "n" is a number that is easy to divide by! In total, just over 14% of plan members follow a strategy that is close to the conditional 1/n approach using Huberman and Jiang's definition.

It is important to note, as Huberman and Jiang do in their analysis, that these results say nothing of the rationality of the individual fund choices. A 50:50 allocation between two of the funds on offer in this plan might well be an optimal choice for a member with a particular attitude to risk.

Panel B of Table 8 expands the analysis of the allocation choice made by members who invest in two funds. A total of 50.8% of these members adopt an exact 50:50 allocation of their contributions. For the remaining members, allocations cluster on other 'round' numbers. A 75:25 allocation is chosen by 16% of members and only 5.7% of members in the two funds category choose allocations other than in units of ten percentage points. Again, there is nothing to say these allocations are not rational, but they are also consistent with members using simple heuristics when deciding on the contribution allocation.

5.3 Results concerning investment return

Table 9 shows our tentative analysis of the determinants of portfolio return. Given that the period in question was characterised by strong equity market performance, we first control for the proportion of the portfolio invested in equities. On average, a member 100% invested in equities earned a return over 16% percentage points higher than a member invested 100% in bonds.

[Table 9 about here]

The results show that there is no significant relationship between age and portfolio performance. Males earn an additional 40 basis points of return compared with females, but and the difference is statistically significant. Higher paid members earn marginally lower returns than others, after controlling for the equity allocation decision. This is interesting as a contrast to our earlier suggestions of income as a proxy for financial sophistication.

One notable result in this analysis is that, other things being equal, switchers earn lower returns than members who hold their asset allocation constant. Members who switch in the period earn returns that are 100 basis points, on average, lower than other investors. The difference is significant at the 5% level. Model B shows that this result is robust to the use of number of switches instead of the 0/1 dummy variable. This is consistent with Barber and Odean's (1999) finding of overconfidence and excess trading amongst retail brokerage investors.

6. Conclusions

In this paper we have used a unique administrative dataset to examine the contribution and investment decisions made by members of a large UK-based DC plan which is sponsored by a FTSE-100 company. We find that the members' contribution rates are positively related to their age and level of income, which is broadly consistent with lifecycle saving theory. However, we also find evidence that is consistent with behavioural theories, for example that higher contribution rates are chosen by sophisticated investors who also are prepared to choose their own investment strategy, and that investors with conservative portfolios do not save at higher rates to compensate for the lower expected return.

In terms of investment choice, we find that use of the default fund declines with tenure and with income. Default fund use increases with age, which may be because the default is largely a fixed-income investment. We find that the equity allocation decreases with age, which is consistent with the lifecycle investment approach, and that equity allocation is higher for males than females and increases with income, results which are consistent with previous research on subjective risk tolerance. There is some evidence of home bias in the members portfolios, but less than has been commonly found. Members with complex, equity based portfolios have lower home bias than their peers. There is little evidence that members allocate their contributions using a naïve 1/n diversification strategy across all available choices, but some members do follow a conditional 1/n diversification strategy and equally weight across the subset of funds they have chosen. Our data on investment return are too limited to draw strong conclusions on the determinants of return. We do, however, find that the more active an investor is, other things being equal, the lower the returns they earn.

The recent literature on individual financial decision making over the lifecycle has emphasised the effect of behavioural biases in decision making. There is evidence that some members of this plan are prone to these behavioural biases, especially when it comes to the active management of their portfolios. However, we also find that a large percentage of the plan's membership behave according to the predictions of standard lifecycle saving theory and lifecycle asset allocation. One speculation is that this might be a result, at least partially, of the effectiveness of the company's pensions communications strategy. While we are unable to test this directly, we can conjecture that a reasonably good pensions communications strategy would be more effective at communicating the importance of saving for retirement than with getting across the message of efficient risk diversification. This is what we find

here. As a consequence, the members of this pension scheme are much closer to being rational lifecycle optimisers than many other recent studies have found.

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Table 1 – Variable definitions

Variable	Definition
ContribRate	Combined employer and employer pension contribution as a % of member's salary
ChoiceDummy	Dummy variable that takes the value of one if the member has made an active fund choice and zero if the member is invested only in the default fund.
Switches	Number of fund switches made by the member in the 12 months ending May 2006.
SwitchDummy	Dummy variable that takes the value one if the member has made switches in the 12 month period and zero otherwise.
BondFlow	Member's chosen allocation of contributions to bond funds (as a % of total).
BondStock	Asset allocation of the member's portfolio to bond funds (as a % of total).
CashFlow	Member's chosen allocation of contributions to cash funds (as a % of total).
CashStock	Asset allocation of the member's portfolio to cash funds (as a % of total).
EquitiesFlow	Member's chosen allocation of contributions to equity funds (as a % of total).
EquitiesStock	Asset allocation of the member's portfolio to equity funds (as a % of total).
12Rtn	12 month total return on the member's pension account.
Age	Member's age
MaleDummy	Dummy variable that takes the value one if the member is a male and zero if the member is a female.
Tenure	Member's tenure in employment with the company.
Pay	Member's annual salary in £.

Table 2 – Descriptive statistics

Variable	Mean	Standard Deviation	First Quartile	Median	Third Quartile
ContribRate	9.3%	5.0%	4.7%	9.8%	12.0%
ChoiceDummy	0.689	0.463	0.000	1.000	1.000
Switches	0.372	1.949	0.000	0.000	0.000
SwitchDummy	0.047	0.212	0.000	0.000	0.000
BondFlow	38.0%	40.0%	0.0%	20.0%	83.3%
BondStock	26.3%	27.0%	4.3%	17.9%	40.1%
CashFlow	1.6%	8.3%	0.0%	0.0%	0.0%
CashStock	1.5%	7.4%	0.0%	0.0%	0.0%
EquitiesFlow	58.5%	40.8%	16.7%	80.0%	100.0%
EquitiesStock	72.2%	27.9%	57.2%	81.5%	93.3%
12Rtn	16.1%	5.2%	13.2%	15.6%	18.8%
Age	35.2	7.8	29.0	34.0	40.0
MaleDummy	0.461	0.499	0.000	0.000	1.000
Tenure	3.6	2.1	2.0	3.0	5.0
Pay	33720	17091	22321	29909	39883

N=3629 for all variables. Variable descriptions are given in Table 1.

Table 3 – OLS regression of the contribution rate on demographic, choice and income variables

	Model A		Model B	
	Coefficient	T-statistic	Coefficient	T-statistic
Constant	-0.122	-4.682	-0.111	-4.311
Age	0.001	9.843	0.001	11.001
MaleDummy	0.011	7.212	0.010	6.377
Log (Pay)	0.015	5.990	0.014	5.322
ChoiceDummy	0.022	13.961	-	-
EquitiesFlow	-	-	0.031	17.999
	N=3629		N=3629	
	R-Sq(adj) = 12.1%		R-Sq(adj) = 14.3%	

Dependent variable is ContribRate, which is the combined employer and employee pension contribution rate as a % of salary. Independent variables as defined in Table 1. See equation (1) in the text. T-statistics based on White adjusted standard errors.

Table 4 – Logit regression of ChoiceDummy on demographic and employment variables

	Model A			Model B		
	Coefficient	Z	P-value	Coefficient	Z	P-value
Constant	-4.624	-5.005	0.000	-4.434	-4.909	0.000
Age	-0.018	-3.712	0.000	-0.017	-3.676	0.000
MaleDummy	-0.095	-1.264	0.206	-	-	-
Tenure	0.179	7.789	0.000	0.177	7.720	0.000
Log (Pay)	0.529	5.731	0.000	0.506	5.651	0.000
		N=3629			N=3629	
		% concordant = 61.5			% concordant = 61.5	

Dependent variable is ChoiceDummy, a zero-one dummy variable that takes the value one if the member has made an active choice of investment fund and zero if the member is invested only in the default fund. Independent variables as described in Table 1. See equation (2) in the text.

Table 5 – OLS regression of equity allocation on demographic and income variables

	Model A		Model B	
	Coefficient	T-statistic	Coefficient	T-statistic
Constant	-0.342	-3.881	0.391	3.259
ChoiceDummy	0.743	119.395	-	-
Age	-0.004	-6.372	-0.008	-9.110
MaleDummy	0.044	6.696	0.049	5.491
Log (Pay)	0.053	5.701	0.067	5.418
	N=3629		N=2499	
	R-Sq(adj)= 75.1%		R-Sq(adj)= 8.0%	

Dependent variable is EquitiesFlow which is the member's choice of the % of contributions to be allocated to equity funds. The independent variables are as defined in Table 1. Model A is estimated for all members in our sample and includes ChoiceDummy as a control because the default fund for most members is 100% fixed income. Model B is estimated using only those members who have made an active choice of investment fund. See equation (3) in the text. T-statistics based on White adjusted standard errors.

Table 6 – OLS regression of the domestic content of portfolio on demographic and income variables

	Model A HomeEquity		Model B HomeAssets	
	Coefficient	T-statistic	Coefficient	T-statistic
Constant	0.316	2.666	0.665	5.292
Age	0.002	2.263	0.006	7.867
MaleDummy	-0.037	-3.929	-0.061	-6.243
Log (Pay)	0.003	0.221	-0.035	-2.750
	N=2419		N=2499	
	R-Sq(adj) = 0.8%		R-Sq(adj) = 4.7%	

The dependent variable in Panel A is HomeEquity, which is the percentage of the members equity portfolio invested in domestic equity funds. The dependent variable in Panel B is HomeAssets, which is the percentage of the members portfolio invested in all domestic assets. Independent variables as defined in Table 1. See equation (9) in the text. The equation is estimated using only those members of the plan who have made an active choice of funds. T-statistics based on White adjusted standard errors.

Table 7 – Equity allocation and home bias by portfolio complexity

	Number of Funds Held	Mean Equity Allocation	Mean HomeEquity	Mean HomeAssets
Q1	2.4	80.6%	44.9%	55.1%
Q2	3.7	82.2%	42.3%	51.9%
Q3	4.6	81.9%	37.8%	48.0%
Q4	5.8	84.4%	34.6%	44.5%
Q5	8.1	85.5%	32.0%	41.8%
Q5-Q1	5.7	4.9%*	-12.9%*	-13.3%*

Data is sorted and ranked into quintiles using number of funds held. Corresponding figures show mean equity allocation, domestic equity share, and domestic asset allocation for those quintiles. Q5-Q1 is the difference between the extreme quintiles. * denotes statistical significance at the 5% level.

Table 8 – Fund allocation decisions

Panel A: Number of funds chosen and Herfindahl indexes

Number of Funds Chosen	Percentage of Members (N=2499)	H	H_U	Percentage of Members in Category Between H and H_U
1	4.3%	-	-	-
2	10.5%	0.5000	0.5050	53%
3	23.3%	0.3333	0.3356	7%
4	23.8%	0.2500	0.2513	15%
5	17.3%	0.2000	0.2008	16%
6	9.4%	0.1667	0.1672	5%
7	5.3%	0.1429	0.1433	2%
8	3.3%	0.1250	0.1253	6%
9	2.4%	0.1111	0.1114	2%
10	0.5%	0.1000	0.1002	8%
All	100%			

Panel B: Allocation choices of members with two funds

Fund Allocation	Percentage of Members (N=262)
50:50	50.8%
60:40	8.4%
70:30	7.6%
75:25	16.0%
80:20	7.3%
90:10	4.2%
Other Splits	5.7%
All	100%

In Panel A Number of Funds Chosen is the number of funds to which the member has a non-zero allocation of contributions. The Percentage of Members is based only on those members who have made an active choice of investment funds. H is the value of the Herfindahl index that is consistent with an allocation of contributions of 1/n, where n is the number of funds chosen. H_U is the upper bound of the Herfindahl index that is consistent with an allocation of contributions that deviates by no more than 20% from a conditional 1/n strategy. In Panel B, the analysis considers only members who have chosen just two funds. Other Splits contains all members who chose splits other than the 'round' numbers shown in the Table. No other individual split accounts for more than 0.8% of members.

Table 9 – OLS regression of 12 month portfolio return on demographic, choice and income variables

	Model A		Model B	
	Coefficient	T-statistic	Coefficient	T-statistic
Constant	0.126	6.705	0.127	6.722
EquitiesStock	0.166	47.592	0.166	47.635
Age	0.000	1.623	0.000	1.636
MaleDummy	0.004	2.485	0.004	2.500
Log (Pay)	-0.009	-4.823	-0.009	-4.844
SwitchDummy	-0.010	-3.201	-	-
Switches	-	-	-0.001	-3.602
	N=2499		N=2499	
	R-Sq(adj) = 49.1%		R-Sq(adj) = 49.1%	

Dependent variable is 12Rtn, the 12-month return on the member's portfolio for the period ending May 2006. Independent variables are as defined in Table 1. EquitiesStock is a control variable in that the period in question saw strong equity market returns. The equations are estimated using only those members who have made an active choice of investment fund. Results using the full sample of members are qualitatively similar. See equation (4) in the text. T-statistics based on White adjusted standard errors.