Solutions to the asset allocation problem by informed respondents: the significance of the size-of-bet and the 1/n heuristic

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Solutions to the asset allocation problem by informed respondents: the significance of the size-of-bet and the 1/n heuristic

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Abstract. Asset allocation is a classic topic in the theory of finance, and a crucial issue for investment policy. Noted for its significance in driving pension fund performance, it is also an issue that individual investors consider when designing their investment portfolios. In theory, Markowitz and those following in his wake have an optimal solution. In practice, however, we demonstrate that when asked to allocate financial assets to a set of asset classes arrayed in order of their riskiness (from low to high), most respondents would vary their investment strategies according to the size-of-bet (the value of assets to be invested). As in previously reported research on the competence and consistency of pension fund trustee decision-making, we show that there are a variety of "solutions" to the posed problem. These differences cannot be explained by social status, formal education or professional training. Observed differences in respondent solutions to the asset allocation problem are due to strategies that mix together intuitive responses to the initial tranche of money with a rudimentary theoretical-cum-practical shared convention. Solutions to the asset allocation puzzle suggest that the size-of-bet is a significant issue for many informed investors, contrary to commonplace assumptions. In conclusion, suggestions are made about taking forward closer scrutiny of these observed patterns.

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1. Introduction

Asset allocation is a classic topic in the theory of finance. In light of Markowitz's (1952) pioneering work on optimal portfolios, studies in this vein tend to utilize a simple set of options (eg. a risk-free asset with an equity) to demonstrate the principles of portfolio design. This approach can be extended to more complex problems including cross-correlations between asset classes and transaction costs of continuous portfolio adjustment (see Litterman et al. 2003). For pension funds, asset allocation is one of a set of crucial investment decisions that bear upon the planned risk-adjusted rate of return given expected liabilities (Campbell and Viceira 2006). The asset allocation decision is perhaps the most important decision when determining the overall investment rate of return, because decisions on active versus passive management, the selection of financial service providers, etc. all depend upon asset allocation.

Asset allocation may be driven by theoretical principles. If left to individuals, however, asset allocation is subject to a variety of behavioral and cognitive "effects." In their path-breaking paper, Samuelson and Zeckhauser (1988) noted that new TIAA-CREF participants tended to allocate 401(k) pension assets on a 50/50 (bonds and equities) basis with little change thereafter despite the long-term accumulation of financial assets and the changing age and status of participants.[1] Where the simplest of life-style and life-cycle models of asset allocation suggest that participants should re-visit their asset allocations on a regular basis, especially as they approach retirement, many participants do not. Information-awareness, prototypical decision-trees, and devices designed to enhance individual decision-making appear to have only modest effects on these short-comings. Benartzi and Thaler (2001) suggested, of course, that well-designed default settings in pension plans can mitigate these effects.

There is a vibrant market for information and advice on asset allocation strategies (see Canto 2006). Similarly, pension fund consultants have developed techniques and methods of analysis to cue pension fund trustee decision-making on this issue; risk-budgeting, asset-liability models, and performance metrics provide formal protocols that make asset allocation an essential component of decision-making (Bauer et al.

[1]/. Not everyone will be aware that TIAA-CREF is a US private pension fund operating on behalf of many university and foundation employers. It offers participants defined contribution pension savings products with IRS tax-preferred status (ie. 401(k) eligible). It is one of the world's largest private pensions provider.

2006). Even so, evidence on trustee decision-making competence and consistency is not altogether encouraging. We have suggested that many UK pension fund trustees lack the fundamental knowledge and skills to be expert decision-makers (Clark et al. 2006a). Judgement in these situations is highly dependent upon the level of formal education, professional qualifications, and (to a lesser extent) role-specific training (Clark et al. 2006b). Most problematic, trustee heterogeneity on these issues may fracture the coherence of board decision-making—extreme positions can become plausible if the logic of investment is undercut by misapprehension (as suggested by Sunstein 2005 but compare with Kahan et al. 2006).

In this paper, we report more results from our project on trustee decision-making. This project was developed using the psychological methods and protocols that are now commonplace when testing decision-making. Following Kahneman and Tversky (1979), our testing regime emphasizes solving problems more than individual attitudes. Here, we were most concerned with respondents' solutions when asked to allocate assets among asset classes rank-ordered in terms of their riskiness (low to high) across four increasing tranches of money to invest—£10 thousand, £100 thousand, £1 million, and £10 million. The underlying research question informing analysis was whether the size-of-bet makes a difference to respondents' asset allocations. Also at issue was whether respondents shared a common solution to the problem, such as Benartzi and Thaler's (2001) 1/*n* heuristic.[2]

In the next section, the asset allocation issue is considered beginning with recognized frameworks through to current uncertainties. If there are *a priori* expectations about respondents' solutions, the gap between theory and practice is sufficiently large to allow for a variety of plausible solutions. This leads to a discussion of what might be expected from respondents' decision-making in light of Kahneman's (2003) comments about the significance of intuition. In section 5, the results of the analysis indicating that the two most common solutions have a significant size-of-bet bias are summarized. It is noted that proffered solutions are not related to respondent status

[2]/. Benartzi and Thaler (2001) defined the 1/*n* heuristic as an options-led allocation rule: respondents seem to allocate assets to all the available investment options whatever their best interests in discriminating amongst the options for the best set of options. They also suggest that the 1/*n* heuristic is "extreme" in that it represents the limit of diversification. See Todd and Gigerenzer (1999) on the use of heuristics in everyday decision making.

(member-nominated versus employer-nominated), formal education, or professional qualifications. Furthermore, there is little evidence for the 1/*n* heuristic. In section 6, a series of suggestions are made about the possible "logics" underpinning observed solutions to the problem. The paper concludes with comments about the status of the size-of-bet asset allocation problem.

2. Asset allocation

Markowitz (1952) is credited with formalizing the logic underpinning the advantages of portfolio diversification. His approach was at once elegant and simple. It depends on holding two assets, one risk-free and the other with a known risk profile, so as to estimate the overall expected risk-adjusted rate of return. Assumptions include zero transaction costs, a known universe, and an ability to infinitely vary the elements of an investor's portfolio. Recognizing that risk carries the prospect of loss and the prospect of gain compared to a risk-free investment, asset allocation has accordingly become one of the foundations of modern portfolio theory. As asset classes carry different risk-premiums, from virtually no risk (and a low rate of return) to very high risk (and the promise of a commensurate rate of return), portfolio design has become an issue of asset mix and management (see Litterman et al.'s 2003 handbook).

Three implications follow from modern portfolio theory. First, the risk of any investment should be considered in relation to the whole portfolio. Consequently, the allocation of financial resources to one asset class must be related to the allocation of resources to the other asset classes that makeup the entire portfolio. Second, optimization of a portfolio's risk and return profile may require investors to continuously adjust the relative allocations of assets as more information becomes available about the variance of returns for specific assets and the cross-correlations between asset classes in terms of their risk-adjusted rates of return. Third, the planned portfolio risk-adjusted rate of return is a function of investor's goals and objectives. A defined benefit pension fund may set a target rate of return (and asset allocation) according to plan-specific expected liabilities whereas an individual investor in a defined contribution (DC) plan may set a target rate of return (and asset allocation) according to their retirement income aspirations (Venti 2006).

Thirty years ago, government bonds provided a guaranteed income over a well-defined time horizon, while equities provided an expected rate of return judged against past performance, current circumstances, and near-term prospects. The investment management industry has provided calibrated risk-adjusted rates of return over various time horizons, segmenting and differentiating those asset classes into (for example) large-cap and small-cap equities, domestic, international, and emerging market equities, etc., while constructing elaborate cross-correlation matrices to aid the construction of portfolios. Most importantly, "new" asset classes have been added to the mix, including various forms of property and urban infrastructure, secured and unsecured corporate bonds, hedge-funds, private equity, and venture capital funds (Torrance 2006). Some of these asset classes are represented by financial products traded on public securities' markets, and some are private and non-traded with difficult-to-estimate risk premiums.

For many small investors, access to new asset classes has been limited due to the lack of information, the lack of experience, and the minimum investment demanded by product providers. In some cases, vendors of highly specialized products have required co-investment over long time horizons without exit options—the risks of such ventures are hard to define, and only the largest institutional investors may have the resources to make informed judgements about investment prospects. On the other hand, individual risk-preferences and desired rates of return may be conditioned by cognitive anomalies so that the spread of financial resources through to the highest risk-categories is affected by psychological predispositions. The work of Kahneman and Tversky (1979) on prospect theory is important in this respect, so too is that of Duflo and Saez (2002) who noted that there can be a "neighbour effect" when choosing amongst 401(k) pension plan investment options.

We must be cautious of aligning ourselves with this literature on a number of counts. First, our study is principally concerned with asset allocation amongst a set of asset classes over a range of bets rather than the choice of investment funds within an asset class. As such, Benartzi and Thaler's (2001) $1/n$ heuristic looms large, although they suggest that it is a naïve solution perhaps less relevant to specific environments and specialized expertise (see Huberman and Jiang 2006). Second, the theory of asset allocation relies upon simplifying assumptions including zero transaction costs and an

unproblematic continuous process of portfolio adjustment. In the real world, therefore, asset allocation decisions are systematically sub-optimal and recognised as such by economic agents (Leland 1984). Third, if combined with context-specific reasoning, these circumstances may give rise to a wide range of solutions where inter-personal comparisons of asset allocation solutions are confounded by individuals' background determining effects. At the limit, there may be as many solutions as there are people.[3]

This is a subjectivist view of individuals and society rather than a materialist view of social structure and relationships that stresses individuals' social identities, common locations, roles and responsibilities. There may be, in fact, systematic patterns in individuals' solutions to the asset allocation problem, though differentiated according to socio-demographic characteristics (a simple testable proposition), and the shared norms and conventions associated with certain roles and responsibilities (a nuanced and more difficult to prove proposition). In the next section, we look at the significance of conventions especially in situations where task-specific expertise is informed by knowledge and understanding. To the extent that responsibility is informed by norms and conventions, decision-making may be underpinned by shared "theories" or "solutions" that reflect the specific circumstances of those responsibilities (Stanovich and West 2000).

In this respect, it is important to observe that our respondents come from certain well-defined segments of the UK population, are of a similar age, are male, and share a very important responsibility: they are trustees in some of the UK's most important defined benefit pension funds. As it turned out, though, this does not mean that they were as competent or consistent decision-makers as we might suppose (when compared against an undergraduate control group). Nonetheless, they do share a common decision-framework set by statute and regulations, and set by norms and conventions derived from collegial relationships and past experience in the finance industry.[4]

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[3]/. See Benartzi and Thaler (2001, 79) where they imply much the same: they do not look at individual asset allocations "because nearly any combination of stocks and bonds could, in principle, be consistent with the maximization of some utility function."

[4]/. It is widely believed that conventions are essential to everyday life in that they integrate individual expectations and behavior around common experience. Conventions may be codified as "rules", but

3. Decision-making in practice

Research in the field of decision-making normally relies upon the responses of university students (Baron 1994). This is as much true of psychology (see Bröder 2003) as it is of economics (see Viscusi and Zeckhauser 2005), but it is less true of the cognate disciplines of anthropology, geography, and sociology (see Heinrich et al. 2005). University students are accessible and are willing to abide by testing conventions that allow for the replication of tests between respondent groups, varying the parameters of tests rather than the context or environment of tests. Most testing regimes are focused upon cognitive ability, one blade of Herbert Simon's (1956) scissors. Our study is at once more ambitious in that it seeks to analyse decision-making in a specific environment with problems relevant to respondent roles and responsibilities, and more circumscribed in the lessons that can be derived thereof because of the limited number of respondents.

The scope of the project has prompted reflection on the underlying assumptions and methods of testing that dominate the field of decision-making. Kahneman (2003) noted that most people hardly ever decide in the manner assumed by academic researchers—people rarely have the time or the patience to contemplate alternative courses of action, sift through available information, search for commonalities between options, and calculate the expected pay-offs. More often than not, people abide by simple rules or templates that worked in the past, rely upon intuition to classify the options and thereby eliminate complexity, and look to others for cues about the appropriate solution. It is entirely possible that most people eschew deliberate decision-making in favour of muddling-through with a mix of strategies that "solve" the problem at hand even if rarely acknowledged as such (March 1994).[5]

One of the virtues of a laboratory testing regime is that it allows for the testing of propositions time and again in all kinds of settings. As more and more evidence has been collected validating many of the insights of prospect theory (for example), the

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may also exist as informal but acknowledged guidelines for action about shared problems. See Lewis (1969) for a game-theoretic treatment of the issues relevant to this paper.

[5]/. See Benartzi and Thaler (1995, 203) on the related notion of mental accounting which they defined as "the implicit methods individuals use to code and evaluate financial outcomes: transactions, investments, gambles, etcetera."

rational actor model has come under sustained attack. This would not have been possible without a set of testable propositions, a replicable testing regime, and a set of agreed standards against which to judge the results of those testing regimes. The contrast with anthropology is striking; for much of the twentieth century, the discipline demonstrated the contingent nature of human reasoning. It has been shown that culture is a crucial factor in affecting risk-related behavior in a wide variety of settings (Douglas and Wildavsky 1983). But anthropological evidence was ignored in mainstream social science because of difficulties in agreeing on a common definition of culture and the context-varying nature of research practice (Kuper 2000).

In this study, we rely upon a formal testing regime but challenge some of its standard practices. As noted earlier, our respondents are not university students in a sterile environment—they are pension fund trustees with well-defined roles and responsibilities (in statute and common law). In part, the project, sought evidence for the proposition that specific roles and responsibilities can make a difference to respondents' performance in well-defined tests of decision-making competency and consistency. By using undergraduates as a point of comparison, it has been possible to calibrate the extent to which age, formal education, professional qualifications, and task-specific training can make a difference to performance in finance-related decision-making (Clark et al. 2006a, 2006b). Trustees and undergraduates are very similar in their underlying competence but differ somewhat in the consistency of their decision-making for problems requiring probabilistic judgement.

One implication of these findings is that being a trustee can make a difference to the consistency of decision-making. Another implication is that trustee performance is less a matter of socio-demographic identity than it is a matter of formal education and professional training (although, in a larger sample, these attributes may be correlated). Yet another implication is that there is something specific to either the skills of trustees or the nature of the problems they must solve (or both) that makes financial decision-making different from decision-making in general. Kahneman (2003) contended, however, that neither the financial significance of the risks taken (resources committed and likely pay-offs) nor the financial incentives facing respondents (for example, whether personally liable) systematically affect decision-making. According to Kahneman, this is evident even in everyday decision-making

where the resources at stake are large, and in literature surveys showing that incentives in university-based testing regimes hardly affect respondents' decision-making performance (citing Camerer and Hogarth 1999).

Kahneman (2003) stressed the significance of intuition, arguing that attention to the financial resources involved may actually negatively affect decision-making performance—the second-guessing of an initial response may result in a compromise rather than a first-best solution. On these issues, and on related larger questions of decision-making competence, Kahneman stressed cognitive ability rather than domain-specific knowledge and understanding. We are sympathetic to his argument in that our study has shown that task-specific financial training can add confusion rather than clarity, especially where the number of training sessions taken is limited. As well, our study has shown that, in a sequence of seemingly-unrelated problems requiring the same kind of decision-technique, those who consistently solve these problems do so by ignoring the detail and focusing upon the essence of the issue. This is, as Wagner (2002) noted, the mark of expertise as opposed to guess-work.

Kahneman's claim about the insignificance of financial commitments can be distinguished from claims made about the nature of expert decision-making. It is our contention that the size of agents' financial commitments may be relevant in decision-making—tests of this issue using university students who bet a trivial amount of money as part of an incentive system designed to encourage serious test-taking are not compelling. Recent research in psychology suggests that there are deeply-embedded biological imperatives that should encourage us to take seriously the value of money when evaluating behavior (see Lea and Webley 2006). But there are few tests of decision making competence involving respondents asked to make bets with large and small relevant financial assets. Furthermore, we are not aware of tests that use informed respondents whose roles and responsibilities are directly related to the allocation of assets and the assessment of financial risk.[6]

[6]/. But see Kudadjie-Gyamfi and Rachlin (1996) who show that, in problems relevant to asset allocation and investment, respondents (undergraduates) can be induced to modify their short-termism (steep discount functions) to take advantage of delayed but higher rewards through a test regime that reinforces delayed gratification. Implied by their study is the existence of experience-weighted discount functions (assuming systematic reinforcement of delayed gratification). Also implied is the possibility that an appropriate institutional framework focused on regulating short-termism and temptation could make a positive difference to individual behavior.

4. Test regime and expectations

Here, we test for the significance of the size-of-bet, interrogating Kahneman's conjecture as well as Benartzi and Thaler's contention that the 1/*n* heuristic is, in practice, a likely solution to the asset allocation problem. In previous papers, the test regime underpinning the project is described in detail (see Clark et al. 2006a, 2006b).[7] To summarize, a group of pension fund trustees from a small set of medium and large UK defined benefit plans were recruited to participate in a test regime designed to assess their decision-making competence and consistency. The project was initiated by the National Association of Pension Funds at a time of considerable debate over the knowledge and understanding of pension fund trustees (Clark 2004). Those participating in the test regime were typically male, over 50 years of age, with a higher than average family income, and with levels of formal education, professional qualifications, and experience unlike their British peers (perhaps like older TIAA-CREF participants; see Munnell and Sundén 2004, 159). There were, nonetheless, differences between trustees in terms of family income, education, and professional qualifications: employer-nominated trustees (about 40 percent of the 39 participants) scored higher on these counts than their member-nominated colleagues.

The test regime consisted of two test-papers, mixing together tests related to decision-making competence and consistency drawn from the literature in psychology and economics with questions related to pension fund governance, attitudes regarding trustee financial competence, and the relationship between immigration and the financing of pay-as-you-go social security. The test papers were challenging in terms of proficiency and knowledge. Unlike many university students who participate in test regimes, trustees were not paid for their participation. Rather they volunteered to participate in the study, recognising the significance of the issues for pending legislation and their roles and responsibilities (Pensions Regulator 2006). Having analyzed the test results, the study has been the subject of a number of conferences, including one co-sponsored by the Financial Times. Though not relevant to the current paper, a group of 80 undergraduates were used as a point of comparison.[8]

[7]/. A copy of the full report is available at the National Association of Pension Funds website www.napf.co.uk

[8]/. Benartzi and Thaler's (2001) data base of asset allocation "solutions" is much more extensive than our own. They were able to collect hundreds of completed questionnaires from more or less educated respondents and were able, therefore, to undertake a series of tests against respondents' characteristics. Their study also relied upon "volunteers" willing to complete and return the surveys.

Those participating in the test regime were volunteers; they came to the test regime with some confidence in their ability and experience, and, in all likelihood, a level of knowledge and understanding of the issues unusual by industry standards. As is typical in tests involving self-selecting participants, we believe they were at the upper-end of the distribution of task-specific skill and expertise.[9] Nonetheless, it has been shown that trustees share with undergraduates many of the cognitive biases observed in other tests of competence. To the extent that they have coherent discount functions, they are risk averse, use information inefficiently, and tend to ignore base-rate information in calculating probability. However, it was also shown that, compared to undergraduates, educated and professionally qualified trustees are more consistent when making probabilistic judgements—an essential skill when setting investment strategy.

On the asset allocation question, respondents were given a set of asset classes arrayed from low risk (money market accounts) to high risk (hedge funds and venture capital) and four separate tranches of money arranged in order from £10 thousand to £10 million (see the template underpinning Tables 1, 2 and 3). Respondents were asked to allocate the money in each tranche between each asset class (by percentage) where the allocation of assets had to add to 100%. Throughout the test-papers, respondents were required to distinguish between what they could do on their own account, and what they would do as pension fund trustees. In this case, trustees were asked how they would allocate assets given tranches of money that they hold or might aspire to hold. Some of the test questions, especially those that required the calculation of probability and the compilation of information from a number of sources were so demanding that a significant number of respondents were unable to complete them (a finding consistent with research on probabilistic judgement; see Kudadjie-Gyamfi and Rachlin 1996). In this case, there were just two incomplete answers; almost all respondents managed to make the columns within each tranche add to 100%.

At the heart of the empirical analysis were five questions: 1. what were the solutions to the puzzle? 2. Did respondents have their own solutions, or did they share with

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[9]/. Recent UK government studies focused upon the characteristics and performance of pension fund trustees include Bunt et al. (1998) and Horack et al. (2003).

others a set of solutions? 3. Were solutions related to socio-demographic status, education, professional qualifications and the like? 4. Were the solutions systematically related or unrelated to tranche size? 5. Was there evidence of 1/*n* heuristic type solutions? Previously reported results suggest that there is a surprising diversity of respondent solutions to common problems (Clark et al. 2006a). The heterogeneity of responses has significant negative implications for the coherence of board-level decisions especially in circumstances where little time is devoted to the collective evaluation of advice, data, and investment options. Here, it should not be surprising to find a variety of solutions: the issue is whether those variations were systematic in that there were commonalities between respondents or groups of respondents. Our expectation was that there would be shared solutions if not a common solution.

5. Asset allocation solutions by size-of-bet

Figure 1 summarizes respondents' asset allocation solutions. Before considering each in depth, it should be emphasized that respondents were asked to allocate four separate tranches of money against a common set of asset classes. It is the authors' contention that responses to the task can be summarized by a set of "solutions," implying a coherent, albeit differentiated, set of solutions according to some underlying if not directly observed "theory". In what follows, we provide a characterization of the three main solutions recognizing that a fourth solution was of less significance in that just one respondent seemed to have utilized such a strategy.

[INSERT FIGURE 1 HERE]

As indicated in the previous section, the task set for respondents was structured by the risk (rank-ordered) of asset classes, and the value of the assets to be allocated (referred to as four tranches of money). Consequently, Figure 1 takes some liberties with the nature of respondents' answers in that both risk (y-axis) and money (x-axis) imply both were continuous variables rather than a set of categories (asset classes) common to four separate tranches of money. Nonetheless, it is clear from analysis of the responses that the level of portfolio risk implied by their asset allocation is related in 2 of the 3 solutions with the size of the tranche of money to be invested. Furthermore, in 2 of 3 solutions the 1/*n* heuristic was not found, and even in the one

case it could be important, it should be understood as a strategy or investment policy rather than a default response.

Strategy A (RAWD): risk aversion with widespread diversification was the most common asset allocation solution (18 of 39 respondents). Here, respondents began with either a heavy allocation to money market products or a balanced portfolio of equities and bonds (weighted towards bonds). Thereafter, with each larger tranche of money respondents spread the money to higher and higher risk categories including, at the limit, venture capital funds. Overall, assets were allocated by risk according to the size of the tranche of money. By £10ml the portfolio was heavily biased towards equities (for many) and even hedge funds and venture capital (see Table 1 for an example). By this assessment, accepted convention in the UK pension fund community was highly relevant driven, perhaps, by industry experience communicated by investment consultants, advisors, and fund managers.[10]

[INSERT TABLE 1 HERE]

Strategy B (IRCD): initial risk with a conventional diversification of assets was the second most common allocation solution (11 of 39 respondents). Characteristically, respondents began with an initial risky strategy, allocating all the money to equities or to equities and corporate bonds. At the next tranche (£100k), respondents spread the money to a few other asset classes excluding lower risk asset classes. Thereafter, at £1ml and £10ml, higher risk classes were included and there was little difference between the allocation of money between assets. In a couple of instances, however, there was re-allocation of money from low-risk asset classes like property to higher risk asset classes like international equities (see Table 2 for an example). Nonetheless, those respondents deploying solution B seemed unfamiliar with hedge funds and venture capital as might be expected given the Myners Report's (2001) criticism of trustees' lack of understanding of investment options and a recent survey of UK pension fund asset allocations (Mercer Investment Consulting 2006).

[INSERT TABLE 2 HERE]

[10]/. Perhaps they also realise, pace Basu and Drew (2006) and Poterba et al. (2006), that the academic evidence from Australia and the US suggests that DC participants are best served if they hold to a long-term investment strategy heavily biased towards risk (equities and the like).

Strategy C (RTFD): risk tolerant with a fixed diversification of assets was the third common asset allocation solution (7 of 39 respondents). In this case, respondents began with a broad-based asset allocation formula and applied it to each of the four tranches of money. The size of the tranche made no difference to the investment strategy. Notice, however, the overwhelming thrust of the solution was towards assets devoted to domestic and international equities and even, in a few cases, significant allocation of money to hedge funds and venture capital (see Table 3 for an example). An equities bias has been an acknowledged characteristic of UK pension funds, reflecting asset allocation strategies popular amongst many funds over the 1980s and 1990s notwithstanding recent shifts towards bonds of various types in accordance with burgeoning liabilities and changing government regulations.

[INSERT TABLE 3 HERE]

Strategy D (HRRT): high risk aversion with risk tolerance was identified in just one case – in two other cases, respondents were unable to complete the task. Here, in marked contrast to previous strategies, the respondent began with a broad-based spread of money between asset classes and then reduced risk exposure by each successive increase on the size of the tranche to be invested. By £10ml he or she had allocated the money to government bonds and property – both, effectively, fixed income asset classes. Here, it seems, the respondent sought to conserve his or her increasing wealth rather than put it at risk (with the prospect of higher returns) through an aggressive asset allocation strategy.

Having observed and codified these solutions, we sought to interpret them by referring to respondents' socio-demographic characteristics and in particular whether they were member-nominated or employer-nominated. In short, it was found that status did not correlate with solution. In a previous paper, we also found that respondents were better able to solve problems of probabilistic reasoning if they had university education, professional qualifications, and (to some extent) formal training in tasks relevant to finance and pension funds (Clark et al. 2006b). Here, though, there was no significant correlation between trustee qualifications and their asset allocation solution (compare Ameriks et al. 2003). Finally, we sought to associate

asset allocation strategies with personality types – that is, whether a preference for risk either personal or social could be correlated with the chosen solution. Once again, there was no significant statistical relationship (Caerlewy-Smith 2006).

Recognising the need for caution when assessing risk attitudes (Clark et al. 2006a), we sought to correlate respondents' expressed conversance with asset classes and investment strategy against their asset allocation solutions. Table 4 summarizes respondents' conversance by type of solution. Here, there were insufficient observations to elicit statistically significant results. Even so, it is apparent that those seven trustees who responded with a RTFD solution (the least common of the three main responses) were likely to claim to be "very conversant" with asset allocation and investment strategy. While there were differences between self-reported conversance as regards asset allocation and investment strategy, what is remarkable about the trustees' attitudes to conversance is the extent to which many claimed to be either conversant or very conversant (whatever the preferred solution). Given their performance in other tests of competence and consistency, it is arguable that they were "over-confident" even if the observed asset allocation solutions could not be distinguished from one-another on the issue of conversance.[11]

[INSERT TABLE 4 HERE]

To test for the relevance of respondents' claimed expertise, recognising that expertise is heavily reliant upon formal education and task-specific training (Wagner 2002), Table 5 summarizes the results of two questions designed to elicit their confidence in their expert judgement. We made no attempt to specify what we meant by expertise relying upon respondents to make their own assessment. In many cases, the experts they deal with through pension funds are consultants and investment managers. The proportion of trustees claiming to have knowledge of these issues at the level of an expert was considerably smaller than the proportion of trustees claiming to be very conversant about these issues. Once again the group committed to a RTFD solution

[11]/. There has been considerable research on "over-confidence" in financial markets. See, for example, Barber and Odean (2005) for a review of the literature arguing that individual investors tend to confuse their own prowess with chance results, and Daniel et al. (1997) on the response of investors to financial market volatility. In sum, it is widely believed that individual investors are over-confident considering the risks assumed – we look at this issue through the term "conversance" (found in UK regulations regarding the knowledge and understanding of trustees).

was the self-proclaimed "expert" group. There was no difference on the investment strategy question – being an expert appears to be a shared judgement about one's overall ability.

[INSERT TABLE 5 HERE]

6. Logic of asset allocation

In the previous section, it was contended that the results of the testing regime yielded three coherent solutions plus another solution and two non-responses. Here, we look more closely at each to suggest how and why they may be plausible solutions albeit justified by rather different behavioral predilections. In doing so, we begin with a set of observations comparing the three important solutions to the problem.

Recognising that the two most important solutions were sensitive to the sums of money to be invested, it should be observed that at £1ml every respondent had undertaken to diversify or spread the available money amongst most asset classes. Furthermore, it should be observed that at £10ml, diversification was almost complete (i.e. each asset class was allocated money whatever the initial allocation strategy). Still, even at £10ml there remained obvious albeit modest differences between each strategy in that IRCD respondents tended not to allocate money to hedge funds and venture capital, whereas RAWD respondents tended to do so as did RTFD respondents (Figure 1). Notice, moreover, that even at £100k most respondents had taken steps to diversify or spread the allocation of money between some asset classes. Even so, at £100k diversification picked-out just a couple of asset classes rather than distributing money systematically as at £1ml and £10ml.

In effect, the nature and pattern of diversification is sensitive to the size of the investment fund. That diversification is so common by £1ml suggests respondents adapted their strategy to the available resources and (presumably) to strategies recommended by investment theorists and practitioners. Here, there are two possible explanations for respondents' sensitivity to the sum of money to be invested. Transaction costs may be so significant at less than £1ml that respondents concentrated on just a few asset classes to minimize those costs. Equally, respondents may be more likely to diversify at larger amounts of money because they are better

able to self-insure against risk. As implied by Zeckhauser and Keeler (1970), there may be a threshold value of assets where diversification between asset classes allows economic agents to cover higher risks by spreading assets to smaller risk classes.

This argument is made more plausible once it is recognised that by £10ml respondents had almost always taken on significant risk; in both IRCD and RAWD the proportion of assets allocated to domestic equities and above was about 60 percent or more. This is an interesting finding especially given previous findings showing that respondents' attitudes to risk were highly risk averse, when investing money on their own account (Clark et al. 2006a). Of course, it must be recognised that, in the UK at least, there has been a strong commitment to domestic equities, and pension fund asset allocation formula have been systematically biased towards equities rather than bonds. This has changed in recent years as liabilities have claimed centre-stage. Nonetheless, it would seem that the "equities" culture of the 1990s continues to be important for many UK pension fund trustees investing on their own account.

There were also differences at the upper-end of the distribution of risk in that hedge funds and venture capital were identified by almost a majority of respondents as desirable risk-and-return opportunities. We would argue that this reflects both the large size of the pension funds from which our respondents were drawn and their "appetite for risk" enabled by a large-value diversified portfolio. On the other hand, the fact that the second largest group of respondents seemed wary of such "exotic" asset classes is further evidence of the long-term significance of convention when investing large tranches of money. After all, the apparent risk aversion of many trustees plus their unwillingness to consider venture capital was a principal motivating argument behind the Myners Report (2001).

These findings provide reasons to be more confident of individuals' investment decision making than some who write in the wake of Kahneman and Tversky, Thaler, and others (as suggested by Hartwig and Ortmann 2003). Even so, our findings are very sensitive to the money to be invested. At the other end of the spectrum, very different implications can be drawn. The near majority of respondents (RAWD) who embrace risk at £10ml were very cautious at the other end of the size distribution. At £10k, RAWD respondents were very risk averse just as they were at £100k (with a

few more asset classes added to their allocation strategies). Basically, their strategy was "safety-first" – conservation of value whatever the nearest available but higher risk options. In this respect, we are mindful of Roy's (1950) classic paper that sets-out the logic behind such a strategy.

By contrast, IRCD respondents were willing to gamble away £10k and even a large chunk of £100k. At the upper end of the risk spectrum, however, they would conserve wealth by pursuing a conventional but relatively more risk averse investment strategy (compared to RAWD and RTFD). It has been noted elsewhere that some people tend to treat lump-sums in a different way from underlying wealth. Here, we have evidence consistent with such a proposition, indicating the existence of threshold values wherein gambling is replaced by the conservation of wealth as the preferred individual investment strategy.[12] By contrast, RAWD respondents were clearly sensitive to the value of lower amounts of cash, preferring safety and low transaction costs associated with money market accounts and the like.

Considering RTFD respondents, it is possible that their consistent asset allocation solution was either a strategy that reflected the circumstances of respondents or was evidence of resistance to temptation wherein respondents deliberately treated each tranche the same (see Ainslie 2001). The former explanation is amenable to further empirical analysis whereas the latter could be an expression of a normative policy often noted in the pension fund community – it could be an expression of what people "should do" in such circumstances.[13] We are doubtful of the relevance of the $1/n$ heuristic in this case because of the precision of distinctions made by respondents in making their asset allocations. Of course, this group was the smallest group other than the HRRT group. They think of themselves as an expert group (see Table 4 and

[12]/. As Ainslie and Haslam (1992a, 1992b) suggested, to gamble is a moment where normal interests are suspended in favour of an emotional boost followed by regret and even self-pity. Gambling may be an expression of ever-present impulsive behavior, "governed" by the size-of-bet. Respondents may give-in at a small size-of-bet so as to satisfy their "craving" for an emotional "high" without putting at risk a large size-of-bet. Ironically, respondents may equally value small and large size-of-bets though for different reasons (analogous to Ainslie 2001 and Laibson's 2003 hypobolic discounting function).

[13]/. Recognising their willingness to gamble (as illustrated by the IRCD solution), respondents may use a fixed allocation formula (RTFD) to avoid dealing with the temptations of small and large amounts of money. As such the RTFD solution could be a mechanism for self-governing behavior as much as it is a wealth management technique (see Ainslie 2001 on the techniques of managing temptation).

5) even if we could not show statistically significant differences in the education or professional qualifications of respondent groups.

It is notable that respondents were given tranche sizes relevant to both their current circumstances and their aspirations for wealth. For many well-paid, over 50 years of age males, UK household wealth including housing approaches £1ml. Likewise, many such people have experience with windfalls (including inheritance) in the order of £10k, £100k and more. Consequently, it is reasonable to suggest that the results of the analysis are more than abstract or hypothetical possibilities. Furthermore, that there are systematic differences between groups of respondents suggests that what people do with one tranche of money may be part of a larger story about what they do (or would do) with larger tranches of money.

Implications and conclusions

This paper characterizes informed respondents' solutions to an asset allocation problem: the distribution of their own money between various asset classes rank-ordered by riskiness across four tranches of money rank-ordered by size. The problem was designed to test Kahneman's (2003) claim that the size-of-bet does not make a difference to financial decision-making under risk and uncertainty as well as test whether trustees use Benartzi and Thaler's (2001) 1/*n* heuristic. Our testing regime is related to experimental economics (Kagel and Roth 1995) and psychology (Bröder 2003), with analysis focused upon a group of UK pension fund trustees asked to allocate assets on their own behalf in an experimental situation. As such, the analysis differs from Samuelson and Zeckhauser (1988) in that a small group of relatively knowledgeable people were the subjects of scrutiny rather than a large data set of DC pension plan participants. Whether our findings hold for "ordinary" pension plan participants must be determined by more extensive testing.

Nonetheless, it is shown that most informed respondents are sensitive to the size-of-bet—the value of the financial assets put at risk. It is shown that informed respondents did not opt for Benartzi and Thaler's 1/*n* heuristic. It is shown that there are plausible, shared, but different solutions to the asset allocation puzzle. Furthermore, it is shown that many of our respondents combined differing conceptions of the value of small and large tranches of money with a common

commitment to portfolio diversification at larger tranches of money. There was, however, a small group of respondents who seemingly conformed to Kahneman's and Benartzi and Thaler's expectations—but this group may be much more sophisticated than either imagined in that their solution to the asset allocation problem conforms to a strategy of total wealth management wherein each tranche of money adds to existing household assets.

The results of this study can be summarized as follows.

- The largest group (RAWD) of respondents had differing conceptions of how to invest small and large tranches of money: they would conserve the value of small tranches of money (up to £100k) but put at risk a significant portion of larger tranches of money.
- The second largest group of respondents (IRCD) would put at risk small tranches of money but be more cautious than the RAWD group in their investment of larger tranches of money by pursuing a rather conventional diversification strategy compared to the RAWD group.
- The smallest group of respondents (RTFD) was risk tolerant and, as noted above, made no distinction between the size-of-bet by utilizing a fixed asset allocation strategy across asset classes and across the tranches of money.
- There do not appear to be statistically significant differences between these three groups in terms of their socio-economic status, their personal and social risk predispositions, and their levels of education, professional qualifications, and task-specific training.
- There does not appear to be statistically significant differences between the groups in terms of their self-ascribed "expertise" and "conversance" with the principles and practices of asset allocation.
- There does appear to be evidence of greater confidence in the RTFD group who ascribe to themselves a high level of "expertise", even if all three groups could be said to be conversant in their knowledge and understanding of investment theory and practice.

More generally, we would argue that the existence of three groups of respondents suggests a degree of coherence-with-difference often unacknowledged in the literature. For large tranches of money, the three groups of respondents share a

commitment to portfolio diversification consistent with modern portfolio theory. The largest group tends to utilize all asset classes even at the top-end of risk whereas the second largest group tends to be more conservative about assuming such risks. The third group assumes a broad and constant spectrum of risk across the tranches of money although there are variations within the group in terms of lower and upper bounds of risks assumed. Although there are differences between groups both in terms of the risks assumed and in the solutions to asset allocation according to the size-of-bet within each group, our respondents did not default to the 1/*n* heuristic. Rather, they demonstrated knowledge and understanding of the virtues of portfolio diversification even if at lower values of money the two largest groups pursued very different objectives.

And yet, there is cause for concern. The second biggest group which combined a willingness to gamble albeit with relative caution is indicative of tendencies recognised by other researchers in the behavior of pension plan participants. Some defined benefit plan participants who take a lump-sum at retirement and some defined contribution plan participants who self-invest their accumulated assets upon retirement, gamble with their retirement welfare. They are either indifferent to the loss of small sums of money and/or they do not believe that such sums of money appreciably affect their long-term welfare. The fact that many UK and US DC participants can cash-out when they change jobs, take loans against their future welfare, and receive retirement pay-outs of much less than £100k suggests that this type of behavior may be a significant issue (Munnell and Sundén 2004).[14] Most respondents did appear sensitive to the very high transaction costs associated with low-value tranches of assets whereas the third group's solution seems more like an exercise in theory than practice unless each tranche was perceived to be an increment to an existing large asset base.

It could be argued that the results of our asset allocation problem are beside the point: whatever the solutions to the problem, the study has done little to challenge the emerging orthodoxy because our respondents are so different from the normal subjects of current pension research (compare with Madrian and Shea 2001). Our trustees are certainly different from the average employees of large corporations; we

[14]/. But compare with Australian circumstances where these types of dilution of accumulated assets are strictly controlled and limits enforced (see Basu and Drew 2006).

would not pretend otherwise. But are they so different from the average TIAA-CREF participant? Given the number of member-nominated trustees, they may be less educated than TIAA-CREF participants. While they have task-specific experience and training, we have shown that training is a mixed blessing in that a limited number of sessions are more likely to add confusion than consistency of judgement. Where trustees differ is in their roles and responsibilities. In this sense, our study has opened a window on the interaction between psychological predispositions and social life, examined by others including Bajtelsmit (2006) and Strauss (2006).

Our study has the virtues and vices of experimental research. While we have emphasized the former, it should be acknowledged that we were not able to test for respondents' sensitivity to changes in their financial well-being and hence any subsequent changes in their solutions to the asset allocation problem (compare with Barberis et al 2001). Since the study is based upon a small number of respondents, we do not have a large database to test-out the generality of the trustee solutions. Furthermore, we have provided very little in the way of an "explanation" of what has been observed – we have relied upon ideas from the psychology literature rather than an encompassing social logic that could integrate "solutions" into one explanation. Therefore, it would be difficult to argue that our results are so far-reaching that the emerging orthodoxy should be over-turned. Nonetheless, we would contend that Kahneman's (2003) conjecture on the irrelevance of the size-of-bet should be subject to further scrutiny. Similarly, Benartzi and Thaler's (2001) 1/*n* heuristic may be more domain specific than recent commentaries on the utility of default options recognize.

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Table 1. Asset allocation (%) for solution A – (RAWD) against size-of-bet

Asset Classes	Value of Tranche (£)			
	10k	**100k**	**1ml**	**10ml**
Money Market	100	30	3	5
Government Bonds		35	20	20
Property				15
Corporate Bonds				
Domestic Equities		35	25	20
International Equities			25	20
Hedge Funds				10
Venture Funds				10

Table 2. Asset allocation (%) for solution B - (IRCD) against size-of-bet

Asset Classes	Value of Tranche (£)			
	10k	**100k**	**1ml**	**10ml**
Money Market				2.5
Government Bonds		10	10	20
Property			10	20
Corporate Bonds				5
Domestic Equities	60	50	45	35
International Equities	40	40	30	20
Hedge Funds			5	5
Venture Funds				2.5

Table 3. Asset allocation (%) for solution C – (RTFD) against size-of-bet

Asset Classes	Value of Tranche (£)			
	10k	**100k**	**1ml**	**10ml**
Money Market				
Government Bonds	5	5	5	5
Property	10	10	10	10
Corporate Bonds	5	5	5	5
Domestic Equities	35	35	35	35
International Equities	40	40	40	40
Hedge Funds	5	5	5	5
Venture Funds				

Table 4. Respondents' self-ascribed conversance with asset classes and investment strategy by asset allocation solutions (percentages).

		Asset Allocation Solutions			
		RAWD	**IRCD**	**RTFD**	**HRRT**
Conversance (asset	**SC**	16.7	16.7	20.0	0
	C	55.6	50.0	40.0	0
	VC	27.8	33.3	40.0	100.0
Conversance (investment	**SC**	11.1	16.7	9.1	0
	C	44.4	33.3	45.5	0
	VC	44.4	50.0	45.5	100.0

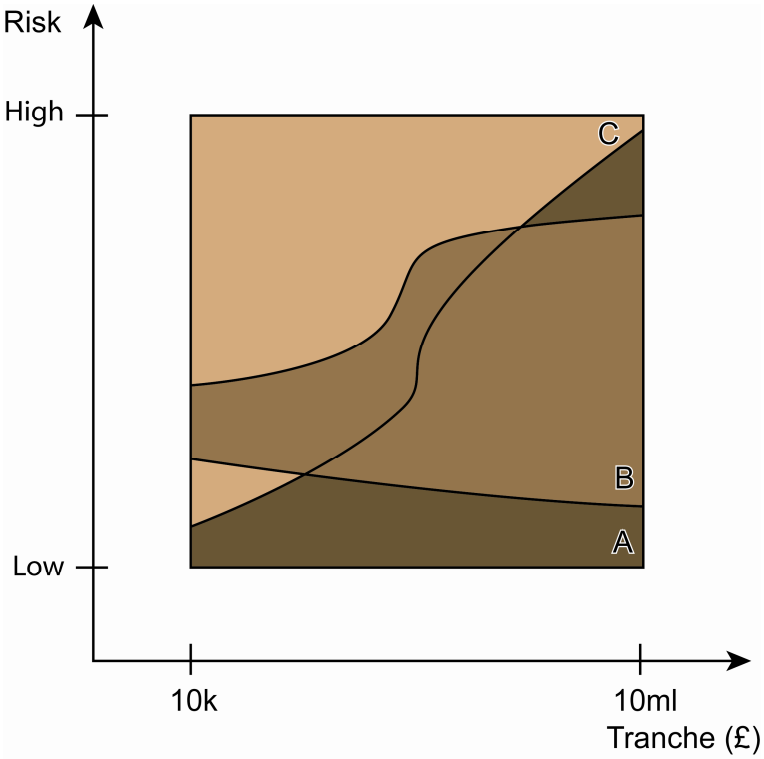
Note: Where conversance is declared by respondents according to one of three categories – SC (slightly conversant), C (conversant), and VC (very conversant) – with respect to their observed asset allocation strategy as classified by authors.

Table 5. Respondents' self-ascribed expertise with asset allocation (A) and investment strategy (B) by asset allocation solutions (percentages).

		Asset Allocation Solutions			
		RAWD	**IRCD**	**RTFD**	**HRRT**
Expertise (A)	**BI**	11.1	16.7	18.2	0
	BA	61.1	50.0	45.5	-
	EL	27.8	33.3	36.4	100.0
Expertise (B)	**BI**	16.7	16.7	18.2	0
	BA	61.1	50.0	45.5	0
	EL	22.2	33.3	36.4	100.0

Note: Where the level of expertise is declared by respondents according to one of three categories – BI (basic issues), BA (basic issues with applications), EL (at the level of all expert) – and with respect to their observed asset allocation solution (classified by authors). Unlike the questions asked regarding conversance (Table 1), respondents did not differentiate between questions related to expertise.

Figure 1. Mapping asset allocation solutions by size-of-bet



Note: Where A, B and C represent asset allocation solutions without regard to the proportional allocation of assets in any tranche of assets