making actuaries less human

lessons from behavioural finance

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Summary

"Policyholders of insurance companies and beneficiaries of pension schemes – whether they know it or not – are placing enormous reliance on the judgement and skill of the actuaries who are advising those financial institutions".
Paul Thornton, Institute Presidential Address, 1998

- The work of actuaries has an enormous impact on the finances of both individuals and companies. Much of the advice and the decisions arising from it involves making judgements about factors which are uncertain and difficult to predict.

- Most actuaries would like to think of themselves as rational beings, coolly applying the laws of probability in their day-to-day work. Work by psychologists suggests that, as human beings, actuaries are subject to a variety of mental biases and decision making errors. The field of behavioural finance looks at how such biases affect financial decisions. Much of the work to date has concentrated on the impact on prices in capital markets.

- This paper first looks at a selection of these biases including how

    - decisions are often made by adjusting from an existing position (anchoring)
    - people are risk averse when facing gains but become risk seeking when facing losses (prospect theory)
    - the framing of a problem can materially impact the decision that is made
    - the frequency with which something is monitored can impact the decision (myopic loss aversion)
    - people have a tendency to ignore underlying probability distributions
    - almost everybody is overconfident
    - when a number of different options are presented, the number, order and degree of difference between the options will affect which option is chosen.
    - the use of separate mental accounts impacts financial decisions (mental accounting)

- The paper looks at how each of these factors might affect actuarial work and then, using the example of setting an asset strategy for a pension scheme, shows how the different biases present a potential minefield for actuaries.

- Finally, the paper takes a brief look at what can be done to mitigate against the effects of these biases and errors. The key conclusion is that actuaries should be much more explicit about how they derive their assumptions and should make that information available to the recipients of their advice.

1. Introduction

Definition of a computer: an actuary with a heart
Definition of an actuary: human petrification with a heart of feldspar

1.1 What if actuaries are human?

Despite suggestions to the contrary actuaries are human. There is a large body of evidence which suggests that humans often behave irrationally and make repeated errors of judgement. Much of the literature suggests that some of these errors are most likely, and likely to be more severe, when the subject matter is complicated, the outcome uncertain and feedback is slow. Unfortunately this description fits a large proportion of the areas that actuaries advise upon.

Some professions, particularly in medical fields, have incorporated these findings into their training to prevent them from having a detrimental impact on their end users. To date, there is little direct evidence of the actuarial profession taking much notice of the findings, with the exception of some members who work in investment consultancies. The investment consultancy arm of one large firm is using behavioural arguments, applied to trustees, to justify its proposed investment manager structure. They have said little publicly, however, about how they are dealing with such issues in preparing the advice they give to clients.

If actuaries suffer from these problems of being human then, given our role in society, it has potentially enormous implications for the financial well-being of a large proportion of the population. If, by some freak of nature, actuaries don't suffer from these problems then the decision makers who receive and act on our advice almost certainly will.

1.2 The importance of behavioural finance

" The radical insight of behavioural finance is that people are human"
Werner De Bondt, October 1999.

Behavioural finance can be defined as the psychology that underlies and drives financial decision making behaviour. It is very fashionable in the financial world at the moment - there are numerous conferences on the subject and many investment mangers are increasingly looking at behavioural finance to justify or enhance their investment approaches. There are even some US investment funds that are solely run on the basis of taking advantage of these errors when made by other investors.

Capital markets are a natural area to examine such theories because data are relatively easy to gather, the results are measurable, and behavioural irrationalities arise overwhelmingly and disproportionately in contexts of uncertainty. There is, however, more than ample literature on behavioural finance as it relates to capital markets so, in this paper, I have only commented on such research when the results are of direct relevance to the work actuaries do. A detailed analysis of behavioural finance and capital markets can be found in a number of publications including Shefrin and Shiller.

1.3 Beware the person who knows

At another level, knowledge of these biases and errors can be, and is, used by others to manipulate our views and decisions. They only way to prevent this is to ensure we also have the relevant knowledge.

1.4 Outline of the paper

I have chosen a small selection of the research that seems particularly relevant to actuaries. I have briefly explained and illustrated each concept before looking at how the effects of some of these biases can be mitigated.

2. Anchoring and adjustment

Question: How many actuaries does it take to change a light bulb?
Answer: How many did it take last year?

Answer the following question within 5 seconds: "Given a piece of paper 0.1mm thick, estimate how thick the paper would be if it were folded on itself 100 times?"

2.1 Introduction

The answer to the second problem above is approximately 127,000,000,000,000,000,000,000km. Most people produce an estimate of a few metres at most. The reason is something called anchoring – people tend to produce their estimate by imagining the first few folds and then adjusting the answer to allow for subsequent folds. The initial estimate acts as an anchor and people fail to adjust properly for the effect of the later folds.

A more detailed experiment that looked at how people make decisions by anchoring and adjusting was carried out by Northcraft and Neale. In the experiment a large number of estate agents were asked to examine and value a property. The agents were given a 10 page booklet that contained numerous pieces of information that were relevant to determining the value of the property. All agents received identical information except that four different versions were used each with a different listed price for the property as follows:

Version 1:	$119,900
Version 2:	$129,900
Version 3:	$139,900
Version 4:	$149,900

The agents were given twenty minutes to examine the property and were than asked to provide their best estimate of the appraised value, the value the house should go on sale for, a reasonable price to pay for the house and the lowest offer they would accept for the house if they were the seller. The table below summarises the results for the first two prices (the other prices showed similar patterns)

Listing price in 10 page booklet ($)	Appraised value ($)	Recommended selling price ($)
119,900 (version 1)	114,204	117,745
129,900 (version 2)	126,772	127,836
139,900 (version 3)	125,041	128,530
149,900 (version 4)	128,754	130,981

table adapted from Plous (1993)

The results show significant evidence of anchoring. The experiment also suggested that experts were not really aware of how they were estimating the various values – when asked for their top three considerations only 1 in 10 agents mentioned the listing price.

2.2 The extent of anchoring

An experiment quoted by Plous showed that the effect grows with the size of the difference between the anchor value and the pre-anchor estimate (defined as the mean estimate people make before being exposed to an explicit anchor). Experiments have shown that absurdly high anchors work just as well as more plausible values. For example, people were asked whether the average temperature in San Francisco was greater or less than 558°F before being asked to provide a numerical estimate for the average temperature. The effect of exposing people to this absurd anchor was to considerably increase their estimates compared to the estimates from people who had not been exposed to the anchor.

Other experiments have shown that the effects of anchoring are pervasive and robust and are extremely difficult to ignore, even when people are aware of the effect and aware that the anchor is ridiculous.

2.3 Implications of anchoring for inflation estimates

One of the most common effects of anchoring is underreaction, where people fail to react to new information quickly enough.

Most investors and actuaries in the 1990s underestimated the speed at which inflation fell and it might be argued that this was the result of an underreaction to new information about inflation. There, is in fact, some quite convincing evidence that this was indeed the case. Perhaps more interesting, however, is that this underreaction is not new – it appears to have been happening for at least the past 40 years.

A study by De Bondt and Bange looked at how US yield curves were affected by expectations about inflation. The study was based upon inflation forecasts that were collected by the "Philadelphia Inquirer" between 1953 and 1987. The study found that the forecast error had a very strong predictable component – it tended to be negative during periods of rising inflation and positive during periods of falling inflation. The authors suggest that this effect is due to underreaction to changes in the underlying rate of inflation. The study was extended to June 1998 by Shefrin who concluded that investors continued to be surprised by the speed at which inflation declined.

2.4 Anchoring in actuarial work

The actuarial "joke" at the beginning of this section has a large element of truth in it. In actuarial work it is common to start a valuation or costing exercise by attempting to keep the results the same in terms of a recommended contribution rate, level of reserve or premium level. This anchoring may well be justified on the grounds of "smoothing", but there is an inherent danger in the process.

3 Prospect Theory

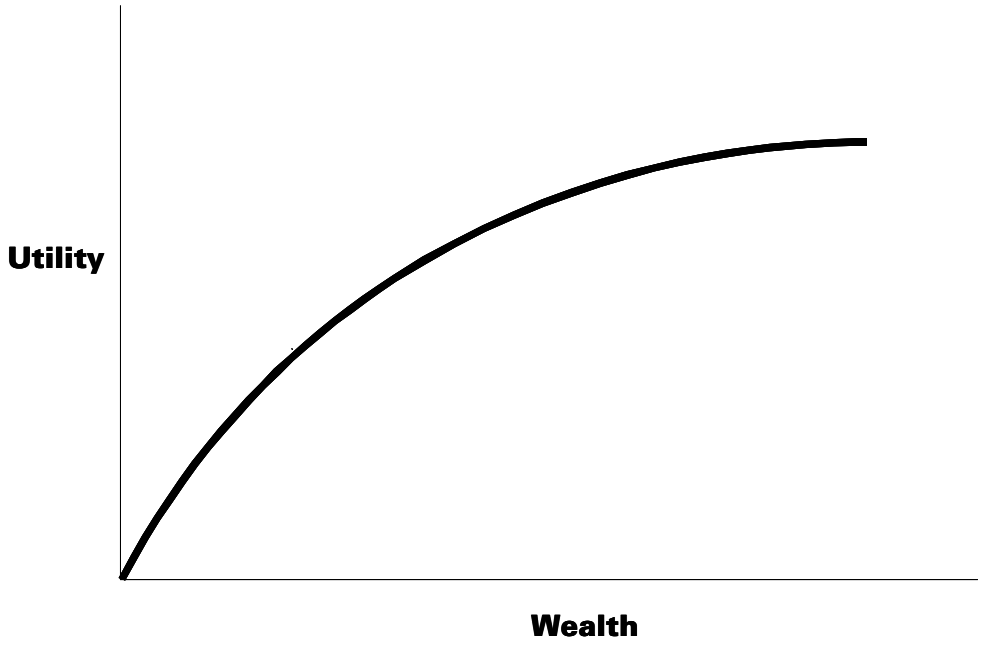
"It is not so much people hate uncertainty – but rather they hate losing"
Amos Tversky 1990

"Our preferences …….can be manipulated by changes in the reference point"
Amos Tversky 1990

3.1 Introduction

Prospect theory is one of the most important elements of behavioural finance and has far reaching implications for financial decision making. In this paper I have only touched on the very basics. In brief it is a theory about how people make decisions when faced with risk and uncertainty.

Before describing prospect theory it is worthwhile briefly to review traditional "expected utility theory". This was originally developed by John von Neamann and Oskar Morganstein and describes how people behave if they follow certain requirements of rational decision making. The most important concept behind expected utility theory was developed in 1738 by Daniel Bernoulli and is that of declining marginal utility, or as Bernoulli put it, "a gain of one thousand ducats is more significant to a pauper than to a rich man though both gain the same amount". This means that people will be risk averse. Specifically Bernoulli argued that the value of money could be represented by the following chart.



Prospect theory presents an alternative structure. It was developed by two Israeli psychologists, Daniel Kahneman and the late Amos Tversky. The fundamental issue underlying prospect theory is best illustrated using the results of one of their experiments (1979). They asked people to choose between two alternatives:

Alternative 1:	an 80% chance of winning $4,000 and a 20% chance of winning nothing
Alternative 2:	a 100% chance of receiving $3,000

Even though alternative 1 has a higher expected outcome of $3,200, 80% of people chose $3,000 certain. As suggested by expected utility theory, these people were risk averse.

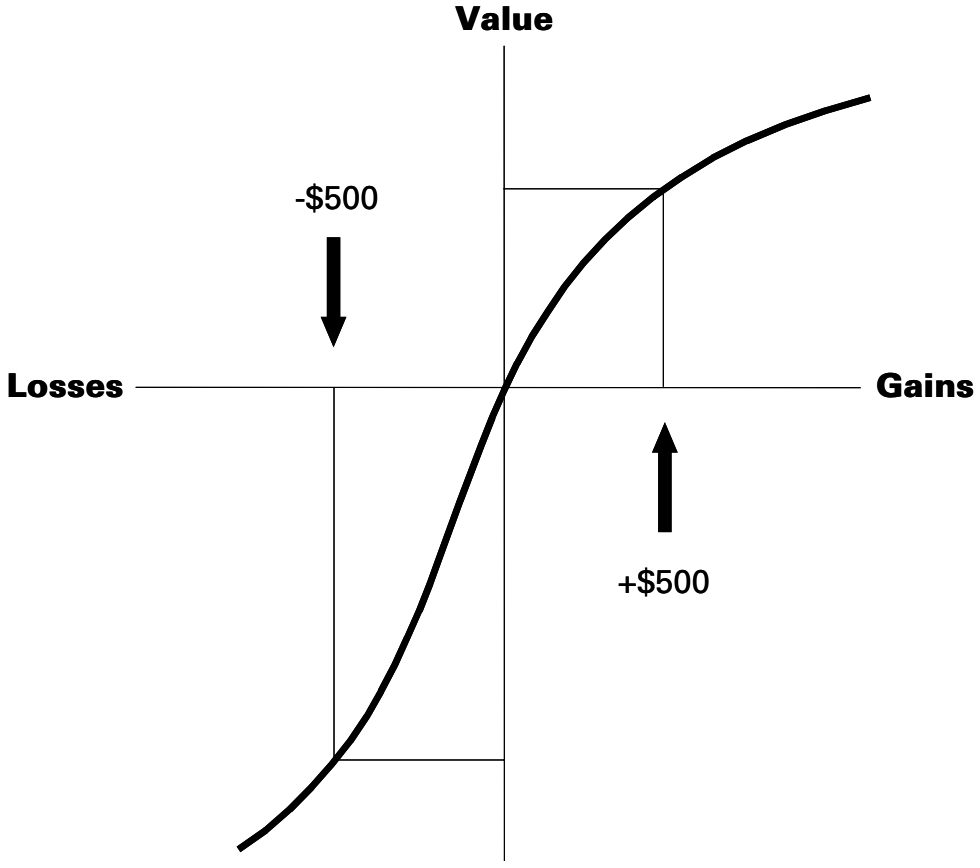
Then Kahneman and Tversky offered the following choice:

Alternative 3:	an 80% chance of losing $4,000 and a 20% chance of losing nothing
Alternative 4:	a 100% chance of losing $3,000

Even though the expected loss of $3,200 is bigger under alternative 3, 92% of people chose the gamble! When the choice involves losses people appear to become risk seeking and not risk averse.

3.2 Prospect Theory

Prospect theory provides an explanation for this striking asymmetry in how people make decisions. Prospect theory replaces the concept of decreasing marginal utility based on total wealth with a concept of value defined in terms of gains and losses relative to a reference point. This is illustrated in the chart below.



Unlike expected utility theory, prospect theory suggests that decisions like the ones above will depend on how a problem is presented or "framed". If the initial position is viewed as a gain (the choice between alternatives 1 and 2) then the value function is concave, representing the risk aversion of the decision maker. If the initial position is defined such that an outcome is viewed as a loss, (the choice between alternatives 3 and 4) then the value function will be convex, representing the risk-seeking nature of the decision maker. Research suggests that relevant to the chosen reference point, losses are weighted twice as much as gains.

3.3 Implications for actuarial work

The results of prospect theory have considerable implications for actuarial work. We frequently present the results of our work in terms of the probability of a particular course of action leading to some defined event. For example, when presenting the implications of a particular investment strategy on a pension scheme statements like "there is a 20% chance that the funding level will rise above 100%" are frequently used. Prospect theory suggests that different decisions might arise if it was expressed using "there is a 80% chance that the funding level will remain below 100%".

Further aspects of framing are considered in more detail in the next section.

4. Framing and question wording

4.1 The power of framing

As discussed in the previous section, framing is an extremely important concept and a subtle change in the way in which a decision is proposed (or "framed") may affect the course of action chosen. Much of the initial research work focused on financial decisions. Later work, however, showed how framing in terms of "gains" or "losses" impacts other areas. Even when such decisions involve their own mortality people are affected by these framing issues.

An experiment by McNeil, Parker, Sox and Tversky showed how framing influenced decisions about how to treat lung cancer. People (including doctors and patients) were presented with summary information on two forms of treatment – surgery and radiation therapy – and then asked which treatment they would prefer.

In half the cases the summary information was presented in terms of a "survival frame" as follows:

> *Surgery Alternative:* "Of 100 people having surgery, 90 live through the post-operative period, 68 are alive at the end of the first year and 34 are alive at the end of five years".
>
> *Radiation Therapy:* "Of 100 people having radiation therapy, all live through the treatment, 77 are alive at the end of one year and 22 are alive at the end of five years"

People were then asked to select the most attractive alternative. Recognizing the much lower five-year survival rates for the radiation option, only 18% of people selected it.

A second set of people was given the same information, but presented in terms of a "mortality frame" as follows:

> *Surgery Alternative:* "Of 100 people having surgery, 10 die during the surgery or the post-operative period, 32 die by the end of the first year and 66 die by the end of five years".
>
> *Radiation Therapy:* "Of 100 people having radiation therapy, none die during treatment, 23 die by the end of one year and 78 die by the end of five years".

Again people were asked to select the most attractive alternative. This time people focused on the high mortality of the surgery alternative in the period shortly after the treatment and 44% chose the radiation alternative. The differences in the proportions choosing the radiation were similar for all types of people, including patients.

4.2 "Insurance" as a magic word

As well as framing in terms of gains or losses the wording of a question can have an enormous impact on the answer given by people or the decision made. Research evidence suggests that changes of only a word or two can have a profound effect.

The effects were demonstrated in an experiment carried out by Slovic, Fischhoff and Lichenstein. They presented people with two options as follows:

Option 1: A 100% chance of losing $50

Option 2: A 25% chance of losing $200, and a 75% chance of losing nothing

Consistent with prospect theory, which predicts that people will be "risk seeking" when it comes to losses, some 80% of subjects chose option 2. If this were always the case however the insurance industry would not exist as it depends on people's willingness to pay a premium (a sure loss) to avoid a larger uncertain loss. To see if rephrasing option 1 in terms of insurance had an effect the experiment was repeated with the following options:

Option 1: An insurance premium of $50 to avoid a 25% chance of losing $200

Option 2: A 25% chance of losing $200,and a 75% chance of losing nothing

This time 65% of subjects chose Option 1! When a sure loss is presented as an insurance premium most people become risk averse rather than risk seeking.

4.3 Structured response questions

Research evidence also shows structured response questions convey an implicit range of acceptable answers. The following questions are taken from experiments which are summarised in Plous. Consider the following questions:

Question 1: Do you get headaches frequently, and if so, how often?

Question 2: Do you get headaches occasionally, and if so, how often?

With question 1 the mean response was 2.2 per week. With question 2 the mean response was 0.7 per week.

In another experiment people were asked the following questions about a movie they had recently watched:

Question 1: How long was the movie?

Question 2: How short was the movie?

The mean answer to question 1 was 2 hours and 10 minutes, and to question 2 was 1 hour and 40 minutes.

4.4 A real world example

One recent example of the possible effect such structured response questions can have is contained in "Excellence in UK Pension Fund Management – A Perspective on Current Practices", published by Frank Russell in October 1999.

The study was reported in both the national press (for example, Financial Times, 11th November 1999) and the pensions press as showing that "barriers to excellence" reduced fund returns by an estimated 50 basis points per year (0.50% p.a.). The questionnaire started by saying

> "The purpose of the questionnaire is to assemble a set of views from you, representatives of Britain's leading pension funds, about what excellence means to you and what you think are the barriers to achieving it".

Participants were then asked to rate 15 factors on a 1 (lowest) to 5 (highest) scale as to "their importance to excellence" and the "excellence rating of your fund". Having rated the factors they were then asked to express their fund's goals as clearly as possible. Finally they were asked to

> "…..list what you consider to be the three most significant impediments to being excellent".

Followed by

> "Please estimate the annual cost to your fund of not being excellent:
>
> £…… or …….basis points".

Based on the evidence above the wording and framing of this final request would clearly influence the response in an upwards direction. In amongst the responses, however, was evidence that not everyone was influenced in this way - one participant disclosed an excellence surplus of 130 basis points per year!

For good or for bad, the reporting of the resultant average figure of 50 basis points in the press has meant that it is now frequently quoted throughout the industry as a factual measure of the impact of what has been described as "poor governance" or "amateur trusteeship".

5. Myopic Loss Aversion

"A watched kettle never boils"

5.1 Introduction

The example in the section on prospect theory looked at how people make decisions when faced with a single "gamble". The way people make decisions about repeated gambles is highly relevant to actuarial work as investment returns can be considered as a series of repeated annual gambles.

Work in this area has been carried out by Benartzi & Thaler in connection with the so called "equity risk premium puzzle" and the way in which individuals select their asset allocation within a defined contribution plan.

5.2 Repeated gambles

The way in which people consider so called repeated gambles was illustrated by an experiment carried out by Redelmeier and Tversky. They first asked people if they would accept a gamble that offered a 50% chance to win $2000 and a 50% chance of losing $500. As suggested by prospect theory, many individuals declined the bet – only 43% accepted – even though it has a positive expected outcome. When people were told that they could play the gamble five times, 63% accepted the gamble. When a different set of people were presented with the exact distribution of the likely outcomes of playing the gamble five times, 83% of them accepted the gamble.

5.3 Explaining the equity risk premium puzzle

The equity risk premium puzzle refers to the fact that the difference in returns between equities and bonds has been so large. Over the past 70 years or so the equity risk premium has been of the order of 6 to 7%pa in some countries. Attempts to explain the size of the premium using traditional utility and finance theory fail unless some very extreme assumptions are made about the risk tolerances of individuals. Indeed, based on such theory, it is difficult to justify the 2% to 3% p.a. equity risk premium that is typically assumed by actuaries at present.

The returns from equities can be considered as being similar to the repeated gamble just described. The expected return in any given year is positive (the equity risk premium) but the range of returns around this level is high – equities have outperformed bonds in about 60% of individual years. Over longer periods the returns become much more attractive – equities have outperformed bonds in about 80% of 10 year periods and 100% of 30 year periods. Benartzi & Thaler estimated how frequently investors have to be evaluating their portfolio in order to make them indifferent between equities and bonds. On US data the answer was about 13 months. Benartzi & Thaler argue that the high returns on equities have been to compensate those who count their money frequently.

5.4 Deciding on asset allocation in defined contribution schemes

Benartzi & Thaler proposed that people making asset allocation decisions in defined contribution pension schemes might invest more of their funds in more volatile higher expected return securities such as equities if they are shown the long-term

distributions rather than the distributions of one-year returns. Benartzi & Thaler carried out a series of experiments to examine this.

People were asked how they would allocate their assets given the choice of two hypothetical funds. For each fund they were given some information about the historical returns to these funds and were then asked to decide how much of their retirement fund to invest in each fund. One fund had equity type returns whilst the other had bond type returns. There were three versions of the experiment as follows

> *Version 1* – subjects were shown the expected distribution of the one-year returns based on the returns over the period 1926 to 1993.
>
> *Version 2* – subjects were shown the expected distribution of 30-year returns based on the distribution of returns over the period 1926 to 1993
>
> *Version 3* – subjects were shown the expected distribution of the likely outcomes, expressed as a percentage of final salary

The results showed that there was a pronounced difference in allocation between the group that saw version 1 and the groups that saw versions 2 and 3. The proportion median allocated to equities in each case was as follows:

Information Provided	Median
One-year returns	40%
Thirty-year returns	90%
Retirement income	90%

Benartzi & Thaler then investigate how the size of the equity risk premium altered these answers. To do this they used a different set of people who also had a defined benefit scheme and so might be expected to be less conservative in their initial selection. The results shown in the middle column are the results when people were shown the same information as in the first experiment. The results shown in the right hand column are those when the equity risk premium (erp) was halved to 3%:

Information provided	Median (erp 6%)	Median (erp 3%)
One-year returns	65%	70%
Thirty-year returns	92%	70%
Retirement income	100%	70%

This had a dramatic effect on the results - there were no longer any significant differences between the proportions allocated to equities under each version.

This demonstrates that the way in which information is presented to individuals can have a strong influence on their investment choices. It also demonstrates the importance of the assumption about the equity risk premium.

5.5 The Minimum Funding Requirement (MFR), myopic loss aversion and framing

It could be argued that if myopic loss aversion had been considered as the MFR was developed the final structure might have been different and the resultant low real bond yields (when compared with other countries) could have been avoided.

The introduction of the MFR meant that schemes had to "count their money" every year, rather than the three year intervals that were previously the norm. Myopic loss aversion suggests that this would cause schemes to have a much lower appetite for equities, leading to a large demand for bonds from pension schemes.

Some actuaries have taken to framing the low real bond yields in terms of the willingness of pension schemes to pay a "convenience premium". Whether people buying annuities regard it as a convenience premium is debatable!

6. Estimating probabilities

6.1 Introduction

Much of what actuaries do involves making estimates of the probability of various outcomes. There is a, however, large body of evidence which suggests that numerous biases affect such estimates. Anchoring has already been considered in section 2. This section looks at a number of other issues which might affect probability estimates.

6.2 People don't like negative events

On particular experiment (Rosenhan and Messick) has considerable implications for actuaries and was carried out over 30 years ago in 1966.

The experimenters had a pack of 150 cards with drawings of either a smiling face or a frowning face. The experiment was carried out in two stages. In stage 1, 70% of the cards had a smiling face on them and 30% had a frowning face. In stage 2, the proportions were reversed – 70% of the cards had a frowning face and 30% had a smiling face.

The format of the experiment was for people to guess before each card was shown whether it was a smiling or frowning face. When 70% of the cards had smiling faces people were quite accurate in their predictions, estimating a smiling face on 68.2% of the trials. However, when 70% of the cards had frowning faces, people only predicted a frown on only 57.5% of the trials.

This experiment and many others have shown that the "valence" of an outcome (that is the degree to which an outcome is considered as positive or negative) has an enormous influence on probability estimates of its likely occurrence.

6.3 Representativeness

Representativeness is best illustrated by an example taken from a study by Tversky and Kahnemann (1982). The following question was posed to subjects:

> Linda is 31 years old, single, outspoken, and very bright. She majored in philosophy. As a student, she was deeply concerned with issues of discrimination and social justice, and also participated in antinuclear demonstrations. Which do you think is the most likely?
>
> *Option 1*: Linda is a bank clerk
> *Option 2*: Linda is a bank clerk and is active in the feminist movement

Almost 90% of people thought option 2 was most likely. It is clear, however, that it is impossible for option 2 to be more likely than option 1.

Tversky and Kahnemann also found similar results with "Bill", who was thought more likely to be an accountant and a jazz player than just a jazz player, and a Wimbledon tennis player, who was thought more likely to lose the first set and win the match than simply lose the first set.

People consider more probable that which they find easier to imagine. Tversky and Kahnemann concluded that:

> " As the amount of detail in a scenario increases, its probability can only decrease steadily, but its representativeness and hence its apparent likelihood may increase."

6.4 Availability

Experimental evidence suggests that in making probability estimates people are influenced by the ease with which something can be brought to mind. A number of experiments have asked people to estimate things like the relative numbers of deaths due to car crashes versus cancer. Because car crashes receive so much publicity people tend to overestimate the incidence of car crashes.

Perhaps more importantly availability can also lead to biased judgements when examples of one event are inherently more difficult to imagine than examples of another. For instance, Tversky and Kahneman (1973) asked people the following question:

> "In a typical sample of text in the English language, is it more likely that a word starts with the letter K or that K is its third letter (not counting words with less than three letters)?"

Of the 152 people who were asked questions such as this, 105 thought that words with the letter in the first position were more probable. In truth, however, there are approximately twice as many words with K in the third position as there are words that begin with it. Because it is easier to imagine words that start with K than have K as the third letter, most people overestimate the relative frequency of these words.

6.5 Confidence increases once an estimate has been made

Plous reports on an experiment that studied this by approaching people who were betting on horses in Vancover, Canada. They questioned people who had placed a C$2 within the previous 30 seconds and people who were about to place a C$2 bet in the next 30 seconds. They asked people to rate their horse's chance of winning on a 7 point scale with 7 indicating the chances were "excellent".

The results were as follows. The average score of those about to place their bet was 3.48 whilst that of those who had just placed their bet was 4.81. In other words after making a C$2 commitment, people became more confident that their bet would be successful.

6.6 Impact on actuarial issues

In actuarial work most initial probability estimates are based on historical data. These estimates are then adjusted in an attempt to make them more accurate for future projections. It is in the process of these adjustments that biases and errors are most likely to occur.

The initial overestimation of the impact of the HIV virus on mortality had a marked impact on the costs of life assurance for many men. It may be an example of the profession being affected by the availability bias - at the time the papers were full of apocalyptic projections of the likely effects of the virus.

7. Overconfidence

Questions: *What's the difference between God and an actuary?*
Answer: *God doesn't think he's an actuary*

7.1 Introduction

This is one of the most prevalent problems in judgement and decision making.

Psychologists have amassed evidence showing that people tend to overestimate their own abilities, knowledge and skills. The findings apply to those with healthy egos and those with low self esteem – whatever level people may perceive their abilities, the reality is that their true abilities are almost certainly lower!

A well worn simple demonstration of people's overconfidence can be made by asking a group of people whether they believe they are above average drivers or not. A typical group will have a substantial majority that believes they are one of the 50% who are above average.

7.2 The experimental evidence

Lichtenstein, Fischhoff and Phillips conducted some of the more important studies demonstrating overconfidence in the 1970s. People were asked a set of factual questions such as "what is the capital of Ecuador?". Each person was asked to give an answer and then estimate the probability that his or her answer was correct e.g. (60% certain that the capital of Ecuador is Quito"). The results showed that person were consistently overconfident. Most remarkably, for questions where people were 100% certain they were correct they were right only 80% of the time.

The response of some psychologists was to suggest that their findings were of little significance because they involved "trivia" questions. In another experiment described in Plous (1993) four psychologists asked some undergraduates at the beginning of the year whether they thought certain events (such as dropping a course, becoming homesick, falling seriously ill etc) would happen to them and how certain they were of their answers. On average students were 84% confident of their answers. The history of each student was then examined at the end of the year and it was found they were, in fact, right only 70% of the time – even when students were 100% certain of their predictions they were only correct 85% of the time.

Other experiments have looked at overconfidence by asking people to assign confidence intervals to their answers to a question. Shefrin (2000) gives a good example. People were asked to provide their best estimate of the gestation period of an Asian elephant. They were also asked to provide a "high guess" and a "low guess" such that there was a 90% chance that the right answer was between the two guesses. If everyone does this correctly then 90% of people should find that the true answer of 645 lies between their low and high guesses. In reality this occurs to only 10% of people – the other 90% are overconfident.

7.3 Overconfidence in professionals

Overconfidence has been observed in many professional fields including clinical psychologists, doctors and nurses, investment bankers, entrepreneurs, investment

mangers, individual investors, lawyers, negotiators and mangers (see Barber & Odean for detailed references).

Nearly all of the studies show that the discrepancy between accuracy and overconfidence increases, in all but the simplest of tasks, as the respondent is more knowledgeable. Accuracy increases, at best, to a modest degree but confidence increases to a much larger degree. In other words overconfidence is at its greatest in our own area of expertise.

The reason for this increase in overconfidence appears to be the belief amongst experts that more information will lead to better decisions. Many experiments show that this is not the case and that humans are extremely bad at processing more than a few pieces of information at a time. One experiment used racecourse bookmakers to test whether more information led to better forecasts. They were progressively given 5 to 40 pieces of information they considered important in picking winners. As the quantity of information rose their confidence rose dramatically, unfortunately the accuracy of their forecasts was unchanged whether they had just 5 pieces of information or 40. Similar tests have been carried out with doctors with similar results – more information does not mean better decisions.

The conclusion from all the research is that overconfidence is greatest for difficult tasks, for forecasts with low predictability and for undertakings lacking fast, clear feedback. Unfortunately, much actuarial work satisfies all three conditions!

7.4 Why does overconfidence persist?

What is even worse is that even when people know they are overconfident they remain so. There are a number of reasons for the persistence of the bias and I have looked at two of them - hindsight bias and confirmation bias - below.

7.5 Hindsight bias

This was demonstrated by Thaler in a test he carried out on his classes in 1986. On the first day of class members were asked to estimate the probability that certain events would happen between 1st February and 1st April 1986. After the end of the period he then asked the class to state whether they believed the event happened or not and then to write down the original probability they remember assigning to that event. The average results are shown in the table:

	Probability given on first day in class (%)	Probability students recall (%)	Students who thought an event did happen (%)
There will be a snow storm in town that accumulates 10 inches or more in one day (midnight to midnight)	54	49	21
The temperature in town will fall below –10 degrees F.	56	49	36
The temperature in town will rise above 70 degrees F	19	35	94
The Dow Jones Industrial Average will rise above 1600	37	61	93
The Dow Jones Industrial Average will fall below 1500	49	36	11

The results highlight the general results of experiments on hindsight bias

- Events that happen will be thought of as having been predictable prior to the event
- Events that do not happen will be thought of as having been unlikely prior to the event.

7.6 Confirmation Bias

Confirmation bias also explains some elements of overconfidence. Experimental results have shown that when people think there is a positive correlation, however illusory that correlation can be shown to be statistically, people will tend to look for evidence that confirms their point of view and will tend to dismiss evidence that does not justify it. This can be illustrated by the example below:

You are given the series 2,4,6 and are required to establish the rule from which the series was generated. Most people start by suggesting adding two to the previous value to give a series:

2, 4, 6, 8, 10 ……..

This turns out to be wrong. People then tend to look at the series and suggest that the next number is obtained by adding the two previous numbers so the series will be

2, 4, 6, 10, 16 ……..

This also turns out to be wrong. People then try various other methods typically focusing on even numbers. The actual rule that generated the numbers is simply one that specifies that each number is larger then the previous number.

7.7 Overconfidence in actuarial work

I would suggest that "overconfidence" in most actuarial work is most likely to arise when actuaries are considering the likely range of values that could be taken by key

assumptions. As an example, I would argue that overconfidence about the likely range of future inflation has led to at least two potential problems. First, guaranteed annuity options have started to "bite" causing problems for insurers – as inflation and bond yields rose after the contracts were introduced many people decided that the conditions in which the guarantee would bite would not recur. Second, the existence of fixed guaranteed pension increases (typically 3% pa, but there are some schemes with 5% pa) is causing problems for some pension schemes – it is unlikely that such a guarantee would have been introduced if people had thought that inflation was ever likely to return to the current levels.

8. Mental accounting

8.1 Introduction

Standard finance theory would suggest that people should net out all their gains and losses in a straightforward manner. The principles of mental accounting say otherwise. In brief, the theory states that because we get the importance of mental accounting was demonstrated by Tversky and Kahneman in a paper published in 1981. They asked people the following question:

> "Imagine that you have decided to see a play where admission is $10 per ticket. As you enter the theatre you discover that you have lost a $10 note. Would you still pay $10 for a ticket to the play?"

A large majority - 88%- of people said they would still buy a ticket.

They then asked another group of people the following question:

> "Imagine that you have decided to see a play and paid the admission price of $10 per ticket. As you enter the theatre you discover you have lost the ticket. The seat was not marked and the ticket cannot be recovered. Would you pay another for another ticket?"

In this case only 46% of people said they would purchase another ticket.

The loss of the ticket and the loss of the $10 are financially equivalent. Tversky & Kahnmann use the concept of mental accounting to explain the results. They suggest that subjects set up a series of mental accounts and in the second question the cost of a new ticket is added to a mental account called "theatre ticket purchase" and subjects decided $20 was too much. In the fist case the loss of $10 is charged to a different account and is not linked to the purchase of a ticket.

8.2 Mental accounting and the "money illusion"

Mental accounting has been suggested as a reason for the "money illusion" – the tendency to focus on nominal changes rather than inflation adjusted changes. Thaler demonstrates it by first setting out the situation of two individuals as follows. (modified to make it clearer to a UK audience)

> "Mr A's car was damaged in a car park. He had to spend $200 to repair the damage. The same day he won $25 in the office lottery pool"
>
> "Mr B's car was damaged in a car park. He had to spend $175 to repair the damage"

He then asks people whom they think is more upset. Almost everybody replies B. This shows just how the power of mental accounting.

To see how mental accounting could explain the money illusion simply convert cost of a repair into the loss in purchasing power due to inflation and the lottery win into a pay rise. In this case workers would prefer a $25 rise in income with a $200 rise in their cost of living rather than a $175 wage cut with no increase in the cost of living.

8.3 Why low inflation will be so challenging for actuaries

A more detailed study of money illusion was carried out by Shafir, Diamond and Tversky (1997) and suggests that although people can adjust for inflation their emotional reactions are based on nominal returns and so they still prefer the situation of the first individual to that of the second individual. This suggest that attempts to force people to think in real terms are unlikely to meet with much success. Other more imaginative solutions will be required!

9. How people make choices

9.1 Introduction

When actuaries present the results of their work to their clients it is common to present a range of options to them, typically showing the effect of different sets of actuarial assumptions. There is a mountain of information on how people make decisions. This section concentrates on a few of the more interesting aspects and one extremely important bias that affects many decisions.

9.2 Framing

The effects of framing have already been discussed in sections 3 & 4. They are extremely important in terms of how people choose amongst options but there are additional factors working as well

9.3 Primary and recency effects

In simple terms the primary effect suggests that people are more likely to choose the first option presented rather than subsequent options. The recency effect, however, suggests that in some instances the final option that is discussed may be chosen!

The available evidence suggests that the primary effect will dominate if the decision is made immediately after the options have been presented, whilst the recency effect will predominate if the decision is made sometime after the options are presented.

9.4 The effect of too many options

It is perhaps intuitively obvious that the greater the choice available, the harder it is to make a decision. Although some research has been carried out with regard to how financial decisions are made, much of the research has been done in connection with how consumers make choices. As these results are similar to those found with the financial studies, yet more interesting, I have used those from consumer marketing.

One of the more interesting experiments is reported in Belsky and Gilovich (1999). Two psychologists set up a tasting booth that allowed customers to taste a range of jams. Every opening hour over a period of two days they alternated the selection that was available – in one hour it was a selection of 24 jams and in the next hour it was a selection of just 6 jams. Anyone who approached the booth was given a $1 coupon that could be used against the purchase of the jam that day. The bar code on the coupon identified whether they approached the tasting booth when 6 or 24 jams were available. The results showed that, although more people visited the booth when it had the larger number of jams available, only 3% of such visitors actually purchased any jam. When just 6 jams were available 30% of visitors to the stand made purchases.

9.5 How the available options affect choice

In an experiment to look how peoples choices were affected by the options on offer a group of people was offered the choice between two Minolta cameras. They were provided with full details of the cameras and their prices which were as follows:

Camera I	Price $169.99
Camera II	Price $239.99

People were evenly split between the two cameras. A second group of people were offered three Minolta cameras - the above two plus an additional one with the following price:

Camera III	Price $469.99

Based on the results from the first group one might expect that however many people opt for the newer model the remaining people would split their choice 50/50 between cameras I and II, The actual result of adding this additional camera was that only about 20% of people chose Camera I, whilst over 40% chose camera II – a ratio of more than two-to-one.

This and numerous other experiments, have demonstrated that people are more likely to choose an intermediate option than one at either end.

9.6 Status Quo Bias

People have a marked preference for keeping things as they are. One of the best demonstrations of this is detailed in Belsky and Gilovich (1999). Individuals were presented with a problem along the following lines:

> "A great uncle has bequeathed to you a large sum of money. In considering how to invest this money you have narrowed down the choices to one of the following four options
>
> 1. Shares of XYZ Inc, a stock of moderate risk with a 50% chance that over the next year its price will increase by 30%, a 20% chance that it will stay the same and a 30% chance that it will decline 20%.
> 2. Shares of ABC Inc, a more risky stock than XYZ Inc, with a 40% chance that over the next year its price will double, a 30% chance that it will stay the same, and a 30% chance that it will decline 40%
> 3. US Treasury Bills, with a certain return of 9% over the next year
> 4. Municipal bonds , with a certain return of 6% tax free over the next year
>
> Please state which option you would select".

People selected as follows:

Option 1	32%
Option 2	18%
Option 3	18%
Option 4	32%

The same problem was offered to other groups of students , except that for each group they were told that the bequest was already invested in a certain manner and they were asked if they wanted to switch to another option. The results were startling – no matter which investment option was presented as the status quo, it was the most

popular choice for that group. For example, 47% of people chose to stay with option 4 (municipal bonds) when they were told they were already invested in it compared to just 32% when none of them was described as the status quo or default option.

9.7 Regret aversion

Part of the reason for the status quo bias is something known as regret aversion. Regret is more than the pain of loss. It is the pain associated with feeling responsible for the loss. If people retain the existing arrangements they minimize the possibility of regret.

9.8 The choice of chocolate bars

Research has been carried out on how individuals make choices when they are faced with a number of choices and may select more than one option.

An experiment reported in Benartzi and Thaler was carried out on young children indulging in trick-or-treat on Halloween night. The children were offered treats under two sets of conditions. Under the first condition they approached two adjacent houses and were offered the choice between two types of chocolate bar at each house. In the other condition they approached a single house with a large display of both chocolate bars on display and were asked to choose any two chocolate bars. The results showed a strong diversification bias under the second condition – every single child chose one of each chocolate bar. In the first condition involving sequential choice from two separate homes, however, just less than half (48%) chose different chocolate bars. Benartzi and Thaler referred to this as "naïve diversification".

9.9 Implications for defined contribution schemes

Naïve diversification in the selection of chocolate bars is interesting but does it translate into other areas that might have a significant financial impact. The answer is yes. Benartzi and Thaler produced evidence that members of defined contribution schemes have a tendency to divide their contributions evenly across the funds offered in the scheme, irrespective of the type or number of funds available. This strategy is a special case of the diversification heuristic and is often referred to as the "1/n heuristic". When this strategy is used, the assets chosen will depend greatly on the make-up of the funds offered in the scheme. This means, for example, that the proportion of assets that participants invest in equities depends strongly on the proportion of equity funds available.

Benartzi and Thaler have carried out a great deal of work in connection with the impact of this heuristic on the selections made by members of defined contribution schemes in the USA. They give a dramatic illustration of the effect using the plans offered to TWA pilots and University of California employees. The TWA fund offered five core stock funds and one core bond fund and on average the participants invested 75% of their assets in equities. The University of California Plan offers one stock fund and four bond funds and on average participants invested only 37% in equities. Subsequent experiments and analysis of over 170 funds showed that the mix of funds offered had a strong effect on the chosen asset allocation.

9.10 Designing a defined contribution pension scheme

Designing a defined contribution schemes involves consideration of a number of the biases detailed in this section and elsewhere in this paper. As just discussed, if there is no default option, people are likely to spread their contributions evenly across the available funds and so the funds that are made available will have a large impact on the asset allocation chosen by members.

The use of a default option, often a lifestyle option which automatically moves the asset allocation from equities to bonds as the individual gets closer to retirement, is likely to result in a large number of people selecting this option to minimise their risk of regret. If the default option is a lifestyle option then the period of transition from equities to bonds will crucially depend upon the assumed relationship between equities and bonds. Given the uncertain nature of this relationship there is considerable potential for biases to enter into and affect this process.

If the lifestyle option is not available or not used then there is evidence that the status quo bias and regret aversion will come into play – people tend not to alter the allocation of their accumulated contributions (but will alter the allocation of new contributions). This could mean, for example, that some members remain heavily invested in equities as they approach retirement.

When people join the scheme they will need to be given some information about the likely pattern of returns. How these returns are presented, and the assumed equity risk premium, used in deriving the figures will influence the asset allocation chosen by members.

Once a scheme is up and running members will need to be provided with regular information about returns. The more frequently they receive information the more conservative they are likely to be in their investment approach due to the effects of myopic loss aversion.

10. A problem at every turn

10.1 Introduction

To show just how many of these biases and errors can creep into the work of actuaries I have considered an actuary who is advising a pension scheme on the most appropriate asset strategy to follow. Assume that the actuary is given free reign to present the initial advice to the client.

Initially the actuary will need to discuss with the client whether to adopt a peer group strategy (following the asset allocation of a typical pension scheme as measured by one of the major performance measurers) or whether to adopt a bespoke strategy. The actuary has already come across the first issue: the minimisation of regret might influence the client to retain a peer group strategy.

10.2 Modeling

If the client decides to adopt a bespoke asset allocation strategy then the actuary will need to provide some advice and this will normally be based on some form of modeling. Typically an econometric model of the behaviour of economic variables and the returns of different asset classes is used in the modeling of assets and liabilities.

The use of an econometric model clearly involves a lot of decisions. If the model is based on historical data the model builder first has to decide what period should be used. In doing so they are open to all sorts of biases. Once people have a data series they will often remove what they perceive as outliers. In doing so they are likely to succumb to the valence effect - nearly every adjustment I have ever seen noted has involved the removal of the effects of a sharp fall in stock markets or a particularly high inflation rate.

Some of the financial and economic relationships in a model may be derived or checked for consistency by looking at the values implied by the current market prices of various investment vehicles. The issue here is that the prices of these vehicles are subject to distortions that have been documented elsewhere in the behavioural finance literature.

Once the model has been set, the user will probably become even more confident in its validity (see 6.5). There is also a danger that it will not be altered sufficiently, due to anchoring effects, to reflect changing market conditions.

There are alternatives to the use of such models, but whichever approach is used the actuary can't do much about advising on the asset mix without assumptions about the return prospects for those assets, including the degree to which they are correlated with each other. The probability distributions of these values, never mind the "best estimates", are highly uncertain and so there is considerable scope for biases to enter into the estimates.

10.3 Presentation of results

Once the actuary has selected the model to use he or she will have to decide how to present the results. A whole new set of problems now arises. The actuary will need to decide

- how many options to present (the more options that are presented the harder it will be for the trustees to make a decision)

- which options to present, (the client is likely to choose an intermediate option so the choice of options will have a crucial effect)
- how the options should be presented (framing effects)
- the order in which the options should be presented (primary and recency effects).

10.4 Post implementation events

Finally, once the client has chosen the appropriate investment strategy there is the risk that the strategy is changed part way through its anticipated period of validity. The policy will, quite sensibly, have been set on a three to five year view (to avoid myopic loss aversion) but a number of such strategies are quickly reviewed in response to some event (such as August 1998) causing the trustees, and possibly the actuary, to overreact and revise the strategy.

11. Protecting against the effect of the various biases

"There is one important caveat to the notion that we live in a new economy, and that is human psychology ……. Our advanced economy is primarily driven by how human psychology molds (sic) the value systems that drives a competitive market economy. And that process is inextricably linked to human nature, which appears essentially immutable ……."
Alan Greenspan

11.1 Introduction

As suggested by the above quote it is difficult to alter many of the behavioural traits outlined in this paper. This is because they arise as a result of psychological factors that have considerable benefits in life as a whole. Some research has been done, however, on how to minimise the effects of some of them.

11.2 Actions

One effect that can be reduced by simply being aware of it is overestimating of the probability of desirable events and underestimation of the probability of undesirable events.

Overconfidence is very difficult to reduce but some reduction can be achieved by considering why particular decisions might be wrong and by reducing hindsight bias which is a major contributor to overconfidence. To reduce hindsight bias research suggests that simply knowing about the bias is not sufficient to remove it - it is necessary to explicitly consider how past events might have turned out differently. If people only consider the reasons why something turned out as it did the evidence suggests that they are likely to overestimate how likely that outcome was and how likely similar outcomes are in the future.

Protecting against the effects of anchoring is difficult. The effects often go unnoticed and because the most extreme anchor values produce the largest anchoring effects a discussion of best or worse case scenarios could lead to unintended anchoring effects. If someone has just considered the best-case outcome it may be difficult to arrive at a realistic set of assumptions for the worst-case scenario.

Framing issues are impossible to avoid because an issue has to be framed in one way or another. To minimise its impact it is important to consider the implications of using a particular frame and, in some cases, to consider alternative frames.

The common theme of all these techniques seems to be that alternative perspectives should be considered and that it should be noted how decisions were arrived.

11.3 Guilty, as charged

If these biases are so prevalent and so difficult to mitigate against you may well wonder whether this paper has been affected by them. The answer is yes. As pointed out by Plous

> "Judgement and decisions research is conducted by human beings who are prone to many of the same biases and errors as their experimental subjects".

12. Summary and Conclusion

"At the end of the day, the valuation calculations that we make depend crucially on the financial assumptions, often the ones subject to the greatest uncertainty and where the results are subject to the greatest sensitivity. One of the areas where actuaries can add the most value is through their skill and experience in arriving at a rational and reasonable set of financial assumptions on which to base calculations".
Paul Thornton, Institute Presidential Address,1998

12.1 Importance of human behaviour to actuaries

Ultimately the advice given by actuaries will impact the long-term financial future of many organizations and individuals. As suggested by the above quotation, actuaries have to arrive at a rational and reasonable set of assumptions and in doing so have to exercise considerable judgement.

The exercise of actuarial judgment needs to be carried out with the knowledge of these potential biases and errors in decision making. The evidence on reducing their effects suggests that the best approach is to be very explicit about how assumptions are derived and to consider the circumstances in which they may be wrong.

When we are required to present a series of possible courses of action to a client their decision will be affected by both the selection of the options to be presented and the way in which those options are presented.

Finally, actuaries need to be alert to the use of these human factors by others to influence or direct our judgements and decisions.

12.2 Conclusion

It might be to the benefit of everyone if actuaries, after all, were not human!

Main references

Belsky, G and Gilovich, T: "Why Smart People Make Big Money Mistakes", Simon & Schuster,1999

Plous, S: "The Psychology of Judgement and Decision Making", McGraw – Hill Inc, 1993

Shefrin, H: "Beyond Greed & Fear", Harvard Business School Press, 2000

Shiller, R J: "Human Behaviour and the Efficiency of the Financial Systems" available at www.econ.yale.edu/nshiller/handbook.htm

References

Barber, B M and Odean, T: "Boys will be Boys: Gender, Overconfidence, and Common Stock Investing", Working Paper, University of California,1999

Benartzi, S and Thaler, R H: "Risk Aversion or Myopia? Choices in Repeated Gambles and Retirement Investments", Management Science, forthcoming.

Benartzi, S and Thaler, R H: "Myopic loss aversion and the equity risk premium puzzle", Quarterly Journal of Economics, February 1995.

De Bondt, W and Bange, M: "Inflation, Money Illutions, and Time Variation in Term Premia", Journal of Financial and Quantitative Analysis, 27, no 4, 1992.

Kahneman D, Slovic P and Tversky A: "Judgement under uncertainty: Heuristics and biases". Cambridge University Press, 1982

Kahneman, D and Riepe, M W: "Aspects of Investor Psychology", Journal of Portfolio Management, Summer 1998

Kahneman, D and Tversky, A: "Prospect theory: An analysis of decision under risk", Econometrica, 47, 1979.

McNeil, B J, Panker, SG, Sox, HC and Tversky, A: "On the elicitation of preferences for alternative therapies". New England Journal of Medicine, 306, 1982

Northcraft, G B and Neale, M A: "Experts, amateurs, and real estate: An anchoring and adjustment perspective on property pricing decisions", Organizational Behaviour and Human Decision Processes, 39

Read, D and Loewenstein, G: "Diversification bias: explaining the discrepancy in variety seeking between combined and separate choices", Journal of Experimental Psychology:Applied 1,1995

Redelmeier, D A and Tversky A: "On the framing of multiple prospects", Psychological Science 3.3 ,1992

Rosenhan, D L and Messick, S: "Affect and expectation". Journal of Personality and Social Psychology 3, 1966.

Shafir, E., Diamond, P and Tversky, A: "Money Illusion", Quarterly Journal of Economics 112, No2 1997

Tversky, A and Kahneman, D: "Judgements of any by representativeness"; 1982 in Kahneman, Slovic and Tversky