Regulating retirement savings: An evolutionary psychology approach

Regulering van pensioensparen: Een benadering vanuit de evolutionaire psychologie

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Table of Abbreviations

401(k) Plan	A defined contribution pension plan that qualifies for tax benefits under section 401(k) of the U.S. Internal Revenue Code
CAPM	Capital Asset Pricing Model
CPP	Canada Pension Plan
DB Plan	Defined benefit pension plan
DC Plan	Defined contribution pension plan
DOSPERT Scale	Domain-Specific Risk-Taking Scale
I-PANIS-SF	International Positive and Negative Affect Schedule, Short-form
IOS Scale	Inclusion of Others in Self Scale
OECD	The Organisation for Economic Co-operation and Development
OFC	Orbitofrontal Cortex region of the brain
OLS	Ordinary Least Squares
PAYG	Pay As You Go Pension Plan
SES	Socio-Economic Status
U.K.	United Kingdom
U.S.	United States of America

Chapter 1: Introduction

1. Background

In many countries, responsibility for retirement savings planning has been shifting from governments and employers to individuals. A concern with this shift in responsibility is that individuals have been shown to make systematic mistakes in all aspects of their retirement savings planning. For example, they under-contribute to their retirement savings plans, under-diversify their portfolios, pay excessive management fees and drawdown their retirement savings too soon (Barber & Odean 2013; Benartzi & Thaler 2007; Mitchell & Utkus 2004). These mistakes can be very costly. Accordingly, this shift in responsibility may be contributing to the low retirement incomes that are being observed in countries such as the U.S. (Munnell et al. 2015).

Until recently, state-provided pensions were almost always defined benefit plans, which pay a retirement income during a retiree's lifetime based on employment earnings and number of years worked. During the last couple of decades, however, governments in most developed countries and in some less developed countries started scaling back their defined benefit plans. To help compensate for the reduced defined benefit plan benefits, some governments introduced mandatory or voluntary defined contribution plans. Under a defined contribution plan, an individual's retirement income is paid solely out of contributions made by or on behalf of the individual and the income earned on those contributions. This shift from defined benefit plans to defined contribution plans is not driven by efficiency concerns, such as a belief that individuals will do a better job than the state of providing for retirement. Rather, this shift was done to allow governments more certainty in their pension costs. Moving from a defined benefit plan to a defined contribution plan shifts to individuals certain risks associated with pensions, such as the risk that funding costs will increase because of future increases in life expectancies or that investment returns will be lower than forecast. (Martin & Whitehouse 2008; European Commission 2012b; European Commission 2010).

This switch to defined contribution plans has also occurred in employer-provided pension plans. Historically, employers who provided pensions to their employees did so through defined benefit plans. However, since the beginning of the 1980's, employers in the U.S., Canada, the U.K. and other countries have moved away from providing pensions through DB plans to providing them through defined contribution plans (Brown 2016). In a typical defined contribution plan, employees contribute to the plan and the employer matches the contribution up to some limit. The employee generally chooses the contribution level and makes the investment decisions. While the trend towards defined contribution plans is not strong in Western Europe, legislation has recently been enacted in Belgium and in Germany to permit employers to offer defined contribution plans (Roessler 2017).

As alluded to in the opening paragraph, individuals make a host of systematic mistakes in managing their defined contribution plans. Traditional economists and finance scholars are puzzled by these mistakes. Two of the usual tools that traditionalists advocate for – more disclosure and better investor education – do not seem to change this behavior (Benartzi & Thaler 2007, p.99). On the other hand, establishing defaults and using other types of nudges have had a very large and lasting impact on individuals' retirement savings planning (e.g. Madrian & Shea 2001). Behavioral finance scholars and behavioral economists have done a good job of documenting the systematic mistakes that individual make in their retirement savings planning. They have identified biases and heuristics which cause people to invest in a sub-optimal manner, and they have come up with policies that lead to improved retirement planning behavior. However, they have not yet developed a unifying theory for why people are so bad at their retirement savings planning.

The motivation for writing this book is a belief that developing a framework within which to analyze why individuals make systematic mistakes in their retirements savings planning will help governments and defined contribution plan administrators to design better plans. Better crafted retirement plans may allow more people to maintain in retirement the standard of living that they enjoyed during their working years. The framework that I develop in this book for why people make these systematic mistakes is that the human brain has not evolved to easily solve problems relating to retirement savings planning. This framework is summarized in section 2 below.

2. Natural Selection and Evolutionary Psychology

The framework that I develop in this book to explain why people deviate from optimal retirement savings planning is based on Charles Darwin's theory of natural selection (Darwin 1859). The theory of natural selection simply provides that heritable traits of an organism will be selected for if they help that organism reproduce at a greater rate than others of that species. Of course, natural selection also applies to human beings. Our brains (and our cognitive abilities and biases) are the way they are because those specific attributes helped our ancestors survive and reproduce. In other words, the human brain evolved from earlier forms to what it is today because the evolved form allowed our ancestors to better solve recurring problems that they faced, such as avoiding predators, obtaining sufficient food and finding and retaining a mate (Kenrick et al. 2009).

The field of evolutionary psychology uses the theory of natural selection to explain human behaviour. It is based on a premise that, to understand the behavior of current-day human beings, one must consider the behavioral traits that would have been useful for the survival of our distant ancestors. During most of the time that the human brain was evolving, humans were hunter-gathers who lived in small groups of 150 people or less. As well, over most of that time, our social structure, environment and technology changed very slowly. It is only when we started farming about 12,000 year ago (a blink of an eye in evolutionary terms) that our social structure, environment and technology changed very rapidly, which threw up new problems that people needed to solve in order to survive and reproduce (Cosmides & Tooby 1995). Evolutionary psychologists assert that, because these changes were so rapid, natural selection has not had sufficient time to produce brains that are optimized to solve the problems that our current environment has thrown up. In other words, they assert that our brains are better suited to solving the problems that hunter-gatherers faced than to problems that arise in modern societies.

One modern problem that we face and which our hunter-gatherer ancestors did not face is saving for retirement, least of all because most hunter-gatherers did not live to an old age (Gurven & Kaplan 2007). Saving for retirement using financial markets is something that has only become possible for most people over the last few hundred years, at most. That timeframe is not nearly long enough for our brains to have evolved to effortlessly solve problems such as how

much to consume now versus how much to save and consume in decades from now. The fact that our brains are not optimized to solve retirement savings problems is not to suggest that we cannot learn to become better at tasks relating to retirement savings. People do learn to be better at saving and investing for retirement. However, because our brains did not evolve to specifically solve those tasks, solving them does not come easily to most people.

I am certainly not the first scholar to suggest that we need to consider how our brains evolved in order to explain the biases and heuristics that behavioral economists have identified. Gerd Gigerenzer's theory of ecological rationality is based on concepts of natural selection (see for example Gigerenzer 2008). Owen Jones, a legal scholar, has used principles of evolutionary psychology to analyze, among other things, criminal law (Jones & Goldsmith 2005). As well, finance scholars have started using genetics (and the interplay between genes and environment) to explain heterogeneity in investment behavior (Barnea et al. 2010; Cronqvist et al. 2015).

3. Research Questions and Methodology

The main research question of this book is whether evolutionary psychology (which itself is grounded in the theory of natural selection) can help to explain the biases and heuristics that people have been observed to use in making their retirement savings decisions. I take a multi-disciplinary approach to answering this question. I start by describing optimal investment strategies that have been developed by finance scholars and economists. I then compile and analyze in detail the evidence from finance and from behavioral economics that people systematically deviate from what finance scholars consider optimal investment strategies. I introduce evolutionary psychology and describe how that scholarship may provide a framework to explain the deviations from optimal investment strategies that we observe. I also use data from psychology and neuroscience to augment the evolutionary psychology framework. At its heart, this book is based on empirical research, both data gathered by others and on experiments which I conducted. Accordingly, I attempt to support with empirical evidence the theories and hypotheses that I develop in answering this research question.

After dealing with the broad research question, I deal with two specific research questions that follow from an evolutionary psychology analysis of retirement savings mistakes.

The two specific questions that I take on are (i) whether men under-diversify their stock holdings more when the evolutionarily important challenge of finding a mate is made salient to them and (ii) whether, in the retirement savings domain, individuals stick to defaults and make the same decisions as their peers to avoid the potential for feeling future regret.

I again use evidence from the disciplines mentioned in the opening paragraph of this section to develop hypotheses relating to each of the two specific questions. However, I go beyond formulating theories and hypotheses that are supported with available evidence. I test hypotheses relating to these two specific questions by conducting online experiments. The first experiment, on mate-seeking salience and under-diversification, is similar in approach to experiments conducted by evolutionary psychologists. The second experiment, on regret and its association with defaults and peer decisions, is incentivized and is closer in character to experiments run by economists.

Throughout the book, I assess the regulatory consequences of my theories and empirical findings using a law and economics framework.

4. Limitations

As far as I am aware, I am the first to use evolutionary psychology to formulate an evolutionary theory to explain the retirement savings mistakes that people make. The task has been formidable and I am humble enough to realize that my theories and methodology can be improved upon. One purpose of taking the evolutionary approach that I took in this book is to stimulate a conversation about the relevance to retirement savings planning of the fact that our brains are evolved organs. Therefore, I look forward to having others improve upon my work.

I have been fortunate enough to have discussed chapters of this book with evolutionary psychologists. I have also presented my work at evolutionary psychology conferences and workshops. That having been said, I do not have a formal background in evolutionary biology or evolutionary psychology. Therefore, I may not have the depth of knowledge in these subjects to know when I am making a mistake. However, because of input from those who have that depth of knowledge, I am confident that I have not made a fatal mistake.

I make no claim that the evolutionary psychology approach is the only approach to explaining why people make mistakes in their retirement savings mistakes. My claim is that the principle of natural selection can help us better understand why people make these mistakes.

I conducted only one experiment for each of the two specific research questions. Accordingly, caution should be taken in applying the results. It is possible that the results are attributable to factors other than the independent variables which were manipulated in the experiments. In addition, caution must be taken in generalizing the results of the experiments to other situations, such as actual retirement savings behaviour.

5. Content Structure

The book consists of six chapters, including this introduction. In chapter 2, I explain how natural selection and evolutionary psychology may help in developing an underlying theory as to why people makes systematic retirement savings mistakes. While the chapter is focussed on explaining why and when individuals may under-diversify their stock portfolios, the theoretical discussion on evolutionary psychology theories put forward in the chapter can be applied to questions of why and when individuals make other seemingly sub-optimal decisions relating to their retirement savings planning.

In chapter 3, I report on an experiment that was conducted to test one of the hypotheses from chapter 2. That experiment tested whether males for whom mate-seeking is made salient under-diversify their stock portfolios more than other males. The design of the experiment is similar to that of evolutionary psychology experiments which test whether males for whom mate-seeking is made salient take greater financial risk than males for whom mate-seeking is not made salient (e.g. Ermer et al. 2008; Griskevicius et al. 2012).

Regret is an emotion that helps humans learn from their mistakes. As learning from mistakes likely enhanced survival and opportunities to reproduce, having the ability to feel, anticipate and avoid regret would have been selected for (Santos & Rosati 2015). The fact that regret is a universal trait supports this view (Breugelmans et al. 2014). I hypothesize in chapter 4 that the emotion of regret may explain many of the retirement savings mistakes that individuals have been observed to make. People make retirement savings decisions partly to reduce the

potential for regret. Regret may also explain why defaults work so well in the retirement savings domain – people follow defaults because it is a regret reducing strategy.

Chapter 5 reports on an online experiment that I conducted with Pieter Desmet to test whether regret may explain why defaults and communicating peer preferences can be so effective in changing behavior. In the experiment, subjects decided between two lotteries and reported the regret they would feel if the lottery they did not choose paid out more than the lottery they chose. Like economics experiments, this experiment was incentivized – one in twenty participants were paid based on the outcome of the lottery they decided on.

Chapter 6 summarizes my main hypotheses and findings, the contribution of my work to the literature and the policy implications of my findings.

Chapter 2: Under-diversification by Individual Investors: Can Evolutionary Psychology Explain it?

> *There is no clear evidence from experience that the investment policy which is socially advantageous coincides with that which is most profitable . . . . The game of professional investment is intolerably boring and over-exacting to anyone who is entirely exempt from the gambling instinct; whilst he who has it must pay to this propensity the appropriate toll.*
>
> John Maynard Keynes, The General Theory of Employment, Interest and Money (1935), Chapter 12

Abstract

According to finance theory and supporting evidence, individual investors maximize expected returns on their stock market investments by holding a diversified stock portfolio and by limiting trading. However, a substantial subset of individual investors deviate from this strategy, causing them to earn, on average, a much lower return than if they had followed a diversified strategy. Less wealthy investors and investors who are single men deviate from portfolio theory more than other investors and, consequently, they earn low stock returns. The prevailing view in finance is that individual investors deviate from portfolio theory because of irrational overconfidence and reliance on heuristics. In contrast, the hypothesis of this chapter is that individual investors deviate from portfolio theory and accept lower rates of expected return on investment to try and satisfy other, more pressing, needs. I use evolutionary psychology to show that investors may be deviating from portfolio theory in an effort to attain evolutionarily important goals, such as to acquire status or to acquire a mate.

1. Introduction

A large body of evidence from finance suggests that individuals are atrocious stock market investors. They buy and sell the wrong stocks at the wrong time (e.g. Odean 1999; Barber & Odean 2001), under-diversify their holdings, (Barber & Odean 2001) and incur excess transaction costs by actively managing their stock portfolios, either on their own or through advisors (Stout 1995).

This bad stock market investing behavior costs individual investors a great deal of money. For example, using data from a large discount stock brokerage firm, Terrance Odean finds that if an individual sells shares of a company to buy shares of another company, on average, the return over the following year on the shares that she purchased will be 3.3 percentage points lower than the return on the shares that she sold (Odean 1999).[1] And this is before considering either management fees or commissions on the purchase and sale of the shares. One law and finance scholar put the total commissions and management fees paid in the U.S. in 1992 at over $100 billion, or about 1.8% of the market value of all U.S. equities (Stout 1995). Under-diversification can also be very expensive for some investors – a 2007 study based on the investment holdings of the entire Swedish population showed that, for the most under-diversified of investors, the cost of under-diversification was more than 5% of their financial wealth (Calvet et al. 2007). Under-diversified investors also lose because they tend to hold the wrong type of stocks – they prefer stocks that have a chance of a very large gain (so-called lottery-type stocks), and these types of stocks tend to greatly underperform the market (Bali et al. 2011).

Some groups of investors are more prone to making these investment mistakes than others. For example, single men earn worse stock market returns than married men, who in turn

[1] The author conjectures that this might occur because stocks that have had recent large price increases tend to be in the news and, thus, they attract the attention of individual investors. The high cost to individuals of short-selling means that far more of them buy these stocks than can sell them. Individuals sell other stocks to buy the newsworthy stocks, driving up the price of the newsworthy stocks above their intrinsic value. Some of these newsworthy stocks later revert to their intrinsic value and individual investors lose money (Odean 1999, p.19). Why arbitrage might not always work to prevent stocks exceeding their intrinsic value is discussed in section 2.3 of this chapter.

earn worse returns than women (Barber & Odean 2001). As well, less wealthy and less well-educated investors are more prone to making investment mistakes, and thus are more prone to earning lower stock market returns than their wealthier and more educated counterparts (Calvet et al. 2009; Anderson 2013).

That this bad stock market behavior persists in the face of evidence of its cost is perplexing to finance scholars. Given the wealth of information available to investors through the media and professional advisors, it ought to be easy for individual investors to avoid making the investment mistakes described above.[2] The rules that individual investors should follow if they wish to maximize their risk-adjusted returns are well-known and uncontroversial. The bedrock investment rule is the portfolio theory of stock market investing, which was first formalized by Markowitz (1952a). Since that time, variants of portfolio theory have been universally accepted by finance scholars and professionals as the preferred model for stock market investment (See for example Bodie et al. 2011). The gist of portfolio theory is that investors maximize their risk-adjusted returns by investing in a portfolio of stocks that is diversified by industry and geographically. The percentage of their assets that an investor ought to invest in stocks will depend on the degree of his or her risk aversion – the higher an investor's risk aversion, the lower the percentage of his or her wealth that the investor ought to invest in stocks (Bodie et al. 2011). However, the basic diversification strategy will apply regardless of investor risk aversion level. A concept that follows from portfolio theory is that, as individual investors generally do not have access to non-public information about individual stocks, they should not try to outperform the stock market through trading – such activity will increase transaction costs without increasing expected returns. Individual investors ought to buy and sell stocks only for liquidity reasons, for tax reasons or to rebalance their portfolio to match their risk aversion level (Bodie et al. 2011).

Economists assume that individuals invest in the stock market for the same reason that they engage in other forms of savings. They invest to temporally maximize their utility. They reduce their current consumption and invest the amount of the reduction in the stock market to

[2] In fact, there is evidence that investors who use financial advisers earn lower risk-adjusted returns than those who do not (Hackethal et al. 2012). There is also evidence that those with less financial literacy are less likely to seek out financial advice (Calcagno & Monticone 2015).

increase their consumption in the future.[3] But if this were the sole reason for individuals investing in the stock market, individuals would invest according to the tenets of portfolio theory, as that strategy has been shown to be the one that maximizes returns (and thus maximizes future consumption). The question that this chapter focuses on is: In the face of overwhelming evidence that diverging from portfolio theory is so costly, why don't individual investors invest according to the tenets of portfolio theory?

The prevailing view amongst economists and finance scholars is that individuals depart from portfolio theory because they lack relevant information or because they suffer from cognitive distortions. The hypothesis of this chapter is that many people invest in the stock market not only to maximize their expected return on investment, but also to (consciously or unconsciously) satisfy other (often more pressing) human needs, and that deviating from portfolio theory better satisfies those other needs. Accordingly, deviating from portfolio theory may even be a sensible strategy for some investors, rather than being solely due to cognitive distortions or to a lack of information.

This hypothesis is based on two recent lines of research relating to gambling. Firstly, a number of finance scholars have presented empirical evidence that investors who participate in gambling activities, such as buying lottery tickets, are more likely than non-gamblers to deviate from portfolio theory (See for example Kumar 2009). Secondly, recent research in psychology and evolutionary psychology suggests that people gamble to satisfy needs, rather than, as was previously thought, solely because they suffer from cognitive distortions (Binde 2013). The fact that gamblers are more likely than non-gamblers to deviate from portfolio theory suggests that people deviate from portfolio theory at least partly for the same reasons that they gamble. If they gamble in an attempt to satisfy certain needs, then they may also deviate from portfolio theory in an attempt to satisfy those same needs (Kumar et al. 2011).

What needs might investors be attempting to satisfy by deviating from portfolio theory? There is survey data and other evidence that individual investors deviate from portfolio theory because that manner of investing gives them the same form of enjoyment or entertainment as they get from gambling (Dorn & Sengmueller 2009). More interestingly, though, is that there is

[3]See (Samuelson 1958) for an early economics savings-consumption model.

also evidence that individual investors both gamble and deviate from portfolio theory to satisfy needs much more profound than entertainment (Binde 2013).

Using experiments and other sources of data, evolutionary psychologists show that young single men of low status take far more risk than others, and that they take these risks to obtain social status or to increase their chances of acquiring a mate, both of which are evolutionarily very important (Daly & Wilson 2001). Evolutionary psychologists have also shown that the same pattern applies to financial risk-taking. In a number of experiments, men (but not women) who are primed to compete for status or for mate acquisition take riskier financial decisions than when they are not so primed (Ermer et al. 2008). Accordingly, the evidence from finance that single men and people of lower social status deviate from portfolio theory more than other investors is consistent with an evolutionary psychology explanation for why investors deviate from portfolio theory (Kumar 2009). That is, some investors may deviate from portfolio theory in an attempt to satisfy evolutionarily important needs, such as the need for social status or the need to acquire a mate. There is also some evidence from evolutionary psychology that risk taking does indeed help men to achieve their goals of increasing status and acquiring a mate (Sylwester & Pawłowski 2011). It follows from this evidence that, even though deviating from portfolio theory reduces expected returns on investment, deviating may actually be a sensible strategy for status-seeking or mate-seeking investors.

That investors deviate from portfolio theory for reasons other than those associated with maximizing expected returns on investment is not a novel idea. The concept has been considered (and even modelled) in the economics literature and in recent finance literature (Barberis & Huang 2001; Barberis & Xiong 2009; Barberis & Xiong 2012; Fama & French 2007). However, the contribution of this chapter is to use an interdisciplinary approach (i.e. finance, psychology and evolutionary psychology) to attempt to explain the needs that individual investors might be trying to satisfy by deviating from portfolio theory.

In Part II, I show how individuals deviate from portfolio theory and how costly these deviations are to individual investors. In Part III, primarily using evolutionary psychology, I describe the needs individual investors may be attempting to satisfy by deviating from portfolio theory. Part IV concludes.

2. Suboptimal Investing – Nature of the Problem and its Cost

2.1. Stock Market Investing: Theory versus Practice

Modern portfolio theory assumes that investors are driven by only two factors – they like to earn expected returns on their portfolio but dislike variance of those returns. In 1952, Harry Markowitz constructed a model showing that an investor can reduce but not completely eliminate variance of returns by holding a portfolio of securities that have a low covariance of returns with one another (Markowitz 1952a). Relying on the assumptions that investors care only about expected return and return variance, William Sharpe and John Lintner each separately developed a model of capital asset pricing known as the Capital Asset Pricing Model ("CAPM"), and which has become the workhorse of modern finance (Sharpe 1964; Lintner 1965).[4] Under the CAPM, variance of expected return on a stock is driven by two types of risk: company-specific risk (also called idiosyncratic risk) and systematic risk. Company-specific risk is, by definition, uncorrelated to market prices in general, and can be eliminated by holding a large number of stocks.[5] Accordingly, that risk is not priced. Systematic risk of an asset can be thought of as the extent to which the price of that asset moves with movements in market prices in general – the more that the price of an asset moves with market price movements, the larger is the systematic risk.[6] The main inference of the CAPM is that the expected return on an asset is positively and linearly related to its systematic risk and that no other factor affects the expected return (Sharpe 1964; Lintner 1965). Based on the CAPM, an investor maximizes her risk-adjusted return by investing in some combination of a risk-free asset[7] and as widely diversified a portfolio of risky assets as possible (Lintner 1965, p.14).

[4] In their models, Sharpe and Lintner both assume that investors have homogeneous expectations and that investors can borrow and lend funds at the risk-free rate of interest. Sharpe recognizes the unrealistic nature of these assumptions (Sharpe 1964, p.434).

[5] By holding a very large number of stocks, an investor's variance of returns is minimized because negative company-specific shocks are likely to be balanced by positive company-specific shocks.

[6] For example, all stocks tend to do well in periods of strong economic growth and tend to do poorly in times of weak growth (Sharpe 1964, p.441).

[7] In the finance literature, long-term bonds issued by a government in its own currency are generally considered to be the risk-free asset. This is because a country that issues debt in its own currency will always be able to repay that debt. However, where a country is not permitted to print unlimited amounts of its own currency, such as countries that use the Euro, there is a default risk associated with government debt (Damodaran 2008).

While the CAPM continues to be the workhorse of finance, the relationship between risk and return implied by the CAPM has been very difficult to prove empirically.[8] Most studies show that the correlation between risk and return is positive but that the relationship is less monotonic and much flatter than the theory predicts (Subrahmanyam 2007) Two explanations have been given for the failure of the CAPM to predict expected stock returns. Richard Rolls suggests that the market portfolio is unknowable and, as a result, *"there is practically no possibility that . . . [a test of the CAPM] . . . can be accomplished in the future"* (Roll 1977, p.129).[9] The second explanation is that the CAPM fails because the assumptions on which it is based, such as the assumption that investors have homogeneous expectations of future returns and that arbitrage is cost-free, do not hold (Stout 1995; Fama & French 2004).

Even if the CAPM is flawed, there is little doubt that holding a diversified portfolio of stocks and minimizing trading is the strategy that individual investors ought to follow if their goal is to maximize their risk-adjusted expected returns.[10] To minimize company specific risk (and thus to maximize risk-adjusted returns), investors ought to hold a portfolio of stocks that is diversified across companies, industries and countries. As well, an investor ought not to trade stock except for liquidity reasons, for tax reasons or to rebalance her portfolio so that the risk profile of the portfolio matches her risk aversion level at any particular time (Bodie et al. 2011). For ease of reference, in the remainder of this chapter, I will use the term portfolio theory to mean any investment strategy that conforms to the concepts of wide diversification and limited trading.

A vast finance literature shows that individual investors regularly deviate from portfolio theory in a variety of ways.[11] These deviations may be usefully slotted into two categories – active portfolio management and under-diversification. Active portfolio management means that individual investors trade too much relative to the dictates of portfolio theory (Barber & Odean

[8] For a summary of the evidence against the CAPM, see Fama & French (2004) or Subrahmanyam (2007).

[9] In theory, the market portfolio would include all possible assets (including such things as human capital) and not just stocks (Fama & French 2004; Miller 1977).

[10] Many studies show that the portfolios of individual investors who hold a diversified portfolio and minimize trading perform best (For an overview of these studies, see Barber & Odean 2013).

[11] Deviations from portfolio theory are enumerated and extensively discussed in Barber & Odean (2013). For a discussion on how individual investors differ in their investment behavior from institutional investors, see Kumar et al. (2013).

2000).[12] Behavior that falls into the category of under-diversification include holding too few stocks,[13] holding stocks whose returns are highly correlated with one another (Goetzmann & Kumar 2008) and having a strong home bias.[14] As well, under-diversified individual investors prefer to hold stocks that exhibit the risk profile associated with lottery tickets; that is, they want stocks that have a low cost, a large chance of a small loss and a small chance of a large gain (Kumar 2009; Goetzmann & Kumar 2008). Alok Kumar finds that individual investors are more likely to hold lottery-type stocks than institutional investors and that less wealthy individual investors are more likely to hold lottery-type stocks than wealthier individuals (Kumar 2009).

The essence of the under-diversification problem is that under-diversified investors take on risk for which they are not compensated. An under-diversified investor could reduce the riskiness of his portfolio without reducing his expected return simply by spreading his investment over a greater number of stock holdings (Bodie et al. 2011). Note that an investor could hold a very risky portfolio and still comply with portfolio theory. For example, an investor who had $10,000 to invest could, in theory, borrow $30,000 and invest the full $40,000 in a very broad-based basket of stocks. This would certainly be a risky strategy since a 25% decline in stock prices would wipe out the investor. However, this strategy would be fully in keeping with portfolio theory since the investor would be employing a diversified buy and hold strategy. Accordingly, a risk-seeking investor need not deviate from portfolio theory to satisfy her desire for risk. However, the preference for lottery-type stocks suggests that individual investors do not want just any risk; they want stocks that have a risk profile which includes the possibility of a very big win.

[12]Using a large data set from a U.S. discount broker, Barber & Odean find that the average portfolio turnover rate is 75% per year (far more than seems necessary for liquidity, tax or rebalancing purposes). Even where investors choose to delegate their stock trading activity by investing through actively managed mutual funds, they trade the mutual funds more than seems optimal. Lynn Stout calculated that the rate of turnover of mutual fund holdings was 26% in 1991 (Stout 1995)

[13] Barber & Odean (2000) find that the average number of stocks held by individual investors was 4. Goetzmann & Kumar (2008) find that between 1991 and 1996, the average number of stocks went from 4 to 7. Both studies find that individual investors tended to hold more volatile stocks (with positive skewness) than the market.

[14] An investor who has a home bias invests primarily in stocks of companies headquartered in the country of residence of the investor (See Strong & Xu 2003 for the proposition that individual investors tend to invest overwhelmingly in stocks of companies in their home country; See French & Poterba 1991 for the proposition that the percentage of investors' portfolios dedicated to foreign stocks has increased over time; See French 2008 for the proposition that investors who trade excessively also tend to buy local stocks; also see Goetzmann & Kumar 2008).

2.2. Bad Investment Behaviour is Costly

Active management and excess trading is very costly to investors. Kenneth French puts the overall cost of active investing in the United States in 2006 at $106 billion, or $330 per American (French 2008). In a U.S. study of 1992 active investing costs, Lynn Stout calculated costs of over $100 billion dollars (Stout 1995) A Taiwanese study found that individual investors lose a staggering 3.8 percentage points of investment return each year because of excess trading (Barber et al. 2006) Two-thirds of the loss is attributable to unnecessary trading commissions and transaction taxes and the remaining one-third is attributable to the fact that shares that individual investors sell perform better than the shares that they buy (Barber et al. 2006) A recent Swedish study found that investors who are frequent traders perform more poorly than passive investors (Anderson 2013) Mirroring the Taiwanese study, they find that two-thirds of the underperformance is attributable to unnecessary transaction costs and one-third is attributable to "*stock selection or timing*" (Anderson 2013, p.4) The study also shows that less educated and less wealthy investors bear a much higher proportion of trading losses than other investors, relative to the value of their stock portfolios.[15]

The cost of under-diversification is more difficult to quantify. Under-diversification reduces the risk-adjusted returns to investors, but, for most investors, this is not nearly as costly as active management (Calvet et al. 2007). However, for some investors, under-diversification has been shown to be very costly. For example, the evidence in a study of Swedish households is that 5% of the population lose more than 5% of their financial wealth because they are under-diversified (Calvet et al. 2007). Goetzman and Kumar (2008) find that, adjusted for risk, the least diversified group of investors underperforms the most diversified group by 2.4 percentage points. Large losses associated with under-diversification have also been identified for individuals who invest their self-directed pension plans in company stock (Meulbroek 2005).

Another cost associated with under-diversification relates to the fact that under-diversified individual investors prefer to hold lottery-type stocks. A preference on the part of some investors for lottery-type stocks may increase the price (and thus reduce the expected returns) of those stocks to below what the CAPM predicts. Accordingly, undiversified individual investors not only take on risk for which they are not fully compensated, they further reduce their

[15] Investors who did not have a university degree and who were among the 40% least wealthy in the country owned 3% of total financial wealth but bore 27% of the trading losses (Anderson 2013, p.5).

expected return by buying overpriced lottery-type stocks. Kumar finds that the return on lottery-type stocks is almost 8% lower than on non-lottery-type stocks (Kumar 2009). As lottery-type stocks are held disproportionately by less sophisticated and less wealthy individuals, those investors bear a high proportion of this cost relative to the size of their stock portfolios. In the remainder of this Part, I review the finance literature which empirically shows that lottery-type stocks are overpriced and explain how lottery-type stock overpricing could persist. The discussion is somewhat technical, although I expect that even those without a finance background can follow it. However, readers can skip ahead to Part III without losing the thread of the chapter.

2.3. Overpricing of Lottery-type Stocks

Andrew Ang *et al.* find that stocks with high idiosyncratic volatility[16] at a given point in time tend to have low future returns relative to the stock market as a whole (Ang et al. 2006). Stocks in the top quintile of idiosyncratic volatility underperform stocks in the bottom quintile of idiosyncratic volatility by about 1% per month (Ang et al. 2006, p.261). This is contrary to what theory suggests, which is that there ought to be no correlation between the idiosyncratic volatility and expected returns. Recent studies have also purported to show that the returns on stocks predominantly held by individual investors (which tend to be stocks exhibiting high price volatility) do not increase with the volatility of the stock price. In fact, in some studies, the returns on such stocks has been shown to decrease with the level of idiosyncratic volatility. This seemingly perverse risk-return relationship has been observed in recent U.S., Dutch and German studies (Goetzmann & Kumar 2008; Hoffmann & Shefrin 2014; Meyer & Schroff 2013, respectively). However, Bali *et al.* (2011) show that if the preference for holding stocks that exhibit an extreme positive return (i.e. lottery-type stocks) is taken into account, this result reverses and returns on such stocks increase slightly with the level of idiosyncratic volatility.[17] This finding is consistent with Kumar, who finds that the average annual risk-adjusted return for portfolios held by individual investors is 1.1 percentage points less than the return on a market

[16] Idiosyncratic volatility is stock price volatility that is not correlated with the market, but that results from company-specific risks. See section 2.1 of this chapter for a discussion of company-specific risk versus market risk.

[17] This relationship between positive skewness and expected returns is not observed for shares held primarily by institutional rather than individual investors (Chichernea et al. 2014; Also see Han & Kumar 2013)

portfolio and that this underperformance increases as the percentage of lottery-type stocks in the portfolio increases (Kumar 2009). This research suggests that it is the preference for positive skewness that is priced, not a more abstract preference for risk.

Shares of companies that have gone into financial distress are an example of lottery-type stocks. Campbell *et al.* find that shares of financially distressed companies have higher than average systematic volatility (Campbell et al. 2008). The CAPM predicts, therefore, that such shares ought to have higher than average returns. However, Campbell *et al.* (2008) find that shares of distressed companies have lower than market returns. Kauser *et al.* (2013) posit that the reason why shares of distressed companies underperform is that their price is driven up by investors because of their "*lottery-type*" attributes. They attribute the underperformance to "*gambling-motivated"* trading behavior of individual investors (Kausar et al. 2013). Shares of companies that are in financial distress fit the profile of lottery-type stocks because they have a very low price, there is a large chance of the shares becoming worthless and a small chance of a very large return if the company is able to become viable. A recent example is the shares of American Airlines. American Airlines went bankrupt in November 2011 and its shares traded as low as $0.20 in that month. However, by April 2014, the price had increased to $27 – 135 times the price in November 2011.[18] In almost all bankruptcy cases, shareholders lose virtually all their investment, but in this particular case the shareholders got a very big win.

At the heart of the CAPM is the assumption that investors need to be compensated for taking on risk – the higher the systematic risk of a stock, the more expected return that an investor will demand in order to hold that stock (Markowitz 1952a; Sharpe 1964; Lintner 1965). It has been assumed in the literature that the compensation for taking on risk is always in the form of higher expected return. However, the compensation could be partly in a form other than expected returns on investment – for example, it might just be in the form of the enjoyment that some investors receive from investing in the stock market.[19] The compensation that is in a form other than expected returns on investment would be difficult to measure and may be greater for certain types of stock, such as lottery-type stocks. If investors obtain greater enjoyment from holding lottery-type stocks than from holding other stocks, they may be prepared to pay more for

[18] http://online.wsj.com/news/articles/SB10001424052702303456104579489282879045884

[19] See discussion in Part III.A.

those stock (in other words, they might be willing to accept a lower expected return) than the price predicted by the CAPM.[20] This preference on the part of individual investors might be what causes the expected return on those stocks to be less (and the price to be higher) than the CAPM predicts (Barberis & Huang 2008).

In theory, if the preferences of individual investors cause certain stocks to exhibit a lower level of expected return than the CAPM predicts, arbitrageurs would short sell that stock until the expected return on that stock equals the expected return predicted by the CAPM. In practice, though, arbitrage may be difficult to accomplish and, in any event, it will not be costless.[21] Arbitrageurs need to borrow stock (which may be difficult, particularly for stock of smaller companies) in order to short sell it (Baker & Wurgler 2006). If the individual investor sentiment for a stock is strong, arbitrageurs may need to hold a large undiversified short position in that stock for an extended period of time (Baker & Wurgler 2006). This is a risky proposition and arbitrageurs would have to balance that risk against their expected profit on the short position. Accordingly, arbitrageurs may be unwilling to short certain stocks, with the result that the low expected return may persist (Shleifer & Vishny 1997).[22] It is even possible that a superior strategy for professional traders is to buy stocks that they believe are overpriced, with the expectation that individual investors will bid up the prices of those stocks even further (Blanc & Rachlinski 2005).

3. Using Evolution to Explain Deviations from Portfolio Theory

Under-diversification and active portfolio management are difficult to explain using traditional finance or economics models (Subrahmanyam 2007). Under economic theory, investing in the stock market is a form of savings; that is, as with other forms of savings, by investing in the stock markets, individuals reduce their current consumption in order to fund

[20] This analysis is similar to that employed by (Brunnermeier et al. 2007). They suggest that individual investors obtain utility from choosing to hold optimistic beliefs about future outcomes, and that they design their investment portfolios in such a way as to maximize the sum of the optimistic beliefs utility and the utility that they obtain from earning high returns on their investments.

[21] For an extensive discussion on the difficulties that arbitrageurs face, see (Barberis & Thaler 2003).

[22] For additional literature on the difficulty of arbitrage, see (Bali et al. 2011, p.444). Fama & French (2007) show mathematically that if some investors obtain utility from holding stock that is unrelated to the expected return on that stock, the price of that stock will remain higher than what the CAPM predicts, even if arbitrageurs are active.

future consumption.[23] If, as the traditional finance and economics models assume, the sole reason for investing in the stock market is to shift consumption into the future, rational individual investors would invest according to portfolio theory because that investing style has been shown to maximize risk-adjusted expected returns (and hence to maximize the expected amount available for future consumption).[24] Accordingly, in the face of the overwhelming evidence that individual investors deviate substantially from portfolio theory and that such deviations are costly, individual investors who deviate from portfolio theory must either (i) be acting irrationally (that is, in a way that does not maximize their utility) or (ii) be attempting to satisfy needs that can be better satisfied by investing in a manner that deviates from portfolio theory.[25]

Over the last 30 years or so, many finance scholars have adopted concepts developed by behavioral economists to explain why investors deviate from portfolio theory (e.g. Subrahmanyam 2007). A common behavioral explanation is that individual investors trade excessively and under-diversify because they are overconfident in their own stock picking abilities.[26] Another common explanation is that investors base their decisions to buy and sell stocks on recent price movement using the so-called availability heuristic.[27] Excess trading and under-diversification may also be aggravated by the disposition effect; investors sell their winning stocks and keep their losers, rather than simply keeping both winners and losers (Odean 1998). The behavioral analysis assumes that under-diversification and excessive trading are irrational and that, with the right incentives and information, investors will change their behavior (Subrahmanyam 2007).[28]

[23] This theory relies on the economics concept of declining marginal utility. Rather than spending all their income as they earn it, individuals prefer to consume evenly over time. Accordingly, they will save in their high income years and use that savings to consume more in low income years (Samuelson 1958).

[24] Or, alternatively, to minimize the amount of current consumption they need to give up to attain a certain level of future consumption.

[25] I suggest that, to know whether a particular behavior is rational, we need to know the objective that the investor is attempting to reach. See for example (Sugden 2008).

[26] For a discussion of overconfidence and under-diversification, see Goetzmann & Kumar (2008).

[27]Under the availability heuristic, individual investors base their investment decisions on readily available information, such as recent stock price movements or recent news items (Goetzmann & Kumar 2008).

[28]The irrationality of this type of behavior was first discussed by (Kahneman & Tversky 1979).

There is a great deal of empirical literature supporting both the behavioral effects discussed in the previous paragraph and the proposition that those behavioral effects reduce investors' expected returns.[29] However, there is also evidence that factors such as overconfidence may not be the main reason for why people deviate from portfolio theory. In a study using trading data and an investor survey, Daniel Dorn and Gur Huberman show that self-reported overconfidence does not explain the degree of diversification or of trading (Dorn & Huberman 2005). Experiments have been conducted that only weakly support the proposition that people who are overconfident trade more (Deaves et al. 2008; Glaser & Weber 2007) and have poorer performance (Biais et al. 2005). Mark Grinblatt and Matti Keloharju show that sensation seeking and overconfidence both contribute to excess trading, but that sensation seeking is the more explanatory of the two variables (Grinblatt & Keloharju 2000). There appears to be even less of a link between overconfidence and under-diversification. Alok Kumar finds that the propensity to under-diversify is negatively correlated with measures of overconfidence (Kumar 2009; also see Kausar et al. 2013). Accordingly, in the face of this often conflicting empirical evidence of the role that overconfidence plays, it is worth considering other potential explanations for why individual investors deviate from portfolio theory.

The hypothesis of this chapter is that individual investors deviate from portfolio theory to (consciously or unconsciously) satisfy needs that they could not satisfy if they invested according to portfolio theory. I defer until later a discussion of what needs investors may be attempting to satisfy by deviating from portfolio theory. However, I do assume that the needs that investing in the stock market satisfy, other than those associated with maximizing expected returns, are all forms of current consumption.

Earlier in this Part, I introduced the concept of savings as a mechanism for temporally maximizing utility. I also suggested that that mechanism applied equally to stock market investing; that is, by investing in the stock market, people decrease their current consumption to increase their future consumption. However, the analysis changes somewhat if individuals invest in the stock market partly for current consumption.

Investor decisions regarding the extent to which they follow or deviate from portfolio theory can be thought of as attempts to further temporally maximize utility by balancing current

[29] For a recent summary and analysis of this literature, see Barber & Odean (2013).

consumption against future consumption. By deviating from portfolio theory, investors give up some future consumption (because they earn lower stock market returns) in order to derive current consumption. In theory, an investor who derives current consumption by investing contrary to portfolio theory could achieve a similar mix of current versus future consumption by (i) reducing the amount that he invests in the stock market but investing according to the tenets of portfolio theory and (ii) spending the amount of the investment reduction on goods or services that give the investor the same type of current consumption that he would have derived if he had deviated from portfolio theory. To determine whether to follow or to deviate from portfolio theory, the investor would need to compare the utility that he derives under each of those strategies. It is conceivable that an investor who makes this calculation (explicitly or implicitly) would decide that deviating from portfolio theory is a utility maximizing strategy, even though it is not a strategy that maximizes expected returns on investment.

It follows from this hypothesis that, even if individual investors could be convinced that their stock market investing behavior was costing them in terms of reduced future consumption, they would continue to trade excessively and under-diversify so long as the utility that they derive from investing in that manner was greater than the utility that they would derive by investing according to portfolio theory.

There is evidence that individual investors do enjoy investing in the stock market in a manner that deviates from portfolio theory, and that they do not derive that same enjoyment by following portfolio theory. In a comprehensive U.S. survey of investors who held accounts at a full-service broker, respondents reacted more positively to the following statements regarding their attitudes towards investing than any other of the proffered statements: "*I enjoy investing and look forward to more such activity in the future*" and "*relying exclusively on mutual funds reduces the personal satisfaction I obtain from making my own investments*."[30]

In a study of German investors which matched survey responses to trading records from a discount broker, those who responded positively to the question of whether they enjoyed investing traded much more than those who responded negatively to that question (Dorn & Sengmueller 2009). Similar results were found in a Dutch study matching survey results to

[30] They rated those statements at 4.09 and 3.94, respectively, with 5 being the most positive response (Lease et al. 1974).

trading records (Hoffmann & Shefrin 2008). Nicholas Barberis and Ming Xiong suggest that the disposition effect (i.e. investors sell their winners and keep losers) is caused by what they call "realization utility"; that is, investors enjoy the feelings associated with selling winners and are averse to the feelings associated with selling losers (Barberis & Xiong 2012). A subsequent experiment tested the realization utility theory by taking images of participants' brains using functional magnetic resonance imaging while those participants were engaged in a simulated trading game. The results were that when issuing sell orders on winning stocks, participants experience a sharp rise in activity in the part of the brain associated with feelings of pleasure (Frydman et al. 2014).

While these studies are evidence that some people deviate from portfolio theory because it gives them a form of current consumption (i.e. enjoyment or entertainment), the studies do not consider whether investors consider the very substantial cost of deviating from portfolio theory. Accordingly, these studies do not answer the question of whether investor deviations from portfolio theory are rational since investors might not be aware that their investment behavior is significantly reducing their return on investment.

Nor do the studies deal with the question of what it is about deviating from portfolio theory that investors enjoy. Do they enjoy deviating from portfolio theory simply because that manner of investing is entertaining, in the same way that watching a movie is entertaining? Or does the enjoyment come about because deviating from portfolio theory satisfies more profound needs? I make the case below that individuals may be deviating from portfolio theory invest to satisfy evolutionarily important needs, such as the need for status and the need to find a mate. The building blocks of my case are (i) recent finance literature which finds that investors who deviate from portfolio theory are also prone to engaging in gambling and other risky behavior and (ii) recent psychology and evolutionary psychology literature which finds that people may gamble and engage in other risky behavior to satisfy evolutionarily important needs. I will expand on those building blocks below, after which I will develop an evolutionary framework for why individuals deviate from portfolio theory.

3.1. Stock Market Investment as Gambling: The Evidence

From the earliest days of portfolio theory, it has been mooted that some people deviate from portfolio theory because they like to gamble.[31] It may seem intuitive that people who participate in the stock market by under-diversifying or through excess trading may also be the same people who like to gamble. However, it is only recently that the link between stock market investment behavior and gambling propensity has been empirically tested.[32] While this literature is still in a nascent stage, the link between investment behavior and gambling is compelling.

Using account data (including stockholdings, trading and demographic information) from a discount brokerage firm, Kumar finds that individual investors who under-diversify prefer to invest in lottery-type stocks, which Kumar defines as stocks that have attributes associated with lottery tickets. As mentioned earlier, these attributes include a low price, a large chance of a small loss and a small chance of a large gain. Stocks that have a high positive skewness of returns (Kumar et al. 2011) or "*that exhibit an extreme positive return*" (Bali et al. 2011; Mitton 2007) have these attributes. A desire to hold lottery-type stocks would tend to result in under-diversification since diversification would reduce the chance of a truly big win. Suppose that an individual investor has a preference for a small chance of an extreme positive return and that the only two stocks that are available to him each have a 1% chance of a tenfold increase in price. Also assume that the return on one stock is independent of the return on the other. If the investor holds one stock, he has a 1% chance of a tenfold return. If he holds both stocks he has only a 0.01% chance of a tenfold return.[33] If the investor's objective is to maximize his chances of earning the extreme tenfold return, he will buy just one of the two stocks. This concept may be generalized to the real world of investing. The more stocks an investor owns, the more likely it is that he will earn a market return rather than a return that is much higher (or lower) than the market return.

Kumar (2009) finds empirically that those investors who fit the profile of lottery ticket buyers (such as young single men) are more likely to both under-diversify and to buy lottery-

[31] In fact, Markowitz himself suggests that stock market speculation is "gambling". He posited that some people may like to buy stocks that have a small chance of a large gain (Markowitz 1952b).

[32] Kumar (2009) was the first to empirically test the link between gambling and stock market investing.

[33] Since the returns on each stock are assumed to be independent of each other, the chance of getting a tenfold return by holding both stocks is 1% multiplied by 1%.

type stocks. He also finds that those of low relative status – those relatively poorer than their neighbours – buy both more lottery tickets and more lottery-type stocks Based on an analysis of the U.S. Consumer Expenditure Survey, Geng Li also finds that people who gamble are more active in stock markets (Li 2012). The implication of this research is that an investor's propensity to gamble somehow affects his or her stock market investing behavior.

Recent empirical studies find that stock trading substitutes for lottery ticket purchases in the U.S., in Germany and in Taiwan – individual investors trade less during periods where the national lottery jackpot is high (Dorn et al. 2014; Gao & Lin 2014). This effect is greater for male and less educated investors and in the trading of lottery-type stocks (Dorn et al. 2014). Kumar (2009) also finds that, like the demand for lottery tickets, the demand for lottery-type stocks increases in bad economic times. A Swedish study used trading records and tax records to find that those who hold under-diversified portfolios also trade excessively, and that those who engage in that behavior tend to have lower income, wealth, age and education (attributes that are associated with lottery ticket buyers) (Anderson 2013). Lucasz Weber and Elke Markiewicz recruited participants into a simulated investment game and, at the end of the game, had participants complete a DOSPERT (a measure of gambling propensity) survey (Markiewicz & Weber 2013). They found that *"gambling risk-taking propensity predicts trading volume"*. Mark Grinblatt and Matti Keloharju used Finnish investor tax filings, driving records and psychological tests given to military recruits to find that excess trading is driven by both sensation seeking (measured in the number of speeding tickets) and by overconfidence (measured by psychological tests administered by the military) (Grinblatt & Keloharju 2009). These studies are all consistent with the proposition that stock trading substitutes for forms of gambling, such as lotteries.

As discussed in Part II.C., the empirical evidence is that the expected returns on lottery-type stocks is lower than on non-lottery-type stocks (Bali et al. 2011; Barberis & Huang 2008). Accordingly, investors who are only interested in maximizing their expected returns ought not to buy lottery-type stocks. The fact that individual investors do buy lottery-type stocks might just mean that they fail to understand that the expected return on those shares is lower than the expected return on non-lottery-type stocks. Experiments have shown that people do misunderstand probabilities in many gambling situations, but there is also evidence that people gamble even when they understand the probabilities. In a 2006 Canadian study, students were

given specialized instruction on the statistics of gambling. Six months after the end of the instruction, those same students were tested on their ability to calculate gambling odds, and were found to be better able to calculate those odds than before the instruction. However, the study also found that those students were no more likely to decrease their gambling behavior than students in the control group (Williams & Connelly 2006). In addition, a number of studies involving pathological gamblers also find that there is little or no correlation between numerical reasoning skills and gambling behavior (Lambos & Delfabbro 2007). These studies suggest that gambling is not due to a simple misconception of the relationship between risks and return. The studies support the proposition that people engage in gambling behaviour because they derive utility from it. To the extent that individual investors deviate from portfolio theory to satisfy the same needs that gambling satisfies, these studies also support the proposition that individual investors derive utility from deviating from portfolio theory.

Additional support for the proposition that individual investors know what they are doing when they deviate from portfolio theory is found in Dorn & Huberman (2005). They use German brokerage account data and survey data to find that individual investors who self-report being less risk averse hold less diversified portfolios and trade much more often. As well, in a U.S. study matching survey data with brokerage account data, those who said they were willing to take more risk held fewer stocks (Polkovnichenko 2005). These studies suggest that investors are not unaware of the level of risk that they are taking on by deviating from portfolio theory.

In summary, there is mounting evidence that people who have more of a propensity to gamble deviate from portfolio theory more than those who have less of a propensity to gamble. There is also evidence that stock market investing is a substitute for gambling activity and that people are aware that they are taking on additional risk when they deviate from portfolio theory. The finding of a link between propensity to gamble and propensity to deviate from portfolio theory suggests that people deviate from portfolio theory for the same reasons that they gamble. Accordingly, if people gamble to satisfy certain needs, we may be able to infer that people also deviate from portfolio theory to satisfy those same needs.

3.2. Gambling (and Deviating from Portfolio Theory) to Satisfy Needs

The analysis in this Part draws on research from the fields of economics and psychology into why people gamble. I first review the prevailing views in economics and psychology that people gamble because they suffer from cognitive distortions. I then review (i) more recent theories in economics that people obtain utility from gambling and (ii) theories in psychology that people engage in leisure gambling to fulfil certain needs. I follow with a summary of the tenets of evolutionary psychology, which I believe offers some promising reasons for why and under what circumstances people engage in risky behavior, such as deviating from portfolio theory.[34]

Research in the field of psychology into why people gamble has only been rigorously conducted during the last 30 years and has generally been limited to studying the motivations of problem gamblers (Fortune & Goodie 2012).[35] Much of this research has focussed on whether problem gambling is associated with various cognitive distortions (Fortune & Goodie 2012). Even less is known about what motivates leisure gamblers – that research is in a nascent stage.[36] However, the results of the limited research into leisure gambling suggests that leisure gamblers may not suffer from the same cognitive disorders as do problem gamblers (Fortune & Goodie 2012). As well, leisure may have different personality traits than problem gamblers (Goodie 2005).[37] As the motivations and personalities of leisure gamblers may differ substantially from those of problem gamblers, it is not clear how relevant the research into problem gambling is to leisure gambling (Fortune & Goodie 2012; Binde 2013).

The prevailing view in economics is that people gamble because of cognitive distortions (Kahneman & Tversky 1979; Von Neumann & Morgenstern 1953). However, as discussed

[34] The use of biological behavioral science, such as evolutionary psychology, in the study of law is recent but growing. For an overview of the field of Law and Behavioral Biology, see (Jones & Goldsmith 2005). For a discussion on how principles of evolution may be incorporated into the field of economics, see (Gandolfi et al. 2002).

[35] The psychology literature uses the terms "pathological gambler" and "problem gambler". A problem gambler is someone who is or is at risk of becoming a pathological gambler (Jacobsen et al. 2007).

[36] See Binde (2013) for a discussion on what motivates leisure gamblers. I use the terms non-problem gambler and leisure gambler interchangeably. There appears to have been a belief among some academics that the study of leisure gambling was a "taboo" subject in the academic world – see (Thompson & Potts 2011). The finding of that paper, based on empirical evidence, is that gamblers are happier than non-gamblers. The likely relationship is that happy people tend to gamble more than unhappy people, rather than gambling causing happiness.

[37] For example, leisure gamblers are less confident and more risk averse than problem gamblers.

below, recent scholarship attempts to fit the desire to gamble into the theory of expected utility maximization.

3.2.1. Cognitive Distortions

Greatly influenced by Amos Tversky and Danial Kahneman, the prevailing wisdom in both psychology and economics is that cognitive distortions play a leading role in gambling (Fortune & Goodie 2012). Kahneman and Tversky are also the founders of the field of behavioral economics, which is the branch of economics most closely associated with the study of decision making under conditions of uncertainty. Unsurprisingly then, in both psychology and contemporary economics, much of the research into gambling has to do with identifying the cognitive disorders which lead people to gamble and (particularly in psychology) considering ways in which such cognitive disorders may be corrected.

Kahneman and Tversky suggest that in making decisions under uncertainty, people do not seem to calculate the odds or to rely on statistical analysis. Rather, they appear to rely on heuristics, and it is the reliance on these heuristics which sometimes leads people to make systematic errors or biased judgements (Kahneman & Tversky 1973). The cognitive distortions that gamblers (or, at least, gamblers who are pathological gamblers) suffer from are thought to be caused by the biases from using the heuristics identified by Kahneman and Tversky (Fortune & Goodie 2012).

Fortune & Goodie (2012) catalogue the common gambling-related cognitive distortions and associate them with the heuristics identified by Kahneman and Tversky. For example, they observe that pathological gamblers believe that they can influence the outcome of random events and they suggest that this cognitive distortion is based on the availability heuristic.[38] Pathological gamblers also believe that there are correlations between independent events such as the outcome of a toss of a coin – if heads comes up, say, 4 times in a row, they believe that the odds of tails coming up in the next toss is more than 50% (Jacobsen et al. 2007; Fortune & Goodie 2012). This latter distortion, often referred to as "gamblers fallacy" is very prominent in pathological gamblers and is thought to be a distortion derived from the representative heuristic (Jacobsen et

[38] Known in the psychology literature as the illusion of control (Fortune & Goodie 2012).

al. 2007; Fortune & Goodie 2012). Pathological gamblers also tend to be overconfident due to using the representative heuristics (Fortune & Goodie 2012). The availability heuristic is thought to be the reason for the observed phenomenon of big wins early in a person's gambling experience making it more likely that the person will become a pathological gambler – the early wins contribute to an expectation of winning in the mind of the person (Jacobsen et al. 2007).[39] Pathological gamblers also believe that their chances of success are *"higher than the objective probability should warrant"* (Fortune & Goodie 2012, p.301). Note the similarity between the cognitive distortions that appear to motivate pathological gamblers and the cognitive distortions which have been identified in the field of behavioral finance which cause investors to deviate from portfolio theory (see introduction to Part III).

More than 80% of people in many western countries have gambled at some point in their lives (Young & Stevens 2009). However, only a small percentage of the population have ever become pathological or problem gamblers (Shaffer et al. 1999).[40] Some of the cognitive distortions identified in the previous paragraph have been shown not to apply, or to apply to a much lesser extent to leisure gamblers. For example, leisure gamblers appear to be less overconfident and less prone to the illusion of control than are problem gamblers (Goodie 2005). Leisure gamblers are also less subject to gambler's fallacy and to seeing illusory patterns (Wilke et al. 2014). As well, pathological gamblers have been found to be more certain than leisure gamblers of their erroneous perceptions (Jacobsen et al. 2007; Cote et al. 2003). Lambos and Delfabbro (2007) find that pathological gamblers make more cognitive mistakes than leisure gamblers. Leisure gamblers have also been found to be less impulsive than pathological gamblers (Breen & Zuckerman 1999). Accordingly, it does not follow from the research into problem gambling that cognitive distortions are a primary motivation for the vast bulk of gamblers. Rather, leisure gamblers may gamble to fulfil certain needs.

[39] Compare that finding to (Kaustia & Knupfer 2008), in which the researchers find that people who do well in the first IPO that they buy into are much more likely to buy into another IPO than those who do not do well on the first one.

[40] They find that the lifetime adult prevalence for pathological gambling is around 1.5% and the lifetime adult prevalence for problem gambling is around 3.85%.

3.2.2. Gambling as Needs Fulfilment

3.2.2.1. Views of Economists

Economists have struggled to explain the prevalence of gambling. The accepted view is that, in a world with decreasing marginal utility of income, rational actors would never accept a fair bet because the gain in utility of a win would be less than the loss of utility in the case of a loss (Marshall 1890). In their treatise of 1953, John von Neumann and Oskar Morgenstern formalized the concept of decreasing marginal utility of income into several axioms.[41] Von Neumann and Morgenstern were certainly aware that gambling was problematic for their model. They ask in their treatise: *"May there not exist in an individual a (positive or negative) utility of the mere act of "taking a chance," of gambling, which the use of the mathematical expectation obliterates?"* (Von Neumann & Morgenstern 1953, p.28). They quickly answered this question in the negative on the grounds that such a utility would contradict the axioms they formulate in their treatise.[42] More recently, Paul Samuelson stated that gambling involves only transfers of money, "creating no new money or goods" (Samuelson 1947).

Marschak (1950) gave the following example of a situation in which one might reasonably be said to gain utility from a risky activity: A mountain climber might prefer to climb a mountain that has a 95% survival rate than climbing either (i) a mountain that has an 80% survival rate or (ii) a mountain that has a 100% survival rate. However, this preference set is not recognized by an expected utility model since it violates the axiom of monotonicity (Marschak 1950). Marschak suggests that revising the concept of rational choice to reflect *"the love of danger"* would make it impossible to attain *"manageable utility indices"* (Marschak 1950, p.139). John Harsanyi and others have suggested that utility theory excludes gambling utility because any utility associated with gambling has to do with the process of gambling and not with the consequences of gambling (discussed in Le Menestrel 2001). In summary, while some of the leading early thinkers on utility theory acknowledged that it is possible that individuals may

[41] The axioms include transitivity, completeness, stochastic dominance and monotonicity (Von Neumann & Morgenstern 1953)

[42] "*Thus a suitable definition of utility (which in such a situation is essentially uniquely determined by our axioms) eliminates in this case the specific utility or disutility of gambling, which prima facie appeared to exist*" (Von Neumann & Morgenstern 1953, p.629).

obtain utility from gambling, they could not fit gambling utility into a rational expectations model and, accordingly, they chose to ignore any concept of gambling utility in their models.

An early attempt to explain gambling within expected utility theory was provided by Milton Friedman and L.J. Savage (Friedman & Savage 1948). They developed a utility function to explain why individuals might be risk seeking regarding certain decisions and risk averse regarding other decisions. The neo-classical utility function that describes the marginal utility of money is concave throughout. In contrast, the utility function Friedman and Savage develop is concave in some parts and convex in others.[43] The implication of such a function is that for some decisions, the expected utility associated with the good outcome of a gamble outweighs the expected loss in utility associated with the bad outcome of that gamble, even though the expected money gain is less than the expected money loss. For example, a person in a low socio-economic class may buy a lottery ticket because the benefit of a win is very large (he moves to a higher socio-economic class) and the cost of losing is very low (the cost of a lottery ticket may have almost no impact on his standard of living). Accordingly, the individual may buy a lottery ticket even if the expected return on the ticket is decidedly negative. This utility function also explains why an individual who gambles also buys insurance. Paying an insurance premium may have little effect on an individual's standard of living, but an uninsured loss may cause the individual to lose socio-economic status (Friedman & Savage 1948).

More recently, researchers have developed models to explain gambling that maintain the traditional concavity of utility functions. John Conlisk developed a model in which there is a separate utility to the process of gambling that is not captured by the income utility function and once this separate utility is taken into account, gambling fits within the diminishing marginal returns to income model (Conlisk 1993). This separate utility has to do with the suspense and excitement of the process of gambling. Marc Le Menestrel maintains the axioms of the neo-classical expected utility function but suggests that individuals may also be motivated by the process of gambling and, accordingly, *that "a rational individual" . . . [will take into account] . . . "a preferred process and a preferred consequence"* (Le Menestrel 2001, p.251). John Nyman *et al.* suggest that gambling fits within the traditional concave utility function once you take into account the fact that individuals who gain gambling winnings get an additional benefit that they

[43] For a diagram of the function, see Friedman & Savage (1948), at p. 295. It bears a resemblance to the kinked value function developed by Kahneman and Tversky (Kahneman & Tversky 1979).

do not get from labor income, namely that they do not have to work for the gambling winnings – gambling income thus commands a premium over labour income (Nyman et al. 2008; Nyman et al. 2013).

While none of these theories have gained wide acceptance among economists, they show an increased understanding that neo-classical expected utility theory ought to be able to account for the observed facts that people derive some form of utility from gambling (Diecidue 2004). While economists have generally understood that people may derive utility from gambling, that utility is not the type of utility that can be modelled and, accordingly, it has been ignored.

3.2.2.2. Views of Psychologists

Because research into the psychology of gambling started relatively recently, it is almost exclusively studied through the lens of cognitive distortions and personality variables, which are the psychological disciplines that prevailed throughout the entire period that the subject has been studied (Jacobsen et al. 2007). However, recent scholarship has started to consider biological, social and evolutionary reasons for why people gamble. Some of this research suggests that people engage in leisure gambling not only due to cognitive distortions but also to satisfy certain human needs, such as the need to garner social rewards or to experience the pleasurable anticipation of a potential reward (Binde 2009).

Per Binde recently developed a theory that while *"a chance of winning"* is common to all forms of gambling, it is not the real motive for leisure gambling – *". . . pure money is the medium of gambling, not what gambling actually is about"* (Binde 2009, p.83). The possibility of gain through gambling induces feelings of pleasure and satisfaction. Studies show that winning can trigger certain neurochemical processes in the brains of humans and animals – the positive feelings associated with being rewarded for taking risk may thus be the result of natural selection. As well, since human societies are built on the concept of reciprocity, receiving more than one pays in a gambling game is "*exceptional and pleasant*" (Binde 2009, p.87). In Binde's theory, the psychological and symbolic value of winning are the ingredients that help fulfil other motivations for leisure gambling (Binde 2009).

It is fair to say that this theory is in its early stages. However, it raises an interesting counterpoint to the prevailing view that gamblers gamble because of cognitive distortions.

3.2.2.3. Evolutionary Psychology

Evolutionary psychology is the scientific field that stands at the intersection of evolutionary biology and cognitive science (Cosmides & Tooby 1994). It is a field that may help to explain the circumstances under which people prefer to gamble (and to deviate from portfolio theory) rather than to take the safer decision. In this Part, I very briefly describe the field of evolutionary psychology and summarize what it might say about decision making under uncertainty.

Evolutionary biology posits that a trait of an organism will be selected for if that trait increases the fitness of the organism (Sterelney & Griffiths 1999). Fitness in this context means the rate at which genes are passed on to the next generation (Cosmides & Tooby 1994). The human brain will have evolved at least from the time that humanoids first appeared, with the traits that were most conducive to fitness being passed on from generation to generation. However, evolution is a slow process. During almost all this time that our brains were evolving, humans were hunter-gatherers living in small social groups, and so the architecture of the brain that humans now possess would have evolved to help people adapt to the environment in which hunter-gatherers found themselves, rather to our current environment. As the environment in which we now live is much different from the one in which our brains developed, our brains may not be as well suited to our current environment as they could be. In other words, our brains remain "*functionally specialized to solve problems that were characteristic of hunter-gatherer societies, rather than those of the modern world (e.g. habitat selection; foraging; social exchange; competition from small armed groups; parental care; language acquisition; contagion avoidance; sexual rivalry)*" (Cosmides & Tooby 1994, p.329).

Rational expectations models of economics are based on the assumption that our brains are general purpose instruments in the sense that they solve any type of problem using the same computational rules and the same logic (Kenrick et al. 2009; Haselton et al. 2009). Evolutionary psychology, on the other hand, posits that we use different systems for managing different challenges that we need to meet to survive and procreate (Kenrick et al. 2009). These include obtaining status, obtaining a mate, retaining a mate, obtaining friends, self-protection, caring for kin and self-protection. Evolutionary psychology also differentiates between proximate and

ultimate reasons for doing a thing (Tybur 2013). For example, the proximate reason for a man buying a Prius automobile may be to help the environment but the ultimate reason for doing so may be to increase his status, thereby becoming more attractive to women (Kenrick & Griskevicius 2013; Sexton & Sexton 2011).

Hunter-gatherers would have had to evolve mechanisms for assessing risk in many different circumstances (e.g. whether to risk injury by hunting or by challenging someone in the group for status) (Gigerenzer 2008; Cosmides & Tooby 1996). Those who were good at assessing those risks would have survived (and passed along their genes) to a greater degree than those who were not as good as assessing those risks. There is ethnographic evidence that *"in a variety of socio-economic systems and for a variety of behaviors, we are able to act as if capable of assessing outcome distributions, value functions and needs or aspiration levels, and of implementing effective, risk-sensitive actions"* (Winterhalder 2007, p.442). In many situations, we do not actually calculate the odds, but assess risk, variance and return using heuristics (Kahneman & Tversky 1973; Gigerenzer 2008). It may be that we apply those same risk assessment mechanisms to assessing financial risk.

The evolutionary biology concept of life history theory, which evolutionary psychology has adopted, posits that organisms must make decisions about how much time and resources to allocate to present reproduction as opposed to allocating resources to things like growth and survival, which will assist it in future reproduction (Kaplan & Gangestad 2005). The organism makes these decisions at any particular time based on such things as its sex, age and its subjective life expectancy (Kaplan & Gangestad 2005). Life history theory has been applied to human decision making (Wang et al. 2009). Evolutionary psychology stipulates that, in addition to risky decision-making being domain specific, it is also not stable over a person's lifetime. Whether a person takes a risky or a safe decision in any particular circumstance may also depend on where that individual is in his or her life cycle and on the particular environmental cues which that individual has been subjected to in the past or in the present (Wang et al. 2009). For example, single men (who are likely to be in mate acquisition mode) may make riskier decisions in order to acquire resources (which they will need to attract a mate) than married men, who might be more concerned with not losing resources because they are in mate retention mode (Frankenhuis & Karremans 2012).

Evolutionary psychology has been criticized as being a "just so" theory (Sterelney & Griffiths 1999). One problem is that since we evolved in an environment that is much different than the one which we now inhabit, the link between our evolutionary history and the current utility of that evolution is quite weak (Sterelney & Griffiths 1999). As well, environment can change the organism, so that putting an organism in an environment that is different from the one in which it evolved weakens the link between evolution and fitness.[44] As well, homo sapiens are the only surviving humanoids, so it is impossible to compare our traits to those of closely related species as biologists do with, for example, birds (Sterelney & Griffiths 1999).

While it is difficult to directly test evolutionary psychology theories by looking back through our evolutionary history, it is possible to test the theories experimentally. The general design of evolutionary psychology experiments is to prime the subjects in a treatment group to be in a certain mode (e.g. mating, disease avoidance) before conducting a task, then comparing the results of that task with the results from a control group who have performed the same task but who have not been primed. Priming involves subjecting subjects to a stimulus (e.g. viewing photographs or reading stories) with the purpose of determining whether exposure to that stimulus subconsciously influences subjects' behavior in a subsequent task (Shanks et al. 2013). A number of experiments (many of which I refer to later in the Part) have been conducted to test whether subjects' propensity to make risky decisions change if they are in a certain evolutionary mode. Under these experiments, subjects are generally primed to be in a specific evolutionarily important mode, such as mate acquisition mode or status seeking mode. They are then asked to engage in a task to determine whether they make risker decisions than subjects in the control group. As deviating from portfolio theory is riskier than abiding by portfolio theory, these experiments may also help to explain the ultimate reasons why people deviate from portfolio theory.

The balance of this Part applies evolutionary psychology theory and empirical evidence (including the experiments referred to above) to determine why people may under-diversify their stock portfolios and buy lottery-type stocks.

[44] For example, improved diets mean that people are taller now than 100 years ago, so it is not possible to say that human height optimizes fitness (Sterelney & Griffiths 1999, p.315)

3.2.2.3.1. Risk Sensitive Foraging Theory

Evolutionary biologists studying animal foraging behavior find that if there are two potential foraging areas open to an animal, it will choose the one that has less variability in yield even if the other has a greater expected yield, provided that the one with less variability in yield provides enough to sustain the animal (Ermer et al. 2008). This is known as risk sensitive foraging theory (Rode et al. 1999). From a survival point of view, this makes sense. More variability in yield might lead to some good feasts but it also leaves open the possibility of not eating for a few days and thus perishing. It is only when the less variable foraging area cannot sustain the animal that it will forage in the more variable area. The human brain evolved during a time that we were foragers, so it is reasonable to conjecture that we are also *"functionally specialized for making [foraging] decisions"* (Rode et al. 1999, p.300; also, Haselton et al. 2009). In other words, humans may have an evolved system for making risk-sensitive judgements that combines data about means, variance and need to come up with the optimal decision, without actually making the detailed calculations. Observations of groups who are still hunter-gatherers show that they typically make decisions that minimize the risk of not getting sufficient food, rather than maximizing the abundance of food (Kenrick & Griskevicius 2013; Kenrick et al. 2009).

If the human brain is specialized for making risk-sensitive resource acquisition judgements, then that same function could be used to make resource acquisition decisions for things other than food (Ermer et al. 2008). Indeed, risk sensitive foraging theory could be applied to stock market investing. Investors have the choice of adopting a low variance diversified approach or a higher risk undiversified approach. If taking a low variance portfolio approach to investing will not yield the investor enough to meet his or her goals, the investor will have to adopt a high variance undiversified portfolio approach to investing to have any chance of meeting those goals. This theory is consistent with the empirical evidence in finance that those who have less wealth tend to under-diversify their stock portfolios more than their relatively wealthy counterparts. Less wealthy investors may buy lottery-type stocks because getting a large payoff may be the only way for them to achieve their aspirations.

Risk-sensitive foraging theory may also be applied to the acquisition of status (Ermer et al. 2008). As discussed in Part III.2.c.ii., status is important to men because women prefer to mate with men who have it. If a man has insufficient status to attract a mate, he may have to

adopt a risky status-seeking strategy, as adopting the safe strategy means that he will fail in an evolutionary sense. Applying risk sensitive foraging theory to stock market investing, low status men would prefer a highly variable investment strategy while high status men would opt for a less variable strategy to make it less likely that they lose status (Daly & Wilson 2001). Accordingly, consistent with the empirical finance data, risk sensitive foraging theory predicts that low status men (proxied by those with relatively less wealth) would under-diversify and hold lottery-type stocks and that high status men would tend to hold a diversified portfolio.

3.2.2.3.2. Risk-taking to Acquire Status

It has been hypothesized that, like many mammals, humans evolved in small social groups in which status relative to others in the group was important, particularly for males (Ermer et al. 2008). Status determines mating opportunities and access to resources. Dominance theory is a well-developed evolutionary tool which is used to predict the circumstances under which animals will compete for status. As status is always a relative concept, competing for status is risky because an increase in one person's status necessarily means a relative reduction in another person's status. As a result, competing for status with other males may lead to injury (in humans, this might include social injury) if competitors decide to fight back (Ermer et al. 2008). Accordingly, deciding when and when not to compete for status is evolutionary very important for men and they should have developed mechanisms for assessing the risks and rewards of competing for status in any given circumstance. Competing for status includes competing for "*culturally valued resources*" (Ermer et al. 2008, p.107), such as money in our society. Cross-cultural studies show that women prefer men who have high status, but that men tend not to be concerned with women's status in determining a mate (Gray 2004).

One evolutionary reason for humans (and particularly for men) having evolved risk assessment capabilities is to be able to weigh the risks and rewards of acquiring resources to increase status and consequent mating opportunities. A well-developed mechanism for weighing these risks and rewards should lead to increased mating opportunities and increased fitness. In addition, taking risks to acquire resources may be a way to directly acquire a mate. Experiments have shown that when men are primed to be in mate acquisition mode they are more likely to take risks to acquire resources than men in control groups that have not been so primed (Baker &

Maner 2008).[45] There is also evidence that when the ratio between men and women is high, men make riskier financial decisions because men must compete more strongly for mating opportunities (Griskevicius et al. 2012). When the ratio of men to women is high, a man who takes a slow and steady approach to financial decision making may find that there are few potential mates available by the time he acquires sufficient resources to attract a mate. As well, men gamble more than women across cultures (Gray 2004).

The empirical evidence from finance is that single men under-diversify and hold lottery-type stocks to a much greater extent than women or married men. Single men may be adopting this investment strategy because they want a chance of a quick big win. A big win will increase their status and, accordingly, increase their chances of acquiring a mate. If the investment strategy does not pay off (i.e. the big win does not come through), they may be no worse off in terms of their chances of acquiring a mate than if they had followed a portfolio theory strategy (Griskevicius et al. 2012).

3.2.2.3.3. Risk-taking as Signalling

Risk-taking behavior itself might be a way for men to signal to women their value as a mate (Hugill et al. 2011). Risk-taking may signal attributes that are desired by women, such as confidence, ambition and mental acuity. Accordingly, male risk-taking may increase the number of mating opportunities (Baker & Maner 2009). Risk-taking may also be a way for men to signal their gene quality – the theory being that only men with good genes can bear the cost of engaging in unnecessarily risky behavior (Sundie et al. 2011). The theory is analogous to the theory of why peahens prefer peacocks with large showy tails. The tails are a signal of good genes as only peacocks with good genes could afford to carry around such unwieldy appendages and survive predators (Sundie et al. 2011).

Men who were primed with sexual/romantic arousal took more risks in a recent experimental task, but only when they were told that *"a romantically available female would view their performance"* (Baker & Maner 2009, p.1138). In an experiment to test whether women were more attracted to risk takers, men completed a questionnaire regarding their risk-

[45] Men are also inclined to accept a smaller amount today rather than to wait for a larger amount in the future in the presence of attractive women (Wilson & Daly 2004).

taking propensity, following which they performed a dance. Female participants were then shown a video (blurred to mask facial and physical attributes) of those men dancing and were asked to rate their attractiveness. Female participants reported being more attracted to dancers who had self-reported a high propensity to take risk (Hugill et al. 2011). In another study, women who were interested in short term relationships reported that they preferred men who were financial risk-takers (Sylwester & Pawłowski 2011). So, there is some evidence that financial risk-taking is in itself an attribute to which women respond positively. Accordingly, it may be that men under-diversify their stock market investments to signal to women their desirable qualities.

Risk-taking may also be a signal to other men. Daniel Fessler recently tested his hypothesis, which he calls the Crazy Bastard theory, that men engage in risky activity because men who become known as risk-takers are less likely to be challenged by other men. Fessler showed that men who engage in risky activity in an experiment were perceived by other men as having greater physically stature, even though they had the same physical stature as the non-risk-takers (Fessler et al. 2014). This is consistent with the results of an experiment conducted by Ermer *et al.* (2008) that men (but not women) make riskier financial decisions in the presence of men who they expect to compete with for status.

3.2.2.3.4. Life History Theory

As discussed in Part III.2.c., under life history theory, organisms allocate resources between current reproduction efforts and somatic effort, such as strengthening the body and survival. More somatic effort now may mean more future reproduction, but only if the organism survives. One variable that is relevant to the organism's allocation between current reproduction effort and somatic effort is the subjective life expectancy of the organism. Organisms which expect a long life tend to defer reproduction efforts and focus on somatic effort early in life, while those with a short life expectancy will start reproducing early in life (Griskevicius et al. 2011; Ellis et al. 2012). This has also been shown to be true within species (i.e. those individuals who have a short life expectancy will start reproducing sooner than those with a longer life expectancy) (Griskevicius et al. 2011). This ability to use environmental cues to trade off the risks of current versus deferred reproduction is evolutionary designed – those organisms who are

better at making these decisions will have better fitness than those organisms that are not good at making those assessments (Wang et al. 2009).

Life history theory has been applied to human behavior. Studies have shown that people who have a lower life expectancy at birth, who grew up with low socioeconomic status, or who grew up in violent or unstable environments are more likely to have children earlier in life (Griskevicius et al. 2011). Vladis Griskevicius conducted a series of experiments to test the hypothesis that the same relationship would hold with respect to financial decision making; that is, that those who grew up with low socioeconomic status would be more likely to make risky financial decisions. He hypothesized that people who grew up being uncertain about the future will use their environmental cues to take risks to increase their current wealth since future wealth will be of less subjective value to them. The results of the experiments were consistent with Griskevicius's hypothesis (Griskevicius et al. 2011).

The empirical evidence in finance is that relatively poor investors under-diversify more than richer investors (Kumar 2009). To the extent that there is a correlation between wealth during childhood and wealth in adulthood, the fact that less wealthy investors under-diversify is consistent with the life history theory. Relatively poor investors would be more likely to prefer a quick big win than richer investors and would be less interested in following a slow and steady diversified investment strategy because they subjectively believe that they may not live long enough to enjoy the fruits of the slow and steady strategy.[46]

Life history theory may explain why single men disproportionately under-diversify their investment portfolios and hold lottery-type stocks. Single men are more likely to be in the mate acquisition stage of their life history. Accordingly, they may be disposed to take risks to acquire resources and status, which may increase their chances of acquiring a mate (Daly & Wilson 2001). Married men, who are more likely to be in mate retention mode, may be more concerned with not losing resources and, accordingly, they may be more likely to take a slow and steady diversified portfolio approach than single men (Daly & Wilson 2001). The finance evidence in

[46] In a recent experiment, participants who came from a lower childhood socio-economic background and who were primed for mortality threats chose more diversified portfolios. However, that experiment was not directly testing risk-reward trade-offs since participants in that experiment were not given any information about the risk or return on the portfolios from which they could choose (White et al. 2013).

consistent with the life history theory, as it shows that single men under-diversify and hold lottery-type stocks to a much greater degree than women or married men.

3.2.3. Summary of Evolutionary Reasons for Under-diversifying

The finance studies summarized earlier in this chapter illustrate that individual investors who have certain demographic attributes, such as low socioeconomic status, being single, being male and being young, are more likely to under-diversify their stock portfolios. Evolutionary theories of human risk-taking predict that people with those same demographic attributes will take risky decisions to meet certain evolutionary challenges, such as mate acquisition. Accordingly, it may be that people under-diversify and buy lottery-type stocks to (consciously or unconsciously) meet these evolutionary challenges. Whether that investing behavior is actually beneficial to investors is an open question; that is, does deviating from portfolio theory really help investors meet those evolutionary challenges, or is the perceived benefit illusory?

It ought to be possible to experimentally test whether there are evolutionary explanations for individual investors' under-diversifying. The framework of the experiment would be to prime participants to be in, say, mate acquisition mode before having them participate in an investment game. Their investment behavior would then be compared to the behavior of a control group that participated in the same investment game. Another approach is to test whether low status males make different investment decisions than high status males in a simulated investment game.

4. Conclusion

Individual investors deviate from portfolio theory by trading too much and under-diversifying their stock portfolios. The empirical evidence in finance is that these deviations are very costly to investors. Individual investors incur unnecessary commissions and other transaction costs associated with trading and they are not adequately rewarded for the risk they take on by holding undiversified portfolios. In addition, their preference for lottery-type stocks result in the expected returns on those stocks being lower than the CAPM predicts.

A rational individual investor who was only interested in maximizing his or her expected investment returns would adopt a buy and hold strategy and would avoid lottery-type stocks. The

observed fact that individual investors do not follow this investment strategy might mean that they deviate from portfolio theory to satisfy current needs.

The needs that individual investors may be attempting to satisfy by deviating from portfolio theory may be evolutionarily driven. Numerous studies in finance show that investors who are young, single, male or who have relatively low wealth tend to deviate from portfolio theory more than investors in other demographics. These results are consistent with the evolutionary psychology literature on risk-taking. That literature finds that young, single men of low status make riskier decisions than others, particularly when they are primed for status seeking or mate acquisition. It ought to be possible to test the evolutionary psychology theories for portfolio theory deviation through experiments in which investors are primed for status seeking or mate acquisition and then observing their investment behavior as compared to a control group that was not so primed. In chapter 2, I report on the results of an experiment I conducted to test whether males who have been primed to be in mate-seeking mode under-diversify more than those who have not been so primed.

Chapter 3: Men Under-diversify Stock Holdings More When Mate-seeking is Made Salient

Abstract

Empirical evidence from finance reveals that individuals vary widely in the extent to which they diversify their stock portfolios. Experiments in evolutionary psychology have shown that the amount of financial risk that an individual takes depends on which evolutionarily important frame of mind the person is in. Building on theory and findings in finance and evolutionary psychology, I designed an online experiment to test whether some of the variation in male stock market investing diversification can be explained by whether mate-seeking is salient at the time of making the investment decision. In the experiment, mate-seeking was made salient to those in the treatment condition by showing them photographs of female models (those in the control condition were shown photographs of something more neutral). Participants were then required to allocate a hypothetical endowment between risky and riskless assets and to choose how much to diversify their risky asset portfolios. I find that males for whom mate-seeking is made salient under-diversify more than those in the control condition. I also tested whether there was a difference in the treatment effect for single males and for males in a relationship. I find that males in a relationship under-diversify more when mate-seeking is made salient, but that the mate-seeking prime had no effect on how much single males under-diversify

1. Introduction

Governments and employers in many countries are moving away from providing retirement incomes through pooled pension plans. Rather, retirement incomes are increasingly being funded through individual pension plans, where an individual's retirement income is based solely on contributions made to his or her plan and the income earned on those contributions (Tapia & Yermo 2007). In most cases, individuals who fund their retirement income through individual pension plans are also required to choose how to invest the assets of those plans. However, many individuals do a poor job of making investment decisions. Indeed, there is evidence that the mistakes that individuals make cause them to fall short of their retirement income needs (Munnell & Mauricio 2005). An increased understanding of why individuals make these investment mistakes may help governments to design rules that reduce the incidence of these mistakes.

One mistake that individuals make, and the mistake that was the subject of chapter 2, is that they under-diversify their investment portfolios. As discussed in that chapter, under-diversification is a concern for two reasons. Firstly, studies have shown that under-diversified portfolios earn lower returns than more diversified portfolios (e.g. Calvet et al. 2007). Secondly, in addition to earning lower expected returns, those individuals who under-diversify their individual retirement plans and who are unlucky may not earn enough investment returns to fund their retirement income needs. A prime example of this is the case of Enron employees. Many of those employees had invested large portions of their individual retirement plans solely in Enron stock and they suffered big investment losses when Enron went bankrupt (Benartzi et al. 2007).

The evidence summarized in chapter 2 is that stock market investing can be a substitute for gambling. Furthermore, there is evidence that young single males both gamble and under-diversify their stock portfolios more than others (Hoffmann & Shefrin 2008; Kumar 2009; Kausar et al. 2013). Accordingly, investors might under-diversify for the same reason that they gamble; that is, to have a chance of obtaining a very large gain (Bali et al. 2011; Dorn et al. 2012; Kumar 2009). This is consistent with the evolutionary psychology

rationale for young single males increasing their risk-taking; that is they do so to more quickly acquire resources and status, with the ultimate goal of increasing the chances of obtaining mating opportunities (Daly & Wilson 2001). The theory is supported by evolutionary psychology experiments which show that males (but not females) for whom mate-seeking is made salient tend to choose riskier financial lotteries than males for whom mate-seeking is not as salient (e.g. Baker & Maner 2008).

As far as I am aware, however, there are no reported experiments in evolutionary psychology or in other disciplines testing whether mate-seeking salience also causes males to increase their risk-taking by under-diversifying more.[1] Since, under finance theory, an individual investor's level of under-diversification is a much bigger concern than the amount of risk that the individual takes, this is a significant gap in the literature.[2] I designed an experiment to fill that gap. It tests the hypothesis that males for whom mate-seeking is made salient under-diversify their stock portfolios more than males for whom mate-seeking is not as salient.

The experiment was conducted online. Mate-seeking was made salient to those in the treatment condition by having them view photographs of Victoria's Secret models while those in the control condition viewed photographs of colourful butterflies. After viewing the photographs, all subjects were to allocate a hypothetical $10,000 endowment among a riskless asset and risky assets.

The results of the experiment support my main hypothesis. Subjects in the treatment condition under-diversified more than those in the control group and the effect was statistically significant. The difference was equivalent to moving from a risky portfolio that is equally invested in three risky stocks to one in which 20% is invested in one stock and 40% is invested in each of the other two stocks. The result is robust to sets of control variables.

In addition to my main hypothesis, I also tested secondary hypotheses relating to diversification decisions of single males versus attached males. I hypothesized that in the control condition of the experiment, single males would under-diversify their risky portfolios more than attached males because mate-seeking would be more salient to them. While I find that single males in the control condition did under-diversify more than attached males, the

[1] Although experiments have been conducted to test whether individuals change their level of diversification when mortality is made (White et al. 2013)

[2] The distinction between the concept of the amount of risk that an investor takes on and the level of diversification is discussed in section 2 of chapter 2.

difference was not statistically significantly. However, using a different measure of under-diversification (diversification of the entire portfolio), I find that single males in the control condition under-diversify statistically significantly more than attached males in the control condition.

Finally, I hypothesized that the mate-seeking prime would have a greater impact on the diversification decisions of attached males than the diversification decisions of single males. I base this hypothesis on the supposition that mate-seeking was more salient to single males than to attached males prior to them viewing the Victoria's Secret photographs. Therefore, the mate-seeking prime would have comparatively less effect on single males than on attached males. I find that the treatment had a large effect on the diversification decisions of attached males, but had no statistically significant effect on the decisions of single males. The difference in under-diversification for attached males is also economically significant — equivalent to moving from a balanced risky portfolio to one in which 15% is invested in one stock and 42.5% is invested in each of the other two stocks. On the other hand, single males in the treatment condition under-diversified to the same degree as single males in the control condition. These results were robust to a set of control variables and to different measures of under-diversification.

In section 2, I summarize the research from finance on who under-diversifies and the research from evolutionary psychology which shows that the manner in which an individual invests may be affected by which evolutionarily significant state of mind that the investor is in. In section 3, I describe the experiment in detail. The results of the experiment are set out in section 4 and discussed in section 5. Implications of the experimental results for the regulation of individual pension plans are discussed in section 6. Section 7 presents my conclusions and directions for further research.

2. An Evolutionary Psychology Explanation for Under-diversification

2.1. Finance Evidence of Heterogeneous Risk Aversion and Diversification Levels

Broadly speaking, there are two decisions that an investor makes that impact the riskiness of his or her investment portfolio. Firstly, the investor must decide what share of his or her funds to invest in risky assets, such as stocks, and what share to keep in risk-free assets, such as savings accounts. People diverge widely from one another in the share of their funds that they allocate to risky assets (even in their retirement plans), with single males

allocating more to stocks than others (e.g. Sunden & Surette 1998). Economists' standard reason for this heterogeneity is that people simply have heterogeneous risk preferences, which are thought to be immutable (Markowitz 1952a; Sharpe 1964).[3] Accordingly, finance scholars and economists generally do not theorize that there is an optimal share of an investment portfolio that ought to be allocated to risky assets.

The second decision that an investor must make relating to the riskiness of his or her investments is how well to diversify the risky portion of the portfolio. Regarding this decision, economists and finance scholars assume that investors like expected return on their investments (i.e. more expected return is always better), but that they dislike variance in those expected returns. With those assumption in place, an investor maximizes his or her risk-adjusted returns by investing in as diversified a portfolio as possible (Markowitz 1952a; Sharpe 1964). An investor who under-diversifies his or her portfolio without being compensated by an increase in expected return is taking unnecessary risk. In traditional economics and finance models, no investor would do this.

However, as discussed in chapter 2, empirical evidence from finance is that a large proportion of individuals greatly under-diversify their stock portfolios. There is also evidence that individuals under-diversify their retirement accounts even more than their non-retirement accounts (Goetzmann & Kumar 2008). This is a cause for concern because many studies have shown that under-diversification negatively affects stock market returns (e.g. Calvet et al. 2007). For that reason, the measures of riskiness that this paper will focus on are those that relate to under-diversification rather than those that relate to the share of funds invested in risky assets.

Studies using actual brokerage account data find that young single males under-diversify their stock portfolios more than married males and that males in general under-diversify more than females (Kumar 2009; Dorn & Huberman 2005; Anderson 2013; Hoffmann & Shefrin 2008; Kausar et al. 2013). The evidence is that they under-diversify for the same reason that they gamble; that is, they do so in order to have a chance of a very large gain (Bali et al. 2011; Dorn et al. 2014; Kumar 2009). To accomplish this, they buy stocks that have the attributes of lottery tickets; that is, stocks which have a low price, a small

[3] Recently, finance scholars and experimental economists have started to work on determining the source of this heterogeneity in risk preferences. There is growing evidence that some of the variance in risk preferences between individuals can be explained by the innate attributes of investors. For example, using actual account data, finance scholars have shown that IQ regulates both stock market participation and portfolio diversification (Grinblatt et al. 2011).

chance of a very large gain and a large chance of a loss (Bali et al. 2011). They under-diversify because holding a diversified portfolio would blunt the odds of getting the very large gain. However, for two reasons, this strategy of under-diversifying and holding lottery-type stocks is costly. Firstly, under-diversification results in the investor being subject to risk for which he or she is not compensated. Secondly, the expected return on lottery-type stocks is lower than the expected return on non-lottery-type stocks (Bali et al. 2011; Kausar et al. 2013).

2.2. Evolutionary Psychology

There is a substantial amount of evidence in economics (Charness & Gneezy 2012) and in evolutionary psychology (Baker & Maner 2008) that males and females differ in their risk-taking preferences, with males generally taking more risk than females. Evolutionary psychologists theorize that biological differences in child bearing costs is one of the reasons that males are, in general, more risk-taking than females (Trivers 1972; Gangestad & Simpson 2000; Buss 1989). The minimum investment that a man must make in order to father a child is very small – some search costs, and a short period of copulation. While for a female, the cost of bearing a child is very high – 9 months of gestation followed by a period of lactation. In the time that it takes a woman to bear one child, a man could in theory have fathered hundreds of children. It follows from this that females are the scarce resource (Trivers 1972). Men, especially young single men, would be expected to compete amongst each other and take risks in order to secure mating rights. (Daly & Wilson 2001). In the words of Daly & Wilson, "*Young men are . . . especially risk-prone because they constitute the demographic class on which there was the most intense selection for confrontational competitive capabilities among our ancestors . . . [and]. . . . young men constitute the demographic class specialized by a history of selection for maximal competitive effort* (Daly & Wilson 1990, pp.94–95)."

It follows from that discussion that when mate-seeking becomes more salient, males would be expected to take more financial risk. For example, if the ratio of males to females in an environment is high, males in that environment would be expected to take more financial risk than in an environment where the ratio of males to females is low. In the former environment, a slow and steady approach to resource acquisition might lead to not finding a mate. There is evidence that males do take greater financial risk in cities where the male-female sex ratio is high (Griskevicius et al. 2012).

Evolutionary psychologists have conducted experiments to test whether people's financial risk-taking behavior changes if they are primed to be in a certain frame of mind. The experiments show that males who are primed to be in a mate-seeking frame of mind (for example, by being shown photographs or videos of attractive females) are more like to choose the riskier of two financial gambles than those in the control groups (e.g. Baker & Maner 2008). They also discount the future more than males who have not been so primed (Wilson & Daly 2004; Kim & Zauberman 2013). The theory is that males take additional risk when in mate-seeking mode to more quickly acquire resources, which may make them more attractive to females. It assumes that a male who does not take this additional risk will have insufficient resources to attract a mate. Therefore, taking a risk and losing leaves them in the same position in regards to mating opportunities than if they did not take that additional risk at all.

In a recent experiment, heterosexual men chose the riskier of two lotteries when they were shown photographs of attractive males (Chan 2015). The hypothesized reason for this result is that when males see attractive men, they are motivated to compensate for their relative physical unattractiveness by taking financial risks to obtain resources with which they may attract a mate (Chan 2015, p.408). Males who are primed to compete for status with other males also chose the riskier of two lotteries in an experimental task (Ermer et al. 2008; Hill & Buss 2010). Another experiment showed that both males and females who are led to believe that they are at a competitive disadvantage with respect to their peers were more likely to choose the riskier of lotteries that each had the same expected return (Mishra et al. 2014).

I suggest that the evolutionary psychology theory and evidence summarized above would apply equally to under-diversification. Having an under-diversified portfolio provides a greater chance of earning a large gain than having a well-diversified portfolio. Accordingly, males who are primed to be in a mate-seeking frame of mind would be expected to under-diversify more.

2.3. Application of Evolutionary Psychology to Finance

Investing in financial markets is not something in which our distant ancestors had to engage. Evolutionary psychologists would assert, therefore, that our brains do not have a

module specifically designed to invest in modern financial markets. Thus, we must use modules that evolved to solve other evolutionary important problems, such as acquiring resources or acquiring status. A consequence of this is that we might make different decisions depending on which evolutionarily important problem is most salient at the time that the decision is made (Kenrick et al. 2009, p.765). This is borne out by the results of the evolutionary psychology experiments summarized above in which subjects took greater or less financial risk depending on which frame of mind they were in.

In a recent paper, Cronqvist and Siegel found that the portion of the difference in stock market behavior between identical twins that could not be explained by genetics did not result from the shared experience or environment of the twins (Cronqvist & Siegel 2014). Rather, it was their individual idiosyncratic experiences that shaped the non-genetic component of their investment behavior, not their upbringing (Cronqvist & Siegel 2014). This finding is consistent with an evolutionary psychology explanation for why investors differ in their risk preferences. Investors who are in a specific frame of mind or who have had specific life experiences will invest differently from those who are in a different frame of mind or who have had different life experiences.

If a person's financial investment decision can be easily influenced by the specific frame of mind they are in when they take that decision, it casts doubt on the prevailing view that financial education will help people make better decisions (Willis 2011). The fact that an individual makes an investment decision based on the frame of mind he or she is in might be a particular problem when it comes to individual retirement saving plans, since people tend to change their investments in these plans very infrequently (Mitchell et al. 2006).

3. The Experiment

3.1. Hypotheses

Building on the evolutionary psychology literature, I designed and conducted an experiment to test whether males under-diversify a hypothetical investment portfolio more when mate-seeking is made salient to them.

The main hypothesis that the experiment tests is:

Hypothesis 1: Males will under-diversify their portfolios more when primed to be in a mate-seeking frame of mind.

The hypothesis is based on the evolutionary psychology theory that a person's risk-taking behavior depends in part on which evolutionarily important domain is most relevant to that person at the time he or she is making that decision (Kenrick et al. 2009; Li et al. 2012). For example, subjects for whom mate-seeking is made salient take greater risk than those for whom self-protection is made salient (Li et al. 2012). Experiments conducted by evolutionary psychologists support the hypothesis that males for whom mate seeking has been made salient take greater risk to both signal their mate quality and to quickly acquire resources that may help them attract a mate (Baker & Maner 2008; Baker & Maner 2009; Wilson & Daly 2004; Chan 2015; Ermer et al. 2008). Hypothesis 1 follows from this evolutionary psychology theory; that is, male investors for whom mate-seeking has been made salient will under-diversify their portfolios to have a greater chance of quickly increasing their resources, which makes them more attractive to females.

The experiment also tests the following two hypotheses:

Hypothesis 2: In the control condition, single males will under-diversify more than attached males.

Hypothesis 3: The mate-seeking prime will have a greater effect on attached males than on single males. That is, attached males in the treatment condition will under-diversify more relative to attached males in the control condition than will single males in the treatment condition relative to single males in the control condition.

Hypothesis 2 is based on the finance evidence that single males (who are more likely to be in mate-seeking mode) under-diversify more than married males (Kumar 2009). Hypothesis 3 is the flip-side of hypothesis 2. Since single males are more likely to be in a mate-seeking frame of mind than attached males, the mate-seeking prime should not have as great an effect on singles males as it would on attached males.

The experiment also tests whether those for whom mate-seeking has been made salient (i) increase the amount that they invest in risky assets or (ii) decrease the amount that they would accept today rather than wait one year for their investments to mature.

3.2. Description of the experiment

Experiments in evolutionary psychology that test whether subjects take greater financial risk when mate-seeking is made salient generally use both male and female subjects. They prime both genders to be in mate-seeking mode and compare their behavior to the behavior of male and female subjects, respectively, in the control condition. A common method for making mate-seeking salient in these experiments is to show subjects photographs of attractive members of the opposite sex (e.g. Baker & Maner 2009). A potential problem with this method of priming is that males and females may react differently to photographs of members of the opposite sex. For example, males are more easily stimulated than females by erotic images (Sabatinelli et al. 2004). In addition, it may be difficult to ensure that the degree of attractiveness of the males and females in the photographs is the same. To avoid these potential problems, I limited participation in the experiment to male subjects and, accordingly, I do not test whether males behave differently than females.

I recruited a sample of 202 subjects through an online experiment platform, Prolific Academic ("Prolific"), over two sessions. The experiment itself was programmed using online software offered by Qualtrics (Qualtrics, Provo, UT). Conducting experiments through online platforms is becoming more common in the social sciences. They provide access to a more demographically diverse subject pool than university social science laboratories and the data quality compares well to data obtained using university laboratories (Buhrmester et al. 2011; Peer et al. 2017).

A recent study compared Prolific to other online experiment platforms (Peer et al. 2017). Prolific compared well to Amazon Mechanical Turk along a number of dimensions "including response rates, attention, dishonesty, reliability and the replicability of existing research findings" (Peer et al. 2017). An additional advantage of using Prolific over other platforms is that Prolific makes it possible to limit participation in an experiment to subjects who meet very precise demographic or other criteria. I specified that, to be eligible to participate in the present study, subjects had to be male, heterosexual, have some investment experience,[4] live in the U.K., Ireland, the U.S. or Canada, have English as a first language and have at least a 90% approval rating on Prolific.

I limited participation to subjects who stated that they had at least some investment experience because it strengthened the quality of the sample. Those with investing experience

[4]The exact wording of the investment criteria question in Prolific is "Have you ever made investments (either personal or through your employment) in the common stock or shares of a company?"

are more likely to better understand the benefits and drawbacks of portfolio diversification, and would therefore make better decisions. In addition, those with experience would be more likely to understand the investment task that they had to perform. In particular, in an online experiment, it is not practical to answer questions that subjects might have on the instructions (as once could easily do in a laboratory experiment). Subjects who have investment experience would be less likely to need additional instructions.

I conducted the first session in the afternoon of March 16, 2017. For that session, I did not limit participation to those having a specific relationship status. A total of 142 subjects participated in that session, all of whom were male. Based on the answers to a question asked during the experiment, 103 of them were in a romantic relationship and only 39 were single at the time of the experiment. To have more balance between singles and those who were in a romantic relationship, I conducted a second session in the afternoon of March 23, 2017 in which 60 male subjects participated. The eligibility requirements for this second session were identical to those in the first session, except that there were two additional conditions, namely that participants must not have taken part in the first session and they must have indicated that they were single at the time that they registered for Prolific. Note, however, that 2 subjects who participated in the second session indicated during the experiment that they were in a romantic relationship. It is possible that their relationship status changed between the time that they registered for Prolific and the date of the second session.

Subjects who reported being in a romantic relationship were 4 years older than those who reported being single. In addition, they were better educated, much more likely to have children and reported feeling more comfortable investing than subjects who reported being single. Table A.1 (in the appendix to this chapter) lists the demographic characteristics of single versus romantically attached subjects.

Subjects were paid a flat fee of £1.50 for participating in the experiment. The experiment was not incentivized – the investment task described below was based on a hypothetical fact situation. However, risky decisions made in hypothetical situations have been shown to be comparable to the decision made when payoffs are low (Holt & Laury 2002).[5]

Prior to starting the experiment, subjects were instructed that the experiment would involve rating how much they liked a series of 15 photographs.[6] They were told that, after rating the photographs, they would answer two questions based on a hypothetical fact situation, and then be required to answer several personal and demographic questions. To start the experiment, subjects clicked on a box to signify that they understood the instructions and to consent to participate in the experiment. Those who consented were told that the experiment would take about 15 minutes and that the experiment had one or more check questions which, if they answered incorrectly, would terminate their participation in the experiment without payment.

Subjects who consented to participate in the experiment were randomly assigned to be in either the treatment or in the control condition. Those in the treatment condition were shown photographs of Victoria's Secret models[7] and were required to rate how much they liked each photograph on a scale of one to ten. Those in the control condition were shown photographs of colourful butterflies and were required to rate them using the same scale as in the treatment condition. In each condition, the order in which the photographs appeared was randomized.

After they finished rating the photographs, subjects proceeded to perform a hypothetical stock investment task. The task is adapted from the Investment Game, designed by (Gneezy & Potters 1997) which has been used in at least one evolutionary psychology experiment (Apicella et al. 2008). In the original Investment Game, subjects allocated an endowment between two lotteries - one that had a 100% chance of paying the amount allocated and the other that had a 2/3rd chance of paying a profit of 2.5 times the amount allocated and a 1/3rd chance of losing the full amount allocated. I adapted the Investment

[5] In that study, in the low payout treatment, all prizes were below $4.00. Risk aversion levels of participants increased sharply only when payouts were scaled up by 20 or more times.

[6] In both the treatment condition and the control condition, subjects were shown 15 randomly selected photographs out of a pool of 20 photographs.

[7] Priming with photographs of Victoria's Secret models was recently conducted in (Chan 2015; Kim & Zauberman 2013).

Game to mimic a choice between one riskless asset and three assets each of which has a 20% expected return and the returns on which are independent of one another. This set-up allowed me to measure risk along two dimensions; how much subjects allocated to risky assets, and the degree to which subjects under-diversified their investment in risky assets. My measure of diversification was based of the variance of the portfolio of risky assets, calculated as follow:

$$Var(X) = (\sum_{i=1}^{6} x_i^2\, p_i) - \mu^2, \text{ where}$$

x_i= is the expected return on outcome *i* of the risky portfolio,
p_i = is the probability of outcome x_i, and
μ = is the expected return of the risky portfolio.

In my version of the Investment Game, subjects were told to imagine that someone had died and left them $10,000 but that, under the terms of the will, they had to invest the $10,000 in one or more of 3 stocks in whatever proportion they wished.[8] They were told that the future value of one stock was independent of the future value of either of the other stocks. They were also told that they had to keep the funds invested for one year, after which they would receive the value of the investment and could then spend it as they see fit. The stocks (and the payout possibilities) from which they could choose are set out below:

Stock	Payout Possibilities
Stock Epsilon:	a 100% chance of paying $1.00 for every $1.00 invested.
Stock Kappa:	a 50% chance of paying $2.40 for every $1.00 invested, and a 50% chance of paying $0.
Stock Omega:	a 25% chance of paying $2.40 for every $1.00 invested, a 50% chance of paying $1.20 for every $1.00 invested, and a 25% chance of paying $0.

The order in which the stocks were listed was randomized.

The expected return on Stock Epsilon is 0% and the expected return on Stock Kappa and on Stock Omega is 20%. The payout possibilities on Stock Omega were designed to be

[8] The scenario is similar to that used in (Zeelenberg & Beattie 1997).

equal to the payout possibilities of an equal investment in two stocks that have the same payout possibilities as Stock Kappa and for which the outcome of one stock is independent of the outcome of the other. Accordingly, the payout possibilities of Stock Kappa and Stock Omega combined is the same as the payout possibilities of 3 stocks that have a 50% chance of returning $2.40 and a 50% chance of returning $0 for each dollar invested, with the outcome on one stock being independent of the outcome of the others. A subject minimizes the variance of the expected return on his risky portfolio by allocating one-third of his total risky asset allocation to Stock Kappa and two-thirds to Stock Omega. He maximizes the variance of the expected return on his risky portfolio by allocating the full amount of his total risky asset allocation to Stock Kappa.

After choosing their stock allocations, subjects were taken to a screen in which they were required to state how much they would accept today for the portfolio they had chosen in the previous screen. This task was intended to test whether time preferences were impacted by the mate-seeking prime, as in (Wilson & Daly 2004).

In the next screen, subjects completed the International Positive and Negative Affect Schedule Short-Form (I-PANAS-SF) (Thompson 2007).[9] The reason for including the I-PANAS-SF is that mood has been shown to be associated with risk-taking and time preferences (Drichoutis & Nayga 2013; Yuen & Lee 2003). It is possible that viewing the photographs in the treatment condition affects subjects' mood differently than viewing photographs in the control condition. The I-PANAS-SF should provide some evidence as to whether those who viewed the treatment condition photographs put subjects in a better mood than those in the control condition.

Subjects were then required to provide demographic information (gender, age, sexual preference, education). Subjects were also asked whether they were currently in a romantic relationship. If they said yes, they were asked about the strength of their relationship, using the *Inclusion of the Other in the Self* (IOS) Scale (Aron et al. 1992; and used in Frankenhuis & Karremans 2012). The IOS gives a visual representation of how close the subject feels to his romantic partner. There are seven sets of two circles on the screen, one circle representing the subject and the other representing his romantic partner. In the first set, the circles do not

[9] The I-PANAS-SF consists of 10 words representing negative and positive feelings. For each word, subjects were asked to report on a 5-point Likert scale to what extent they currently felt that feeling. For purposes of the analysis in this chapter, "mood" is the difference between the sum of the extent of the positive feelings less the sum of the extent of the negative feelings.

overlap. In each subsequent set, the circles overlap more than in the previous set. The subject must choose the set of circles that best represents his sense of closeness to his partner.

Subjects were also asked to report on a 3-point Likert scale how much experience they had in buying stock on a stock market (1 for no experience; 3 for very experienced). They were also asked to report on a 7-point Likert scale how comfortable they were in making financial investment decisions (1 for low comfort; 7 for high comfort). Finally, subjects were asked about their childhood socio-economic standing[10], as this has been shown to be correlated with investment styles in later life (Cronqvist et al. 2015).

4. Results

The pool of 202 subjects were randomly allocated to the treatment condition or to the control condition – 105 were allocated to the control condition and 97 were allocated to the treatment condition.

Panel A of Table 1 below shows the means and standard deviations of certain personal characteristics of the subjects, both in the full sample and in the control and treatment conditions. The age, education, percentage who were single, percentage who were married, childhood socio-economic status and investment experience of those in the treatment condition are very similar to those in the control condition.[11] However, using a two sample t-test, those in the control condition are statistically significantly more likely to have children than those in the treatment group (p-value = 0.0342). Other than that characteristic, the means of the personal characteristics of those in the treatment condition did not differ significantly from the means of those in the control condition.

[10] Subjects were asked how strongly they agreed with 3 questions regarding their socio-economic status when they were children, on 7-point Likert scale (Griskevicius et al. 2011), with 7 representing high socio-economic status. The Childhood ses variable that I use is the sum of the answers to the three questions.

[11] Education was coded from 1 to 7: 1 representing the lowest level of education (some high school) and 7 the highest (doctorate).

Table 1: Mean and Standard Deviation of (A) Subjects' Personal Characteristics and (B) Variables Potentially Affected by the Treatment

Panel A: Subjects' personal characteristics	*n*	Full Sample Mean (s.d.)	*n*	Control Group Mean (s.d.)	*n*	Treatment Group Mean (s.d.)
Age	202	37 (12.59)	105	36 (12.18)	97	37 (13.07)
Education (scale of 1 to 7)	202	3.8 (.97)	105	3.8 (1.02)	97	3.8 (.93)
Childhood ses (scale of 3 to 21)	202	11.5 (4.46)	105	11.7 (4.02)	97	11.2 (4.91)
Percentage single	202	42%	105	39%	97	44%
Percentage married	202	25%	105	27%	97	23%
Percentage have children[12]	190	43%	98	49%	92	36%
Investment experience (scale of 1 to 3)	202	1.87 (.6)	105	1.90 (.63)	97	1.84 (.57)
Panel B: Variables potentially affected by the treatment	*n*	Full Sample Mean (s.d.)	*n*	Control Group Mean (s.d.)	*n*	Treatment Group Mean (s.d.)
Current mood	202	7.39 (3.94)	105	7.44 (3.78)	97	7.34 (4.13)
Average photo rating (scale of 1 to 10)	202	6.76 (1.49)	105	5.98 (1.20)	97	7.60 (1.31)
Investment comfort (scale of 1 to 7)	202	5.08 (1.45)	105	4.95 (1.54)	97	5.23 (1.34)
Excess variance of risky portfolio	183	0.27 (.28)	95	0.23 (.24)	89	0.31 (.30)
Percent allocated to risky assets	202	56% (.32)	105	54% (.32)	97	58% (.31)

Panel B of Table 1 lists the variables that could possibly be affected by the mate-seeking prime. While those in the treatment condition rated the photographs higher than those in the control condition, self-reported mood of subjects in the treatment condition was the same as the mood of those in the control condition. There was no significant difference between the investment comfort of those in the treatment condition versus those in the control condition. I define excess variance as the difference between the log variance of a subject's risky portfolio and the log of the minimum possible variance of the risky portfolio, normalized to a $1 investment in risky assets. Percent allocated to risky assets is the percentage of the $10,000 hypothetical endowment the subject allocated to risky assets. As expected, both the excess variance and the percent allocated to risky assets was greater for subjects in the treatment condition than for those in the control condition.

[12] 12 participants declined to answer the question as to whether they have children.

I then ran OLS regressions to determine which, if any, of the variables listed in Table 1 were correlated with (i) the excess variance of a subject's risky portfolio or (ii) the share that a subject allocated to risky assets. For this purpose, I split the data into the control condition and the treatment condition. The results are summarized in Table 2 below. I primarily used this information to determine which, if any, of these variables might be used as control variables in multiple regressions to determine whether there is a treatment effect.

Table 2: OLS Regression Results of (A) Excess Variance and (B) Risky Asset Share on Individual Characteristics (p-values in brackets)

	(A) Excess Variance		**(B) Risky Asset Share**	
	Control Group	Treatment Group	Control Group	Treatment Group
Single	0.056 (.307)	-0.048 (.505)	0.070 (.313)	-0.020 (.768)
Age	-0.001 (.717)	0.003 (.267)	-0.003 (.241)	0.000 (.869)
Education	0.047* (.073)	-0.008 (.844)	0.007 (.828)	0.046 (.21)
Childhood ses	0.006 (.336)	-0.006 (.446)	0.003 (.732)	0.016 (.022)
Investment experience	-0.110** (.026)	0.010 (.898)	0.107* (.085)	0.004 (.959)
Rating	0.016 (.488)	0.005 (.851)	-0.048* (.098)	0.008 (.764)
Mood	-0.004 (.611)	0.002 (.803)	0.004 (.652)	-0.011 (.229)
Investment comfort	0.030 (.151)	0.013 (.689)	-0.011 (.67)	0.009 (.765)
Intercept	-0.022 (.919)	0.167 (.585)	0.683 (.016)	0.180 (.495)
n	*94*	*89*	*105*	*97*
R-squared	0.1128	0.0523	0.0749	0.1073

*statistical significance: 10% level; **statistical significance: 5% level; ***statistical significance: 1% level

The evidence from finance studies is that single males allocate more to risky assets and under-diversify more males than married males. While, in the experiment, the excess variance and risky asset share are higher for single males in the control condition than for attached males in the control condition, the differences are not statistically significant. I also ran regressions of excess variance and risky asset share on single, and the results are very similar to the results when single was included in the multiple regression reported in Table 2.

One difference, of course is that I am comparing single males to those in a romantic relationship, while the finance studies compared single males to married males.[13]

Previous studies have shown that the propensity of an individual to take financial risk is correlated with the individual's age and his childhood ses (Jianakoplos & Bernasek 2006; Griskevicius et al. 2011). As well, an individual's mood has been shown to affect financial risk taking (Drichoutis & Nayga 2013). However, none of these three variables are correlated with excess variance or risky asset share, either in the control condition or in the treatment condition. In addition, how well subjects rated the photographs had no effect on excess variance or on risky asset share, either in the control condition or in the treatment condition.

In the control condition, more educated subjects under-diversified more, and those with more investment experience under-diversified less. Both of those results are statistically significant. The results are consistent with the empirical finance literature that show that more experienced investors allocate more to risky assets and under-diversify less, but that more educated investors under-diversify more (Goetzmann & Kumar 2008). However, in the treatment condition, education and investment experience ceases to explain any of the variance in the level of diversification.

I next ran the main OLS regressions to determine whether subjects in the treatment condition under-diversified more than those in the control condition. The results of these regressions are reported in Table 3. The results reported in column (1) are of a regression of excess variance on a dummy variable for treatment,[14] with no control variables. The regression reported in column (2) includes as independent variables the treatment dummy, a single dummy (1 if the subject was single, 0 otherwise) and an interactive term of single times treatment, to test whether the treatment differentially affects subjects who are single.

The regressions reported in columns (3) and (4) have the independent variables used in column (2) but also control for certain variables. The regression reported in column (3) uses as controls the variable for which the mean in the control group differed from the mean in the treatment condition (i.e. having children) and for the two variables that were statistically significant in the regression reported in Table 2 (education and investment experience). The regression reported in column (4) uses the variables from column (2) and controls for all the personal characteristics on which I collected data.

[13] Those studies all used brokerage account data. That data listed marital status but likely did not include data on relationship status.
[14] 1 if the subject was in the treatment and 0 otherwise.

Table 3: OLS Regression Results of Excess Variance of the Risky Portfolio on Treatment and Individual Characteristics (p-values in brackets)

	(1) All	(2) All	(3) All	(4) All
Treatment	0.076*	0.124**	0.150***	0.140**
	(.064)	(.02)	(.008)	(.014)
Single		0.053	0.086	0.085
		(.363)	(.184)	(.195)
Single*treatment		-0.118	-0.146*	-0.142*
		(.157)	(.089)	(.102)
Age				0.002
				(.242)
Education			0.016	0.017
			(.459)	(.434)
Childhood ses				-0.002
				(.759)
Investment experience			-0.038	-0.047
			(.302)	(.224)
Have children			-0.007	-0.028
			(.889)	(.599)
Intercept	0.230	0.211	0.196	0.160
	(.175)	(.)	(.093)	(.236)
n	*183*	*183*	*171*	*171*
R-squared	0.0188	0.0298	0.0246	0.0685

*statistical significance: 10% level; **statistical significance: 5% level; ***statistical significance: 1% level

The purpose of the regression summarized in table 3 is to test what effect the treatment condition had on the diversification of risky portfolios. However, 19 subjects only invested in the safe stock, Stock Epsilon which, by design, has a variance in return (and an Excess Variance) of zero. Accordingly, subjects who invested only in Stock Epsilon are not included in the regression summarized in table 3. Hence, in columns (1) and (2), there are 183 reported observations out of the 202 subjects.[15] As well, note that the number of observations in columns (3) and (4) is lower than in columns (1) and (2) because I obtained data on whether subjects have children from the information that subjects provided to Prolific when they registered, and some individuals did not provide data on whether they had children.

[15] See section 4.1 for the results of a regression using a variable, variance_full, of the entire portfolio.

The treatment had a statistically significant effect on the degree of diversification for the sample as a whole. In specification (1), which used no control variables, the excess variance was 0.076 higher than in the control group (p-value = 0.064). The results do not change significantly in (unreported) regressions without the interactive term in which control variables are added to the regression. As an additional check for statistical significance, I ran a nonparametric test, the Wilcoxon signed-rank test. The p-value from that test was 0.0654, almost identical to that of the OLS regression reported in column (1). Accordingly, the results support Hypothesis 1.

Because of the addition of the interactive term, "single*treatment", the variable "single" includes only single males in the control group. The coefficient in each of columns (2), (3) and (4) are positive, which means that single males in the control condition under-diversify more than attached males in the control condition. However, in none of those specifications is the result significant, and the results do not support Hypothesis 2.

The regressions reported in columns (2), (3) and (4) indicate that the treatment effect is driven solely by attached males. For example, in the regression reported in column (2), the excess variance for attached males in the treatment condition is 0.124 higher than for attached males in the control condition (0.335 in the treatment condition versus 0.211 in the control treatment), and the difference is statistically significant (p = 0.02). However, the excess variance for single males in the treatment group differs only slightly from that of single males in the control condition, and the difference is not statistically significant.[16] Accordingly, the results support Hypothesis 3.

I then ran OLS regressions to see whether the treatment condition had any effect on the share that subjects allocated to risky assets. The results of these regressions are reported in Table 4. The regression reported in column (1) regresses the share allocated to risky assets on a dummy variable for treatment, with no control variables. The regression reported in column (2) uses the treatment dummy, a single dummy and an interactive term of single times treatment, to test whether the treatment differentially affected subjects who were single. The regressions reported in column (3) has the independent variables used in column (2) but also controls for the personal characteristics on which I collected data.

[16] The excess variance for single males in the control condition is 0.264 and the excess variance for single males in the treatment condition is 0.270.

Table 4: OLS Regression Results of Share Allocated to Risky Assets on Treatment and Individual Characteristics (p-values in brackets)

	(1) All	(2) All	(3) All
Treatment	0.032 (.477)	0.064 (.279)	0.085 (.175)
Single		.057 (.376)	0.069 (.333)
Single*treatment		-0.79 (.386)	-0.109 (0.256)
Age			-0.002 (.429)
Education			0.026 (.274)
Childhood ses			0.012** (0.026)
Investment experience			0.056 (.170)
Have children			-0.002 (.968)
Intercept	0.545 (.000)	0.523 (.000)	0.229 (.128)
n	*202*	*202*	*190*
R-squared	0.0025	0.0071	0.1362

*statistical significance: 10% level; **statistical significance: 5% level; ***statistical significance: 1% level

The treatment condition did not have a statistically significant effect on how much subjects allocated to risky assets. As well, the regressions in columns (2) and (3) showed no differential treatment effect for single males versus attached males.

I also ran regressions to determine whether subjects in the treatment condition differed in the amount they would accept today rather than to wait one year for their investments to mature. In none of the regressions was the treatment coefficient statistically significant. The regressions are reported in Table A.2 of Appendix A.

4.1. Robustness Checks

The results are robust to other measures of diversification. I created a variable, variance_full, to describe the variance of the entire portfolio of a subject (both the risky and

the riskless portion of the portfolio). This variable increases in value both in the share allocated to the risky portfolio and in the under-diversification of the risky portfolio. Accordingly, it captures both how much a subject allocates to risky assets and how much he under-diversifies his risky portfolio. The regressions for which variance_full is the dependent variable are reported in Table A.3 of Appendix A. I found no treatment effect when variance_full was regressed solely on the treatment dummy (column 1) or on the treatment dummy, the single dummy and the treatment-single interactive term (column 2). However, adding control variables (columns 3 and 4) shows that variance_full is higher for attached males in the treatment group than for attached males in the control group. The regression reported in column 3 also show that variance_full for single males in the control condition is significantly higher than for attached males in the control condition. This latter result lends some support for the hypothesis that single males under-diversify more than attached males in the control condition.

The other measure of diversification that I used was the amount invested in Stock Kappa (the more variable of the two risky stocks) as a percentage of the total amount invested in risky stocks (the "Kappa Share"). There was no treatment effect for the sample as a whole when I regressed Kappa share on the treatment dummy, either with or without controls. However, controlling for single and adding the treatment-single interactive term reveals that attached males in the treatment condition increase their Kappa Share by 10.4% over attached males in the control condition. The results are similar when control variables are added. The Kappa Share of single males in the treatment condition is not significantly different from the Kappa Share of single male in the control group, whether or not control variables are used. The regressions for which Kappa Share is the dependent variable are reported in Table A.4 in Appendix A.

As described in section 3.2, those subjects who said that they were in a romantic relationship were also required to indicate the strength of their relationship. I regressed excess variance on the treatment dummy and the relationship strength variable. While relationship strength is positively correlated with excess variance, the relationship is not statistically significant. This does not change when control variables are added to the regression. The regressions for which relationship strength is the dependent variable are reported in Table A.5 of Appendix A.

5. Discussion

My main hypothesis is that subjects who viewed the Victoria's Secret models would under-diversify their risky portfolios more than those in the control condition. The results of the experiment support this hypothesis. The excess variance of those in the treatment condition was greater than for those in the control condition, and this result is both statistically and economically significant. This result is robust to adding various control variables. It is also robust to using a non-parametric test of significance. Therefore, my main hypothesis (that subjects for whom mate-seeking is made salient under-diversify more than those in the control condition) cannot be rejected.

One clue as to the mechanism by which the mate-seeking prime works is that, in the control condition, investment experience had a statistically significant effect on excess variance, and in the expected direction (see Table 2). That is, those with more investment experience under-diversify less. However, in the treatment condition, the investment experience variable had no effect on excess variance.

To explore this further, I regressed excess variance on a treatment dummy, an investment experience dummy (1 if the subject had some stock market investment experience, 0 otherwise) and an interactive term of treatment times investment experience (see Table A.6 in Appendix A). In the control condition, the excess variance of subjects who had investment experience was 0.152 less than those with no investment experience. This is both economically large and statistically significant (p-value = 0.026). It is also consistent with the empirical finance evidence that shows that more experienced investors under-diversify less (Goetzmann & Kumar 2008). However, in the treatment condition, the excess variance of those with investment experience was not statistically significantly different than for those who had no investment experience. This result may be evidence that when subjects are presented with a mate-seeking prime, they move from deliberative thinking to intuitive thinking (Kahneman 2011).

As discussed in section 3.2, there is evidence that mood regulates financial risk-taking. In at least one experiment testing the impact of mood on risk-taking, positive affect was induced by showing subjects erotic photographs (Knutsen et al. 2008). However, I did not find any difference in self-reported mood between those who viewed the photographs of Victoria's Secret and those who viewed the control photographs. Furthermore, under-diversification was not correlated with mood.

One caveat is that the mood questionnaire (I-PANAS-SF) immediately followed the investment task, so it is possible that the investment task affected subject's moods. To test for this, I regressed subjects' self-reported investment comfort on their mood. Those who reported more investment comfort also scored much higher in the I-PANAS-SF (p-value = 0.000). Accordingly, the investment task may have put those who were not comfortable making investment decisions in a bad mood. However, it might also be that those who report less comfort in things like financial investing are generally in a worse mood than those who are more comfortable. In any event, the fact that mood and investment comfort are highly correlated suggests that subjects gave truthful answers to the mood elicitation questions.

I hypothesized that, in the control condition, single males would under-diversify more than attached males, as single males are more likely to be in mate-seeking mode, even without the priming mechanism. This hypothesis is consistent with the evidence from finance that single males under-diversify more than married males and that they prefer to hold stocks that have a small chance of a very large gain (Kumar 2009). While the excess variance of the portfolios of single males in the control condition was greater than for those of attached males in the control condition, the difference was not statistically significant. However, in a regression using the variance of the full portfolio as the dependent variable and a full set of control variables, single males in the control condition under-diversified more than attached males in the control condition.

The mate-seeking prime had a large effect on the extent to which attached males under-diversified. However, it had no effect on the extent to which single males under-diversified. The excess variance of attached males who had been primed to be in mate-seeking mode was much higher than attached males in the control condition, and the difference was statistically significant. There was virtually no difference in the excess variance of single males in the treatment condition from single males in the control condition. This result was robust to adding control variables.

I suggest that a reason why single males were unaffected by the mate-seeking prime is that mate-seeking was already salient to them, and therefore the mate-seeking prime had no marginal effect. There is evidence from finance that single males under-diversify more than others, and that this is due to a desire to obtain lottery-type returns (Kumar 2009). While in my experiment, the excess variance of the risky portfolio of single males in the control condition was not statistically significant, it was economically large. As well, using the variance of the full portfolio, I found that in the control condition, single males took more

risk than attached males. This lends some support to the argument that single males are already in mate-seeking mode, so that the prime did not put them further into mate-seeking mode.

Perhaps another reason why the mate-seeking prime had no effect on single males is that they view more online pornography than attached males (Malcolm & Naufal 2016), and the relatively tame images of Victoria Secret models had no effect.

The mood of those in the treatment condition was the same as those in the control treatment, and mood was not correlated with measures of financial risk-taking in the multiple regressions. Accordingly, there is no evidence that viewing the Victoria's Secrets models photographs simply put men in a better mood, and that it was this better mood that caused riskier financial decision-making.

In summary, the results support the proposition that the extent to which males under-diversify their stock portfolios is, in part, dependent on the evolutionarily important domain that is relevant to them at the time that they make the decision.

6. Implications for Regulation of Individual Pension Plans

As discussed in the introduction to this chapter, there is a movement away from providing retirement benefits through pooled pension plans to providing them through savings plans that are managed in large part by individual plan-holders. This is occurring despite the evidence that individuals make costly mistakes in managing their plans. A goal of this chapter was to test whether the evolutionary psychology analysis discussed in chapter 2 can contribute to a discussion of why individuals make these mistakes and what the regulatory response ought to be. For example, if investment mistakes are due to the manner in which our brains evolved, then things like investor education and disclosure may not be sufficient to change behavior. More coercive measure might be called for.

The main finding of this chapter is that males for whom mate-seeking is made salient under-diversify more than other males. An implication of this finding is that, if mate-seeking happens to be salient to a male at the time that the joins a retirement savings plan, he may under-diversify his portfolio more than if mate-seeking was not salient to him. So, for example, the performance of a male employee's individual retirement plan might depend on whether the human resources person who helped him set up his plan was an attractive female

rather than a male, or if the employee happened to see a lingerie ad prior to making his asset allocation decision. However, the implications of this research are much broader than whether mate-seeking is salient to a male employee at the time that he joins a plan. If, as evolutionary psychologists suggest, a person's choice of portfolio depends on which evolutionarily important frame of mind he or she is in at the time that making the asset allocation decision, there is a large random element to the variance of the person's retirement savings plan. If a male employee happens to be concerned with mate-seeking, he will choose a less diversified portfolio, but if the person is, say, fearful because of a recent terrorist attack, that person will choose a more diversified portfolio (White et al. 2013).

An evolutionary psychology approach lends additional support for making contributions to retirement plans mandatory and for limiting investment choices for individual retirement savings plans (Bubb & Pildes 2014). This is particularly true since employees tend not to change their initial asset allocation decisions (Mitchell et al. 2006). Accordingly, the state of mind that the employee happens to be in at the time that he makes the initial asset allocation decision may have a large and persistent impact on the performance of his retirement savings plan.

7. Conclusions and Further Research

The results of the experiment that this paper reports support the proposition that males for whom mate-seeking is made salient under-diversify more in a simulated investment task than those for whom mate seeking has not been made salient. However, this increased under-diversification is driven by males who are in a romantic relationship. The investment behavior of single males was not affected by the mate-seeking prime. This might well be because single males were in mate-seeking mode before they viewed the priming photographs, and therefore the photographs had no effect on their investment behavior.

Evolutionary psychology theory is that females for whom mate-seeking is made salient will not increase their financial risk-taking, and this has support in the evolutionary psychology experimental literature (Baker & Maner 2009). Additional research would include running an experiment similar to the one reported in this paper, but using female subjects. If females did not under-diversify more when mate-seeking is made salient, this would lend additional support for the conclusion that financial diversification of an individual

depends on which evolutionarily important domain is relevant to the individual at the time that the decision is made.

Another area for additional research would be to make other evolutionarily important domains relevant to subjects to see if their investment behavior changes in the direction predicted by evolutionary psychologists. For example, evolutionary psychology theory and evidence is that both males and females for whom self-preservation is made relevant would take less financial risk (Li et al. 2012).

Appendix

Table A.1: Mean and Standard Deviation of Demographic Characteristics of Single Versus Romantically Attached Subjects

Demographic Characteristic	*n*	Single Mean (s.d.)	*n*	Romantically Attached Mean (s.d.)	Oneway Test of Diff. in Means (p-value)
Age	84	34 (12.57)	118	38 (12.32)	(0.0126)**
Education (scale of 1 to 7)	84	3.69 (0.98)	118	3.93 0.96)	(0.0818)*
Childhood ses (scale of 3 to 21)	84	11.12 (4.75)	118	11.72 (4.24)	(0.3396)
Percentage have children[17]	80	16% (0.37)	110	62% (0.49)	(0.0000)***
Investment Experience (scale of 1 to 3)	84	1.87 (0.64)	118	1.87 (0.58)	(0.9645)
Investment Confidence (scale of 1 to 5)	84	4.83 (1.60)	118	5.27 (1.31)	(0.0380)**
Mood	84	7.04 (4.21)	118	7.64 (3.74)	(0.2808)

*statistical significance: 10% level; **statistical significance: 5% level; ***statistical significance: 1% level

[17] 12 participants declined to answer the question as to whether they have children.

Table A.2: OLS Regression Results of Minimum Amount Accepted for Chosen Portfolio on Treatment and Individual Characteristics (p-values in brackets)

	(1) All	(2) All	(3) All
Treatment	1,345	1,723	1,397
	(.175)	(.187)	(.296)
Single		1,125	997
		(.426)	(.492)
Single*treatment		-988	-445
		(.625)	(.830)
Age			29.62
			(.477)
Education			-204.2
			(.696)
Childhood ses			88.98
			(.447)
Investment experience			-1,571*
			(.075)
Intercept	11,143	10,704	12,413
	(.000)	(.000)	(.000)
n	*202*	*202*	*202*
R-squared	0.0092	0.0124	0.0313

*statistical significance: 10% level

Table A.3: OLS Regression Results of Variance of Full Portfolio on Treatment and Individual Characteristics (p-values in brackets)

	(1) All	(2) All	(3) All	(4) All
Treatment	0.035	0.074	0.096*	0.094*
	(.363)	(.145)	(.062)	(.068)
Single		0.077	0.102*	0.103*
		(.157)	(.063)	(.066)
Single*treatment		-0.097	-0.134*	-0.130
		(0.217)	(.092)	(.105)
Age				-0.000
				(.920)
Education				0.014
				(.486)
Childhood ses			0.0111**	0.004
			(.012)	(.455)
Investment experience			0.023	-0.032
			(0.483)	(.400)
Intercept	0.252	0.222	0.274	0.297
	(.000)	(.000)	(.483)	(.031)
n	*202*	*202*	*202*	*202*
R-squared	0.0041	0.0148	0.0518	0.0543

*statistical significance: 10% level; **statistical significance: 5% level

Table A.4: OLS Regression Results of Kappa Share of the Risky Portfolio on Treatment and Individual Characteristics (p-values in brackets)

	(1) All	(2) All	(3) All	(4) All
Treatment	0.043	0.047	0.104*	0.102*
	(.312)	(.268)	(.057)	(.008)
Single		-0.073*	0.000	-0.007
		(.099)	(.993)	(.909)
Single*treatment			-0.140*	-0.133
			(.100)	(.126)
Age		-0.002		-0.002
		(.282)		(.282)
Education		0.019		0.017
		(.400)		(.443)
Childhood ses		0.003		0.004
		(.551)		(.455)
Investment experience		-0.0400		-0.032
		(.293)		(.400)
Intercept	0.274	0.340	0.274	0.297
	(.000)	(.001)	(.000)	(.031)
n	*183*	*183*	*183*	*183*
R-squared	0.0056	0.0415	0.0298	0.0543

*statistical significance: 10% level

Table A.5: OLS Regression Results of Excess Variance on Treatment and Relationship Strength (p-values in brackets)

	(1) All	(2) All
Treatment	0.134**	0.117**
	(.020)	(.042)
Relationship strength	0.014	0.016
	(.429)	(.365)
Age		0.001
		(.618)
Education		0.044
		(.132)
Childhood ses		-0.009
		(.193)
Investment experience		-0.004
		(.938)
Intercept	0.138	0.030
	(.168)	(.874)
n	*108*	*108*
R-squared	0.0523	0.0891

**statistical significance: 5% level

Table A.6: OLS Regression Results of Treatment, Investment Experience and Interactive Term on Excess Variance (p-values in brackets)

	(1) All
Treatment	-.0864
	(.301)
Investment Experience	-.152
	(.026)
Investment Experience * Treatment	0.211
	(.028)
Intercept	0.348
	(.000)
n	*183*
R-squared	0.0496

Chapter 4: How Regret May Explain Defined Contribution Plan Decision-Making

Abstract

Governments and employers in many countries are moving away from paying fixed pension benefits (so-called DB plans) towards paying pension benefits out of plans that are managed by the individual retirees (so-called DC plans). This is despite the evidence that people make systematic mistakes in managing their DC plans. While the existence of these mistakes is well documented, no overriding theory for why people make these mistakes has yet been put forward. In this chapter, I hypothesize that the evolved trait of regret might partially explain the set of systematic retirement savings mistakes that people have been observed to make. I follow the discussion on that hypothesis with a discussion on the regulatory implications that flow from retirement savings decisions being driven by regret.

1. Introduction

In many countries, responsibility for accumulating and investing retirement savings has shifted from governments and employers to individuals. Although this trend is not yet prevalent in Western Europe, both Germany and Belgium recently introduced legislation that will allow employers to offer defined contribution pension plans (Roessler 2017). This shift to individual responsibility is occurring despite the extensive evidence that people exhibit weak and unstable preferences and make costly mistakes in making virtually all of their retirement savings decisions (Benartzi & Thaler 2007).

For example, one tendency that employees exhibit is a strong reliance on defaults (e.g. asset allocation defaults), even when sticking to these defaults is not in their best interest (Madrian & Shea 2001). Another tendency of individuals is to make the same retirement savings decisions as their peers, resulting in retirement plan portfolios that depend on who the co-workers happen to be (Mugerman et al. 2014). Also, a substantial portion of employees holds a large percentage of their assets in stock of their employer (Benartzi et al. 2007), making them vulnerable to large losses if the employer becomes insolvent. On the other hand, a substantial portion of employees invest all or most of their plan assets in riskless assets, such as money market funds, ensuring that they earn low returns. Furthermore, employees seem willing to pay for active management of their retirement savings despite the fact that actively managed funds are more expensive than index funds and the 40 years of evidence that actively managed funds as a group underperform the market (Bogle 2016). Finally, employees rarely make changes to their original asset allocations, even when doing so would enhance their risk-adjusted returns (Mitchell et al. 2006).

While there is substantial evidence of individuals' poor decision making when it comes to their retirement savings planning, why they do so is not clear. To be sure, explanations have been given for the behavior described above. Behavioral economists have suggested that people rely on defaults because they are implicit advice or that they allow individuals to make pension decisions without having to understand the complexity of the decisions they are making (Benartzi et al. 2007). Status quo bias may also explain reliance on defaults. However, there is a dearth of empirical evidence to support any of these assertions. Explanations for why individuals tend to make the same retirement savings plan

decisions as their peers (including investing in company stock) are also numerous, including compliance with social norms and social learning, and there is evidence to support these explanations (e.g. Bursztyn et al. 2014). However, there is no over-arching explanation in the literature for why individuals might engage in the full range of seemingly anomalous behavior described above. The hypothesis of this chapter is that relying on defaults, making the same decisions as peers and the other behavioral deviations described above may be a way for individuals to cope with the anticipation of regret that they might feel in making retirement savings decisions.

Regret is a negative emotion that is *"uniquely tied to the making of decisions*" and is therefore distinct from disappointment (Martinez et al. 2011). Asserting that regret is a negative emotion, however, does not infer that regret is necessarily a "bad thing". As discussed in section 4.2, regret may be an evolved trait that helps us make better decisions (Zeelenberg et al. 2008). In other words, learning from experience is useful to survival, and a desire to avoid regret helps us to make better decisions.

Two conditions must be present for a person to experience regret over a bad outcome of a decision. Firstly, the person must have felt that he or she had been *responsible* for the decision that resulted in the bad outcome. Secondly, the person must have been able to at least imagine the outcome, the so-called *counterfactual*, that would have occurred if he or she had made an alternative decision (Martinez et al. 2011). There is ample evidence that the mere anticipation of regret induces individuals to fail to make decisions that would have given them a positive expected return (Mellers & Mcgraw 2001; Connolly & Butler 2006).

I suggest that decisions that individuals make regarding their individual retirement savings plans are highly susceptible to anticipated regret. Firstly, when individuals are specifically being asked to make their own contribution and asset allocation decisions, they would feel responsible for how their pension assets perform. Secondly, given that it is very easy to for an individual to determine, *ex post*, whether making different investment decisions would have led to better outcomes, it is very easy for individuals to imagine counterfactuals at the time that they are making an investment decision. As a result, in making decisions regarding their individual pension plans, individuals may very well anticipate the regret they will feel if the decision turns out badly. Accordingly, they may decide in such a way as to reduce the possibility of future regret.

For example, by relying on a default, doing what their peers do or paying for active management of their individual savings plans, individuals may reduce the felt responsibility for their retirement savings decisions. If things go badly, they can blame others. As a result,

this behavior allows them to reduce the anticipated regret they might otherwise feel from making decisions relating to their plans. Furthermore, by making the same decisions as their peers or investing only in safe assets, they are less likely to be aware of the counterfactuals if the outcome of their decisions is bad. This reduced likelihood of becoming aware of the counterfactual also reduces anticipated regret. If, for example, most of an individual's peers invest in a stock fund, the individual will know that he or she is more likely to be aware of the counterfactual if he or she invests in a bond fund and the stock fund subsequently outperforms the bond fund. The good performance of the stock fund will likely be a subject of conversation at the water cooler. To reduce the chances of learning the counterfactual, individuals may invest in the same way as their peers.

This chapter proceeds as follows. In section 2, I describe the historical shift from defined benefits plans to defined contribution plans. In section 3, I summarize the mistakes that individuals have been observed to make in managing their retirement savings plans. Section 4 describes the theory of regret and its role in decision-making under uncertainty or risk. In section 5, I apply regret theory to explain the mistakes summarized in section 3. In section 6, I discuss the implications of my research for the regulation of individual pension plans. Section 7 concludes.

2. Brief History of the Evolution of Employer and Government Pensions

2.1. Employer Pension Plans

Employers in the U.K. have provided pension payments to some employees on an ad hoc basis as far back as the 18th century to reward loyalty and to encourage them to make way for younger employees (Blackburn 2003). However, a U.S. company, American Express is credited with being the first large corporation to provide formal pensions to its employees. That company started providing pensions to a limited number of employees in 1875 (Blackburn 2003). Other large U.S. corporations followed, and by the 1920s, approximately 7.5% of Americans were covered by private pension plans (Blackburn 2003). Employer pension coverage was greatly expanded following World War II. One reason often given for the post-war growth in pensions was that employers used pensions to attract employees because post-war wage controls prohibited them from increasing wages. However, the increase may have had more to do with employee turnover becoming more costly in capital-

intensive industries and with increased unionization (Dobbin 1992). By 1979, more than 35% of employees in the U.S. were covered by employer-provided pensions which paid fixed retirement benefits (Aaronson & Coronado 2005, p.24).

2.2. Government Pension Plans

Over the last few centuries, European monarchs, including Louis XIV, promised pensions to soldiers and to civil servants to obtain their loyalty. These promises were generally personal to the monarch and were provided to only a small percentage of the population (Blackburn 2003, p.34). It was not until 1889 that a universal government-provided pension plan was implemented. In that year, Germany legislated a broad-based pension, under which modest periodic pension payments were payable to any German citizen who attained age 70 (Blackburn 2003, p.45). By the 1950s, governments in all developed and many developing countries were providing at least some level of universal pensions (Blackburn 2003, p.56). In Western European countries, government pensions provide the bulk of retirement income, while in most of the rest of the world, the bulk of retirement income is funded by contributions made by employers and individuals (OECD 2015).

Until the 1980s, both employer-provided pension schemes and government pension schemes almost always paid fixed retirement benefits calculated by reference to criteria such as years of services or final salary at retirement (Brown 2016). These types of plans are referred to in the literature as defined benefit or DB plans. The other main type of pension plan is the defined contribution plan (DC plan). In DC plans, an individual's retirement benefits are paid out of contributions made by or on behalf of the individual and the investment returns on those contributions.

2.3. Shift to DC Plans for Employer-Provided Pensions

Since the 1980s, there has been a dramatic shift in many countries from employers providing benefits through DB plans to providing them through DC plans. (Broadbent et al. 2006; OECD 2016 at p. 20). Among developed countries, this shift has been especially pronounced in the Anglo countries – U.S., Canada, U.K., and Australia. Australian employees are required by law to contribute a specified portion of their earnings to an occupational DC plan, while in the other Anglo countries, participation in DC plans is

voluntary. Nevertheless, far more private sector employees in the U.S., the U.K. and Canada are now covered by DC plans than by DB plan (Broadbent et al. 2006). For example, between 1979 and 1998, in the U.S., the percentage of employees in the private sector covered by DB plans fell from 35.1% to 14% (Aaronson & Coronado 2005, p.24).

This shift to DC plans is likely the result of a confluence of factors. Increased employee mobility makes DC plans relatively more attractive to employees, since DB plans tend to accrue benefits slowly, if at all, in the early years of employment. Secondly, pension regulation has been strengthened to require companies to fully-fund their pensions and more fully report on their pension liabilities, making DB plans costlier to employers. Thirdly, increasing life expectancies and lower real returns on investment have made pension promises more expensive than employers expected when they made those pension promises. Companies have also had to make additional contributions years later to fund past pension promises to account for the higher life expectancies and lower returns. For employers, DC plans have the benefit of certainty – in DC plans, employers make fixed contributions, and avoid the possibility of having to make additional contributions in the future if, for example, life expectancies increase further (Broadbent et al. 2006; Aaronson & Coronado 2005). A study by the U.S. Federal Reserve found that both "employee demand" and "employer supply" were responsible for the shift from DB plans to DC plans (Aaronson & Coronado 2005). Furthermore, technological changes and more robust public financial markets have made it much cheaper than in the past for people to individually invest their retirement savings (Broadbent et al. 2006).

2.4. Government Pensions – Shift to DC Plans

During the same period that employers started the shift to DC plans, many countries fully or partly converted their DB plans to DC plans. In 1982, Chile became the first country to replace its Pay as You Go (PAYG) government pension plan[1] with a mandatory defined contribution plan (Borzutzky & Hyde 2016). Starting in the mid-1980s, pension plans of many developing countries went into financial distress, and the World Bank provided

[1] Essentially, a PAYG plan is a DB plan in which future pension liabilities are not pre-funded. Pension payments to retirees are paid from contributions made by those who are working. Current contributions may exceed or be exceeded by current pension payments.

financial support for the restructuring of those plans.[2] The World Bank's published policy was to advocate for a multi-pillar approach to pension reform. The Bank preferred a small universal PAYG pension pillar and a larger mandatory DC plan pillar, with contributions based on employment earnings. Accordingly, it encouraged countries which it was financially assisting to fully or partially convert their PAYG plan to mandatory DC plans (World Bank 1994; Holzmann & Hinz 2005). Developing countries, such as Mexico, Peru and Argentina, replaced their PAYG government pension plans with the financial assistance of the World Bank (Tapia & Yermo 2007). The World Bank was also instrumental in partly converting the PAYG plans of former Soviet Bloc countries into mandatory DC plans (Holzmann & Hinz 2005; Blackburn 2003). As of 2007, twenty-nine countries have mandatory individual retirement accounts, mostly in Latin America and Central and Eastern Europe (Tapia & Yermo 2007).

Mandatory DC plans are still relatively rare in Western European and other developed countries. Sweden replaced a portion of its PAYG plan with a mandatory DC plan, but the maximum contributions to the DC plan are quite low (OECD 2015, p.352). Denmark also has a mandatory individual occupational pension plan that pays benefits based on the amount of contributions and an imputed return on those contributions (OECD 2015, p.241). Israeli workers who are not covered by a collective bargaining agreement are required to contribute to a DC plan (OECD 2016 at p. 29). Many Western European countries have legislation that provides for personal pension plans (e.g. for self-employed persons). These plans pay benefits based on the amount contributed. However, they make up a small percentage of pension assets in those countries (OECD 2016). Both Belgium and Germany recently introduced legislation to permit employers to offer DC plans (Roessler 2017). The legislation was introduced to encourage smaller employers to offer pension plans to their employees. The legislation has yet to take effect in either country.

What seems clear is that the reasons governments and employers moved from DB plans to DC plans had little to do with a desire to increase individual choice in their retirement savings. Governments and employers shifted to DC plans, in large part, to transfer to individuals the investment and longevity risks associated with providing pensions, and to reduce their cost of providing pensions (Lusardi & Mitchell 2005).

[2] The World Bank made 204 loans in 68 countries to support pension reform between 1984 and 2004 (OECD 2016)

3. Individuals Systematically Make Mistakes in Managing DC Plans

One hallmark of DC plans is that plan participants bear much more responsibility for making decisions than do DB plan participants. Where DC plans are voluntary, individuals decide whether to participate in the plan, how much to contribute and how to invest the assets. Where the plans are mandatory, individuals are still generally required to make asset allocation decisions.[3] If, as traditional economic theory suggests, individuals make these decisions on a rational basis, the increased choice associated with DC plans would be a strong argument in favor of DC plans over DB plans. However, there is a great deal of evidence that individuals are not very good at managing any aspect of their DC plans, from enrollment decisions, contribution rate decisions, asset allocation decisions and drawdown decisions (Benartzi & Thaler 2007). I describe in sections 3.1 to 3.6 below several commonly observed mistakes that individuals make in their retirements saving planning and explanations for those mistakes in the existing literature.

3.1. Excess Reliance on Defaults

In making their retirement savings decisions, people appear to be easily swayed by defaults and by how choices are framed. Relying on these observations, behavioral economists have successfully advocated "nudging" people into making better retirement saving decisions. The use of nudges, particularly the use of defaults, in the retirement savings arena has been very successful in increasing participation in employer-sponsored retirement savings plans (Chetty, 2016).[4] In fact, defaults have been shown to be more effective than tax subsidies in increasing retirement savings (Chetty, 2016). The evidence of the effectiveness of defaults prompted the U.K. government to introduce legislation requiring employers to automatically enrol new employees in their pension plans, subject to an opt-out (Cribb 2016).

[3] It is certainly possible to design a DC plan in which individuals are not responsible for asset allocation decisions. For example, for the first 20 years that the Chilean mandatory DC plan existed, all participants contributed to a single well-diversified fund (Tapia & Yermo 2007). As well, in Denmark, contributions to the mandatory DC plan simply earn a notional interest rate (Martin & Whitehouse 2008; Aaronson & Coronado 2005). However, most DC plans require that participants make their own asset allocation decisions (Mottola & Utkus 2008).

[4] Interestingly, one of the main reason that U.S. companies want to increase their pension plan participation rate is to comply with IRS non-discrimination rules that provide tax benefits for company pensions only if they are made available to all employees, and not only to highly compensated employees (Choi Laibson 2002). The concern is that if too few non-executive employees fail to join the company DC plan, the plan will not comply with the non-discrimination rules.

As well, several U.S states now require employers to enrol new employees in their DC plans with an opt-out (Munnell et al 2016). DC plans to which employees are automatically enrolled generally also have a default contribution rate and a default asset allocation which, in the U.S., is now generally a well-diversified stock and bond fund (Chan et al. 2017). Accordingly, unless a new employee takes some positive step, he or she will be enrolled in the DC plan at the default contribution rate and in the default investment.

People follow defaults to a remarkable degree. Madrian and Shea (2001) studied the effect of an automatic enrollment plan on pension participation for employees of a large U.S. corporation. Prior to the implementation of the automatic enrolment plan, new employees were not enrolled in the pension plan until they filled out a form (which they were not obliged to do). After the change, all newly hired employees were automatically enrolled in the DC plan at a default contribution rate of 3%, which was invested in a money market fund, Employees could opt out of any of the defaults by filling out a form. The participation rate of new hires after the change to an opt-out system increased from 37% to 86%. Furthermore, 76% contributed at the default contribution rate and 75% maintained their assets in the default money market fund. This savings choice (3% contribution rate and only investing in money market funds) was made by less than 1% of employees hired before the switch to automatic enrollment.

Choi Laibson (2002) reported changes in participation rates of a similar magnitude in a study of several large U.S. employers who switched to an automatic enrolment rule with an opt-out. As in the Madrian and Shea study, new employees tended to contribute at the default rate and to stick to the default investment, which was a stable value fund or a money market fund. By contrast, prior to the change to automatic enrolment, most employees invested primarily in stock funds. Employees in the automatic enrolment system did move out of the default investment over time, but more than 50% of them kept to the default investment during the 3 years following when they joined the plan.

Similar results were found in a recent U.K. study (Cribb & Emmerson 2016). That study looked at the impact that the automatic enrolment law had on pension plan participation rates. They found that auto-enrolment led to a participation rate of 88%, which was a 37-percentage point increase from the pre-automatic enrolment period.

An OECD publication reviewed, among other things, opt-out rates for countries that had mandatory DC plans. The study found that, in most countries, the percentage of individuals who opted out of the default investment was very low. For example, in Peru, only 0.4% of individuals opted out of the default and the opt-out rate in Australia and Sweden was under 10% (Tapia & Yermo 2007). In another study, (Mugerman et al. 2014) found that only 7% of participants switched out of the default investment when Israel changed its pension rules to give employees a choice of investments in their DC plans.

To induce their existing employees to make better investment choices, some employers in the U.S. have undergone "reenrollment". Under a reenrolment, all DC plan assets are sold and invested in a well-diversified fund. However, employees are given the option to partially or fully opt out of the reenrolment, in which case their plan assets covered by the opt-out are retained as is. Reenrollments usually occur when the employer changes its DC plan administrator. The apparent concern of some employers is that their employers either have too much invested in company stock or have too much invested in low yielding money market funds. A study by Vanguard Funds of a recent reenrolment plan of a U.S. subsidiary of a Fortune 100 company showed that only 26% of employees partially or fully opted out of the default fund (Mottola & Utkus 2009). Average investment in company stock decreased from 20% to 2% and investment in the money market funds went from 26% to 3% (Mottola & Utkus 2009). Accordingly, even in a reenrollment, defaults have a large effect.

It is difficult to explain within a traditional economics framework the dramatic changes in participation rates, contribution rates and asset allocation changes that result from a mere change in defaults (Choi et al. 2002; Beshears et al. 2009). One explanation that fits within that framework assumes that making decisions relating to a DC plan can be very difficult, especially for new employees, who tend to be young people with little investment experience. Accordingly, the information gathering costs for those individuals might exceed the benefits of immediately participating in the pension plan. If a default with an opt-out regime reduces the information gathering costs associated with deciding to participate in the plan, the benefits of participating in the plan could exceed the information costs while it would not have done so under an opt-in regime (Madrian & Shea 2001).

While that argument is theoretically sound, I question whether it is valid in practice. The contribution rates and asset allocation decisions are not one time decisions. Employees can generally change either of those parameters at any time. Accordingly, I suggest that the

information gathering cost for the initial decision to participate is quite low. A new employee could get advice on whether to participate and how much to contribute from acquaintances who have investment experience or, for a small fee, from a professional. The employee could then adjust the contribution rate and the asset allocation as he or she obtains more information about his or her retirement needs, etc. By contrast, the cost of not participating in the DC plan, even for short periods can be much higher, particularly if the employer matches the employee contribution. Therefore, even in an opt-in regime, for most employees, the benefits of participating in the DC plan should far outweigh the costs of gathering the information required to make the decision to participate.

Another argument for the success of defaults is that defaults are seen (incorrectly) as advice from the employer as to the appropriate savings parameters for its employees (Beshears et al. 2009; Madrian & Shea 2001, p.33). This may be particularly true for financially unsophisticated employees.[5] Therefore, following defaults reduces the complexity of the decisions that they must make. The decision is simplified to one of participating at the default parameters or of opting out (Beshears et al. 2009). Choi, Laibson 2002 attribute the reliance on defaults to the so-called theory of passive decision-making – that people will do whatever "requires the least current effort". (Choi et al. 2002, p.70 and 80). Reliance on defaults has also been attributed to the status quo bias (Madrian & Shea 2001).

3.2. Peer Effect

There is an abundance of evidence that individuals tend to make the same investment decisions as their peers. Using a data set that included all common stock trades made by Norwegians over the Oslo Stock Exchange during a two-year period, Hans Hvide and Per Östberg found that stock purchase decisions of individuals are strongly influenced by the purchase decisions of their co-workers. However, this influence does not lead to increased stock returns (Hvide & Ostberg 2015). Markku Kaustia and Samuli Knüpfer found strong peer effects amongst Finnish neighbours using a data base of all trades conducted by Finnish residents over a Finnish stock exchange over an 8 year period (Kaustia & Knupfer 2012). They found that when individuals in a neighbourhood experienced strong stock returns in a

[5] In U.S. national survey, only 15% of respondents described themselves as knowledgeable or experienced investors (Utkus & Young 2014). As well, written tests performed by U.S. citizens show that financial illiteracy is endemic (Utkus & Young 2014).

month, in the following month others in that neighbourhood tended to buy the stocks owned by their neighbours (Kaustia & Knupfer 2012, p.25).

These type of peer effects have also been observed in DC plan decision-making. That is, there is evidence that people tend to make the same retirement savings decisions as their peers. In a university library system, the participation rate in the university DC plan varied substantially from library to library, even though employees were, in effect, randomly assigned to libraries. The participation rate between libraries varied from 14% to 73%. Even after controlling for a host of other factors, the variation in participation rate between libraries persisted. The authors interpreted the results as suggesting that an employee's decision to participate in the plan is influenced by the participation decisions of his or her peers (Duflo & Saez 2002).

Prior to a regulatory reform, employees in Israel mandatorily contributed to a default savings plan chosen by their employer. After the reform, employees could stay with the default plan or choose to allocate their mandatory contributions to any of approximately 200 funds. Using data from a large Israeli employer, Yevgeny Mugerman *et al.* found that employees who moved out of the default tended to choose funds which their peers had previously chosen. For the purpose of this study, a peer of an employee is someone who works in the same department and has the same ethnicity as the employee (Mugerman et al. 2014). Duflo and Saez also found that investment choices are strongly influenced by peers. In their study, employees of the same library tended to invest in the funds of the same mutual fund vendor (Duflo & Saez 2002). These results are consistent with the finding that peer effects in risky decision-making increase in the strength of group identity (Gioia 2017). A chain of supermarkets in Texas was covered by a single DC plan. In some stores in the chain, employees were invested mainly in stocks and, in other stores, employees were invested mainly in bonds. Apparently, employee at each store sought advice from and invested the same way as the butcher of that store (Benartzi & Thaler 2007, p.94).

In the studies referred to above, it was difficult for the researchers to ascertain whether people invest in the same manner as their peers for "social learning" reasons or because investing in the same manner as their peers gives them "social utility". Social learning means that individuals learn from the choices of their peers.

A recent finance field experiment sought to identify how much of peer effects in financial decision-making was due to social learning and how much was due to social utility (Bursztyn et al. 2014). The experiment was conducted through a Brazilian brokerage house. The experimenters first created matched pairs of investors. The members of each matched pair were friends or relatives of each other. The first of each matched pair was offered a 50% chance of purchasing a financial asset. If an investor accepted the offer, a lottery was immediately held to determine whether he or she would be allocated the asset. The same offer was then made to the second investor of the pair. However, before this second offer was made, the second investor was told that the financial asset was offered to the first investor and whether the first investor accepted the offer. In one treatment, the second investor was also told whether the first investor was allocated the asset. The results reveal that both social learning and social utility played a role in the decision making of the second investor of the pair. Second investors accepted the offer to purchase the asset at a much higher rate when told both that their matched investor accepted the offer and was allocated the asset than when they were only told whether their peer accepted the offer. As the fact that the asset was allocated to their peer gives the second investors no additional information about how the first investor feels about the quality of the proposed investment, this increase in the acceptance rate was the "social utility" component of the peer effect (Bursztyn et al. 2014, p.1292).

3.3. Active Management

401(k) plans[6] in the U.S. generally offer participants a choice between actively managed mutual funds and index funds (Munnell 2014). Index funds mimic a stock index, such as the S&P 500. Actively managed funds attempt to "beat the market". The other main difference between index funds and actively managed funds is the fees charged by the managers. Index funds based on a broad index like the S&P 500 index charge in the range of one-tenth of one percent (10 basis points) of the asset value per year. In 2013, the average fee paid by 401(k) participants for actively managed equity funds was 74 basis points (Munnell 2014). Using data from 2002 to 2009, Ian Ayres and Quinn Curtis found that the fee differential between index funds and actively managed funds was 78 basis points (Ayres & Curtis 2015). There is a great deal of evidence that investors earn higher investment returns

[6] A type of DC Plan.

by investing in index funds rather than in actively managed fund. On average, actively managed funds under-perform index funds by about the amount of the fee differential (Fama & French 2009).

Despite this evidence, people continue to invest in actively managed funds. The average losses from investing in actively managed funds rather than in index funds can be very high. For example, a 75 basis point fee differential reduces the return on the asset by 15% over the life of the investment (Munnell 2014).

3.4. Investing in Company Stock

A 2004 study found that 11 million 401(k) participants had more than 20% of their plan assets invested in the stock of their employer (referred to in the literature as company stock) and more than half of that group had more than 60% invested in company stock (Mitchell & Utkus 2004). The amount invested in company stock has decreased over the last decade.[7] However, a significant minority of employees still hold most of their investments in company stock (Utkus & Young 2014). Investing in company stocks is a particularly bad asset diversification decision. An employee's lifetime employment earnings are dependent in part on the financial health of his or her current employer. Investing pension funds in company stock means that their retirement income is also dependent of the financial health of the employer. If the employer goes bankrupt, like Enron Corporation, the employee loses both a job and a retirement income (Benartzi et al. 2007).[8] By investing in company stock, employees are taking on additional risk, and they should only take on that additional risk if they are compensated for it in some way.

One explanation for why employees hold company stock in their retirement savings plans is that they have private information about the employer that allows them to earn excess returns. However, there is no evidence that the future performance of company stock is

[7] A large part of this reduction is likely due to two factors. Firstly, some companies now no longer make matching contributions in the form of company stock (Martin & Rafsky 2007). This change may have been driven by a spate of litigation in which employers were sued by plan participants after large market price reductions of the company stock (Benartzi et al. 2007). Secondly, after the bankruptcies of Enron and WorldCom, Congress legislated the Pension Protection Act of 2006, which permits employees to sell company stock issued as matching 401(k) contributions after 3 years (Von Neumann & Morgenstern 1953).

[8] Enron employees had more than 62% of their plan assets in stock of Enron at the time it went bankrupt (Von Neumann & Morgenstern 1953).

positively related to the proportion of company stock in the company's 401(k) plan. (Huberman & Sengmueller 2004; Benartzi et al. 2007; Favreau 2017). Another reason commonly given is that holding company stock provides employees with non-monetary benefits, such as feeling part of the team, (Benartzi et al. 2007, p.52). When asked in a survey about whether their feelings towards holding company stock affects their attitudes towards their employer, the answer was highly correlated with how well the company stock had performed. Those whose stock performed well felt that their attitude towards their employer was improved by their holding of stock, and those whose stock performed poorly felt that holding company stock negatively affected their attitude toward their employers. The researchers found no evidence that employees obtained non-monetary benefits from holding company stock once the performance of the company stock was taken into account (Benartzi et al. 2007, p.53).

3.5. Investing in Riskless Assets

A significant percentage of employees retain most of their pension assets in low risk money market funds. In a study covering 2.9 million 401(k) plans, 13.4% of employees were found to be fully invested in low risk funds and that this percentage was much higher for low income employees (Mottola & Utkus 2008, pp.5 & 22). The percentage of employees wholly invested in money market funds is even higher if the money market fund is the default fund. The employees of one large U.S. employer that made a money market fund the default fund for its 401(k) plan, 75% of new employees had all their assets invested in the money market fund (Madrian & Shea 2001). The concern with employees having a large percentage of their assets in money market funds is that the low returns on those funds will make it difficult for employees to earn enough to fund their retirement incomes (Mottola & Utkus 2008).

The fact that some individuals invest primarily in risk-free assets is generally explained by differences in risk aversion (Butler et al. 2014). However, the risk aversion explanation is more difficult to maintain in the face of the evidence that defaults have such a large impact on how much people invest in risk-free assets. If risk aversion were the main reason individuals invested excessively in risk-free assets, the percentage of their portfolio that they invest in such assets should not depend so much on whether those assets are the default investment.

3.6. Rarely Rebalance

DC plan participants in the US appear to rarely make changes to or rebalance their portfolios. An investor might be expected to rebalance if, for example, one asset in the portfolio has increased in value much more relative to the others. Selling some of that asset and using the proceeds to buy more of the other assets might lead to a better diversified portfolio (Mitchell et al. 2006). A participant might also want to change if their life circumstances change or if their preferences change. Additionally, those who initially invested in an undiversified portfolio might make changes as they gain experience in managing their portfolios.

Using a dataset on 1.2 million U.S. workers, (Mitchell et al. 2006) found that 80% of participants made no trades to their DC plans and a further 11% made one trade in the two-year period studied (2003 – 2004). Another study found that the median number of changes in a year is zero (O'Donoghue & Rabin 2001). A further study found that 73% of participants made no changes to their portfolio and 14% made only one change over a 10-year period (Ameriks & Zeldes 2004, p.31). It is clear from these studies that most employees are reluctant to change their DC plan investments once they have made the initial investment.

3.7. No Over-arching Theory for Why Individuals Make These Mistakes

One reason often given for why people generally make poor retirement savings decisions is that a large portion of the population has low levels of financial knowledge (Tokar Asaad 2015). An obvious solution, and one that has been tested extensively, is to provide financial education to help people make better retirement savings decisions. Unfortunately, the results have been very disappointing (e.g. Choi et al. 2002; Willis 2011). The evidence is that short periods of financial education do not improve decision-making (Willis 2011). Accordingly, a low level of financial knowledge is not likely to be the sole explanation for the retirements savings mistakes that we observe.

There is ample evidence that people rely on heuristics and biases is making retirement savings decisions (Willis 2011). There is also ample evidence that relying on heuristics and biases can be very costly to individual investors (e.g. Benartzi & Thaler 2007; Calvet et al. 2007). However, there is little evidence in the behavioral economics literature as to why

people rely on heuristics and biases, and why education does not seem to be effective in reversing these heuristics and biases. In other words, while behavioral economists and finance scholars have provided plausible explanations for why individuals make each of the mistakes described in sections 3.1 to 3.6, they have yet to provide a theory that explains why individuals make this set of mistakes.

In the following sections of this chapter, I will propose that a trait that evolved through natural selection may help explain why people exhibit the retirement savings behavior described in this section. That evolved trait is regret.

4. Regret and the Anticipation of Regret

Regret is a negative emotion experienced when the outcome of an individual's decision is less favorable than if the individual had made an alternate decision (Zeelenberg & Beattie 1997). Regret is proto-typically related to decision making. The hypothesis of this paper is that many of the mistakes that people have been observed to make, and the biases and heuristics that they rely on in managing their individual pension plans are explainable by a desire to avoid regret. I also hypothesize that the social nature of the workplace amplifies the regret that employees might feel from making pension plan choices which turn out badly.

Regret has been widely studied in many disciplines. In economics, regret has been used to explain decision-making that appears to diverge from Von Neumann and Morgenstern's (Von Neumann & Morgenstern 1953) rationality axioms (Savage 1951; Bell 1982; Loomes & Sugden 1982). Finance scholars have shown that regret plays a role in stock market investing (Saunders 1993; Kuhnen & Knutson 2011). Regret's role in decision-making under uncertainty and risk been extensively studied in psychology (Zeelenberg et al. 2007). Neuro-scientists have shown that those with damage to their brains that leave them unable to experience regret make different decisions under risk and uncertainty than those with normal brains (Camille et al. 2004). Regret has also been studied in the context of consumer decision-making (e.g. Inman & Zeelenberg 2017). Accordingly, there is a rich body of regret research from a wide range of disciplines.

In this section, I summarize the research into the emotion of regret and its impact on decision-making under risk and uncertainty. I start with a summary of the development of

regret research, then discuss regret as an evolved trait. The focus of section 4.3 is on those aspects of regret that seem most relevant to explaining the role of regret in decision-making in individual retirement savings plans.

4.1. The Development of Regret Research

Well before psychologists started seriously thinking about the role that regret plays in human decision-making, a few economists had considered that people take regret into account when making decisions (Zeelenberg et al. 2007). Early theories by economists that regret explains observed decision-making under uncertainty, such as (Savage 1951), were not generally accepted by the economics community because the explanations violated the Von Neumann & Morgenstern (1953) rationality axioms (Bell 1982). This problem was overcome by including regret in the utility function. David Bell hypothesized that many of the observed violations of the "rationality" axioms, such as transitivity, occurred because decision-makers want to avoid feeling regret if the decision turned out to be incorrect, even though it was the correct decision given the information available at the time (Bell 1982). Bell devised a formal model incorporating both monetary gain and regret into an individual's utility function. His model measures regret as the difference between the value of the assets that the individual received and the value that the individual would have received if he or she had made the best alternative decision (Bell 1982). Loomes & Sugden (1982) put forward their own model of rational choice under uncertainty which includes regret in the utility function.[9]

Psychologists took an interest in the regret models and began experimentally testing whether regret plays a role in decision-making under risk or uncertainty. Psychology theories of regret and decision-making are based largely on the models developed by Bell and by Loomes and Sugden. Psychologists still routinely cite those papers (Connolly & Butler 2006). In their regret experiments, psychologists generally elicit self-reported levels of regret that subjects feel in making actual or hypothetical decisions (Connolly & Butler 2006). The results of these experiments support the economics models that regret plays a role in decision-making under risk or uncertainty (Zeelenberg et al. 2007).

Economists also conduct experiments to determine the role of regret in decision-making under uncertainty or risk. However, unlike psychologists who record subjects' self-reported regret, economists infer the existence and intensity of regret from actual choices

[9] For a discussion of the history of regret in economic theory, starting with Savage (1951), see (Reb 2008).

made by individuals (Connolly & Reb 2012). Accordingly, there is no evidence that subjects in economics experiments actually experience regret (Connolly & Butler 2006). Two recent law and economics papers reported on a series of experiments testing the role that regret plays in decision-making under risk. Like economics experiments, subjects in those experiments were paid based on their performance on the experiment. However, like psychology experiments, subjects also self-reported the degree of regret they felt about actual decisions or hypothetical outcomes (Arlen & Tontrup 2015a; Arlen & Tontrup 2015b). Even though the economics (and law and economics) experiment methodologies differ from the psychology methodologies, they also support the proposition that regret plays a role in decision-making under risk or uncertainty.

There is also neuroscience evidence that regret plays a role in decisions under uncertainty. People with damage to the orbitofrontal cortex (OFC) are unable to experience regret. In a recent neuroscience experiment, the OFC subjects consistently chose the riskier of two lotteries, regardless of the outcome of the other lottery in the previous rounds of the experiment. Those with normal brains adjusted their choices based on the outcomes in earlier round, consistent with a desire to reduce anticipated regret. OFC subjects also chose the disadvantageous lottery more often, and earned less than, the other subjects (Camille et al. 2004).

Regret has been rated as the most intense negative emotion that people feel and the second most commonly-felt emotion (love is rated first) overall (Zeelenberg et al. 2007). This may be one of the reasons why financial education has had little effect on employees' retirement savings behaviour (Willis 2011). Learning about how to make "better" retirement savings decisions may not reduce the pain of regret, and therefore individuals will continue to make regret-reducing choices.

In conclusion, there is now a large body of theoretical and empirical literature in several academic fields which supports the proposition that regret plays an important role in decision-making under uncertainty or risk. In addition, scholars in the various fields generally agree on when a decision under risk or uncertainty is likely to generate a high degree of regret.

4.2. Regret as an Evolved Trait

Regret is a universal human emotion. It is experienced by people in all countries and cultures in which it has been studied (Breugelmans et al. 2014). This lends support to the proposition that the emotion of regret is an evolved trait. Like other emotions and behaviors, regret evolved because those who experienced it survived and reproduced at a greater rate than those who did not (Zeelenberg et al. 2008; Mishra 2014, p.288). Marcel Zeelenberg developed a theory that "emotions are for doing"; that is, the experience of an emotion causes an individual to focus on specific goals and to take action to accomplish those goals (Zeelenberg et al. 2008; also see Lerner et al. 2015, p.33.10). The feeling of regret *"bias people to learn about appropriate courses of action and adjust their behaviors, especially after they have made a poor choice"* (Santos & Rosati 2015, p.326). The bias of learning from previous experience is very useful to survival, in that those who did not experience regret would be less likely to learn from their mistakes. Regret may have evolved long before humans came along. Recent experiments have shown that monkeys also adjust their behavior based on counterfactuals and may even experience regret (Santos & Rosati 2015; Zeelenberg et al. 2007).

While regret is an evolved trait, this does not mean that it is fitness enhancing in our current environment or that the emotion is optimized to help us make decisions under uncertainty or risk in all domains (Cosmides & Tooby 1994). Until about 12,000 years ago, humans were hunter-gatherers living in small groups and living on the edge of survival. The emotion of regret that we now experience would have evolved during the period that our ancestors were hunter-gatherers to help them solve problems that were relevant to them in that environment (Cosmides & Tooby 1995).

There is no guarantee that regret works well to solve problems that our distant ancestors did not have to face, such as investing in sophisticated financial markets (Mishra 2014; Boudry et al. 2015). It would not be surprising if regret sometimes inhibits the making of good decisions relating such things as DC plans. For example, as discussed further in section 4.3, individuals may adopt a strategy of avoiding retirement saving decisions altogether to avoid the regret they anticipate feeling if their decisions turned out badly.

4.3. Regret Aversion and Strategies to Reduce Regret

Regret aversion is the observed phenomenon that, when making decisions under uncertainty, individuals anticipate the regret that they will feel in the future if the outcome of the decision is worse than if they had made an alternative decision (Mellers & Mcgraw 2001).[10] For an individual to experience regret or the anticipation of regret, two conditions must be met. Firstly, the individual must feel responsible for the decision. The proposition that people feel less regret when they feel less responsible for a decision is supported by a substantial body of evidence (Zeelenberg et al. 2007). The second condition is that the individual must be aware of, or at least be able to imagine, the outcome if he or she had made an alternate decision (Zeelenberg et al. 1998).[11] This proposition also finds support in the empirical evidence.

As regret is painful, individuals will make decisions in such a way as to reduce the possibility of experiencing regret in the future (Connolly & Butler 2006; see Coricelli et al. 2007 for neuroimaging support for this proposition)[12] One way for an individual to minimize potential regret is to gather all data relevant to the decision and to thoroughly analyze the problem before making a decision (Zeelenberg et al. 2007). Reb (2008) found evidence that the quality of decision-making improves when the anticipation of regret is made more salient.[13] One problem with this approach to reducing future regret is that, for some decisions, even the best reasoned decisions might turn out badly. For example, even the most well thought-out stock market investing plan may have a bad outcome if unforeseen or unknowable circumstances occur. In retrospect, investing all of one's assets in the stock of Google when it made its initial public offering would have been a better decision than investing in a well-diversified stock portfolio. The possibility that the Google stock will outperform the diversified portfolio could lead an investor who invested in the diversified portfolio to anticipate feeling regret over that decision, even though, objectively, that decision was the right one. Furthermore, a decision-maker can never know with certainty whether he

[10] However, individuals tend to overestimate the degree of regret they will experience if the outcome of another decision turns out to be better than the outcome of the decision they made (Mellers & Mcgraw 2001, p.213)

[11] There is also a view that counterfactual thinking is triggered by negative affect of a bad outcome of a decision (Roese & Olson 1997).

[12] There is some debate in the psychology literature as to whether anticipated regret is an emotion or is merely a prediction about an emotion (Zeelenberg et al. 2007).

[13] Subjects primed to think about regret spent more time and effort in making decisions and improved the quality of their decisions (Connolly & Reb 2012, p.37).

or she has taken all factors into account and has properly assessed all relevant risks. As well, there are limitations to the functioning of the human brain that make it impractical for an individual to take all relevant factors into account when making a decision (Simon 1972). Accordingly, individuals might attempt to avoid the anticipation of regret in other ways (Zeelenberg & Beattie 1997; Zeelenberg et al. 2007).

Another approach to reducing anticipated regret is to weaken either of the two prerequisites for that emotion (i.e. felt responsibility and knowledge of the counterfactual). For example, the anticipated regret associated with a decision is reduced when an individual transfers responsibility for that decision, either implicitly or explicitly, to another person (Zeelenberg et al. 2007; Arlen & Tontrup 2015a). Anticipated regret may also be reduced if the decision is made in such a way that it is difficult to know the counterfactual. There is experimental evidence that individuals purposefully avoid acquiring information regarding past decisions, such as asset allocation decisions, in order to avoid regret (Shani & Zeelenberg 2007).[14] A recent experiment in which subjects were willing to pay to avoid learning what others did in a previous iteration of the experiment lends support for the proposition that people will sometimes prefer not to know the counterfactual in order to reduce the anticipation of regret (Arlen & Tontrup 2015a). In another laboratory experiment, subjects were found to be less likely to repurchase an asset that they sold in a previous round if the price of that asset went up after they sold it, even though they knew price changes from round to round were random. Investors avoid paying attention to stocks they sold and which have gone up in price to reduce feelings of regret (Weber & Welfens 2007, p.8).

Another way to avoid regret aversion is "to opt for 'normal' choices that are easily justified" (Zeelenberg et al. 2007) This might be one reason why sticking to default choices produces less regret than opting out of the defaults (Inman & Zeelenberg 2017). Actions have more potential for causing regret than inactions (Gilovich & Medvec 1995; Zeelenberg & Pieters 2004, p.167). Therefore, another way for an individual to reduce the regret associated with a decision is to not make the decision at all. This might also help to explain the reliance on defaults – accepting the default is an inaction that is less likely to induce regret than opting out of the default, which is more clearly an action. Accordingly, regret aversion can lead to individuals failing to make decisions where making the decision would be utility enhancing but for the potential regret associated with the decision.

[14] However, curiosity may override the initial decision to block the information (van Dijk & Zeelenberg 2007).

Expectation of receiving feedback from a decision not taken plays a large role in feelings of regret (Zeelenberg & Beattie 1997, p.64). For example, in experiments where subjects must choose between one of two lotteries, the anticipation of regret is greater in those cases where subjects expect to be told the outcome of the lottery not chosen (e.g. Zeelenberg et al. 1996).

Peer effects appear to amplify feelings of regret. Boles & Messick (1995) found experimental evidence that a person will feel more anticipated regret if that person made a choice in the presence of a person who made an alternative choice. Their theory behind that proposition is that the presence of the other person increases the salience of the counterfactual and therefore makes anticipated regret more pertinent (Boles & Messick 1995). Cooper and Rege (2011) tested experimentally the proposition that the anticipated regret of a bad outcome of a decision is amplified if peers made the opposite decision. The authors used the term "social regret" to mean that social comparisons amplify regret (Cooper & Rege 2011, p.92). In each of three rounds, subjects had to make a choice between two gambles. After the first and second rounds, those in the treatment group were told what the majority of their peers chose in the previous round.[15] Those in the treatment group were much more likely to switch to the choices made by their peers in the previous round than those who were not told of their peers' choices. The authors determined that the most likely explanation for this result is social regret (Cooper & Rege 2011). The tendency for subjects to switch to the majority decision resulted in a high degree of homogeneity within groups, but greater heterogeneity between groups (Cooper & Rege 2011, p.109).

The social regret theory finds support in Delfino *et al.* (2016), where subjects had to allocate tokens between a safe and a risky choice. Subjects were much more likely to imitate the choices of their peers when told the average investment of the peer group than when told the investment of a particular member of the peer group in circumstances where there could be no rational social learning from the decisions of others (Delfino et al. 2016). In a recent law and economics experiment, subjects who were told that subjects in a prior study chose to trade one lottery ticket for another were more likely to trade their tickets than those who were not given any information about the choices of other subjects. This was despite the fact that subjects in the later study understood that subjects in the earlier study had no better

[15] The experiment was designed to rule out other confounding factors, such as learning, imitation, knowledge spillovers and social interaction effects.

information than they had. Those subjects in the later study who were told of the choices of prior subjects also reported feeling less anticipated regret from trading than those in the control group (Arlen & Tontrup 2015a).

The Netherlands runs traditional State Lotteries in which numbers are drawn at random, and individuals win prizes based on the number of correct numbers they chose. In addition, the Dutch government runs what it calls a Postcode Lottery. Each postal code in The Netherlands covers a maximum of 25 households, usually all on the same street. In the Postcode Lottery, a postal code is drawn at random every week in a televised event. Anyone who lives in a household covered by the drawn postal code and who bought a ticket shares in the prize. In a 2004 study, subjects reported that they would feel more regret if they did not buy a Postcode lottery ticket and it won than if they did not buy a ticket for the State lottery and it won. The researchers provided evidence that this increased regret resulted both from the ease of learning the counter-factual (i.e. that the subject would have won if he or she had purchased a ticket) as well as the element of social comparison (i.e. being able to compare your outcome with that of the neighbours) that induced this increased feeling of regret (Zeelenberg & Pieters 2004). This is an interesting real world example of peer effects amplifying regret.

In summary, there is abundant evidence that peer effects amplify regret aversion. Because of this increased regret that peer decisions can induce, individuals who know that their peers made a particular decision under uncertainty or risk may be more likely to make the same decision than if they had no information (or could not easily obtain information) on their peers' decision.

Regret aversion theory may also do a better job than risk aversion of explaining the observation that individuals often choose a sure thing over a risky bet, even when the expected return on the risky bet is much higher than the expected return on the safe asset (Zeelenberg et al. 1996). For example, assume that an individual has a choice between a sure thing and a risky bet and that the individual will not know the outcome of the risky bet unless he or she chooses it. If the individual chooses the risky bet, he or she can always compare the outcome of that bet with the sure thing. However, if the individual chooses the sure thing, he or she will not know the outcome of the risky bet unless he or she actively takes steps to find out the outcome of that bet. Accordingly, the individual might choose the sure thing to reduce the potential regret associated with the risky bet (Reb 2008). In a recent experiment, subjects

were given the choice between a riskier and a safer lottery. In all conditions, subjects were told that they would be given feedback on the lottery they chose. However, in one treatment, they were told that they would also be given feedback on the riskier lottery, regardless of which lottery they chose. In another treatment, they were told that they would be also be given feedback on the safer lottery, regardless of which lottery they chose. Subjects were more likely to choose the riskier lottery in the conditions in which they were told that they would be given feedback on that lottery, and more likely to choose the safer lottery when told that they would always be given feedback on the safer lottery (Zeelenberg et al. 1996). These results lend support for the proposition that regret aversion better explains tendencies to choose safer rather than riskier assets than risk aversion (Zeelenberg et al. 1998; Zeelenberg et al. 1996).

5. Anticipated Regret as an Explanation for DC Plan Mistakes

Many decisions that individuals make regarding their DC plans seem susceptible to regret. In a DC plan, the individual is at least notionally responsible for decisions relating to the plan, such as whether to participate, how much to contribute and how to invest the contributions. As well, given that information on investment returns of assets that are eligible for investment in DC plans is widely available, the outcome from making alternative investment decisions is at least knowable.[16] As an individual will be aware at the time he or she makes DC plan decisions that the counterfactuals will be knowable, the decision itself may induce regret aversion. Accordingly, individuals may make DC plan decisions, in part, in such a way as to reduce future regret.

In section 3, I described mistakes that individuals have commonly been observed to make in managing their DC plans. In sections 5.1 to 5.6 below, I describe how regret aversion can help to explain those DC plan mistakes.

5.1. Strong Reliance on Defaults

Regret may play a large role in the effectiveness of defaults in DC plans. The decision of how much to contribute to a DC plan and how to invest those contributions requires a great

[16] The outcome of alternate DC plan decisions, such as whether to participate and at what rate to contribute, are not as easy to imagine.

deal of information about the future. For example, in calculating how much to contribute and how to invest those contributions, an employee needs to forecast the expected return and variance of the investment options, his or her retirement date and his or her life expectancy. To make an informed decision, the employee would also have to be able to measure the utility trade-offs from giving up current spending for spending in retirement. In addition, the employee would have to factor into the equation future changes in lifestyle such as getting married, having children, potential early disability and changes of job prospects due to future technological change. If the future turns out differently than the one forecast, the employee may feel regret from having not made other retirement savings decisions. Furthermore, employees will be aware that the forecasts on which the DC plan decisions are made are likely to be wrong. Accordingly, regret aversion will be felt at the time that the DC plan decisions are to be made, rather than only if the outcomes turn out badly.

To avoid the anticipation of regret, employees may simply avoid making any positive retirement decisions and may simply accept the defaults. If things turn out badly (e.g. the employee would have done better by investing in another asset or the employee ends up with insufficient retirements savings), the employee can allocate the blame to others. In addition, an employee who spends time choosing between alternative investments may become aware of the performance of the investments that he or she did not choose, possibly leading to regret. By accepting the default investment, the employee is less likely to be aware of the alternatives to the default, and will be less likely to experience regret. In addition, if an employee knows that most of his or her peers will stick with the default, the employee is less likely to learn of the counterfactual if he or she also sticks with the defaults. Peer effects are discussed in more detail in section 5.2.

5.2. Peer Effects

A desire to reduce anticipated regret may help to explain why individuals tend to make the same decisions as their peers in their retirement savings planning. There are two credible mechanisms by which making the same DC plan decisions as co-workers could reduce regret aversion. First, it might reduce the sense of responsibility that an employee might otherwise feel for the investment decision. For example, if an employee has reason to believe (or can convince himself or herself) that the co-worker is financially knowledgeable, the employee might then feel less responsibility if it turns out that other investments would

have produced a better return. The other channel is that investing in the same securities as co-workers might decrease the chances of learning the counterfactual; that is, how another investment fares in the future. If a co-worker's investments do well, that co-worker is likely to talk about it. If it turns out that the investments that the employee made performed worse than those of the co-worker, the employee might feel regret. Investing in the same securities as the co-worker reduces the possibility of feeling regret.

In the field experiment conducted by Leonardo Bursztyn *et al*. (discussed in section 3.2), the researchers conducted a follow up survey to determine what it was about the peer tie-in that induced the second investors to accept the offer to purchase the asset. While the researchers did not specifically ask about regret, regret seemed to have played a role in the decisions of the second investors (Bursztyn et al. 2014, p.1292).

5.3. Active management

Regret aversion might also help to explain employees' tendency to invest in actively managed funds. By delegating to a manager, employees might feel less responsibility for their investment decisions and, therefore, feel less regret aversion than if they invested in index funds. If the investment turns out badly, then the employee can blame the fund manager. This is consistent with the experimental evidence of Arlen & Tontrup (2015a) in which subjects were willing to pay an agent to make a risky financial decision to reduce the regret they would feel if the decision turned out badly.

A consistent empirical observation in finance is that individual investors tend to sell winning stocks and to hold losing stocks – the so-called disposition effect (Summers & Duxbury 2007). One reason put forward to explain the disposition effect is the avoidance of regret. Until the losing stock is actually sold, individuals defer the regret they would feel from making a bad investment (Statman & Shefrin 1985). In a very recent study, Tom Chang *et al.* showed empirically that this tendency to hold onto losers is reversed for mutual fund holdings, but only for actively managed mutual funds. Individuals tend to sell losing funds and to hold onto winning funds. A disposition effect is still observed for index funds, although the effect is smaller than for directly held stock (Chang et al. 2016). The authors use cognitive dissonance to explain this reverse disposition affect. By purchasing actively managed mutual funds, investors do not feel responsible for the outcome of the investment.

This feeling of lack of responsibility reduces the cognitive dissonance that they would otherwise feel. The dissonance would occur if they were responsible for the decision because of the need to hold two contradictory thoughts – that they are good investors and that their investment decision turned out badly. By delegating the investment decision, they can blame the manager for the poor fund performance.[17]

Reducing responsibility is also central to the avoidance of regret. In fact, the authors acknowledge that their cognitive dissonance explanation is related to the regret avoidance explanation (Chang et al. 2016, p.295). Accordingly, one reason for DC plan holders to buy actively managed funds is as a strategy to avoid regret; that is, to have someone to blame if the investment goes badly.

5.4. Investing in Company Stock

Regret aversion may help explain large holdings of company stock in DC plans. For companies that make company stock an investment option for their DC plans, employees will be aware of, or at least could imagine that they will be aware of, the day-to-day trading price of company stock. They will also know, or imagine that they will know, that at least some of their co-workers will own company stock. This combination of (i) knowledge of the counterfactual and (ii) of peer effects has been shown to induce a high level of regret aversion (Delfino et al. 2016). Therefore, an employee may invest in company stock to avoid potential future regret. In other words, part of the compensation that an employee receives for holding company stock may be a reduction in regret aversion that he or she would feel by not investing in company stock (Bell 1982).

Investing DC plan assets in company stock may also be an instance of the social regret theory of David Cooper and Mari Rege (Cooper & Rege 2011). In making decisions under uncertainty and risk, individuals tend to make the same decisions as their peers. That tendency is not because of social learning or a desire to conform, but to avoid social regret (Cooper & Rege 2011). In the case of company stock in DC plans, if the stock performs well, social regret will be high if an employee does not invest in company stock and most of his or her co-workers do invest. Therefore, the employee invests in company stock to reduce social regret.

[17] Of course, they disregard the fact that they chose the manager.

The results of the survey about the Dutch Postcode Lottery described in section 5.2 (Zeelenberg & Pieters 2004) support the proposition that regret aversion (amplified by peer effects) explains why employees hold company stock in their DC plans. In that survey, subjects reported that they would feel more regret if they did not buy a Postcode lottery ticket and it won than if they did not buy a ticket for the State lottery and it won. In the Postcode Lottery, people will almost certainly know that their postal code won, as those who bought tickets and won are their neighbours. A similar logic applies when employers offer company stock to their employees' DC plans. The ability to easily learn that the stock performed well and that coworkers bought the well-performing stock makes not purchasing company stock regret inducing.

Investment in company stock varies greatly by company, even among the subset of companies that issue company stock as their matching contributions (Benartzi et al. 2007, p.46). A recent study found that part of this variance can be explained by the between-company variance in company stock purchases by management: the percentage of company stock in employees' 401(k) plan was positively related to management's open-market company stock purchases (Favreau 2017). The relationship held even after controlling for whether a company issues company stock as a matching contribution (Favreau 2017).

The researcher hypothesized that this peer effect was caused by employees' desire to conform to the social norm of investing in company stock (Favreau 2017, p.17). However, the results are also consistent with a regret or social regret story. For companies where there is a culture of owning company stock, the current price of the company stock is likely to be very salient to employees, since it is likely to be a subject of discussion around the water cooler. In addition, employees will be aware that many of their co-workers own company stock. Accordingly, the existence of a company stock culture may cause an employee to reduce regret aversion by investing in company stock (Bell 1982; Loomes & Sugden 1982). On the other hand, if there is no culture of holding company stock, the stock price is less likely to be salient and, peer effects will be low. Accordingly, regret aversion from choosing not to hold company stock is also likely to be low. Therefore, regret aversion can increase the between-company variance in company stock held in DC plans. This hypothesis is also consistent with the findings of (Mottola & Utkus 2009) that employees invest with the same fund companies as their peers.

In the survey referred to at the beginning of this section, researchers asked employees about the regret they would feel if they failed to invest in either company stock or in the general stock market, and the investment subsequently doubled in price (Benartzi et al. 2007). Employees self-reported that they would feel the same level of regret in both scenarios. However, there are reasons to believe that employees would feel more regret aversion in the company stock scenario. For example, the performance of any individual stock is much more volatile than that of the general stock market. Accordingly, company stock will exhibit a greater number of large one-day price increases than the general stock market. These large one day increases would likely be a subject of discussion among co-workers, particularly among those who owned company stock. Therefore, employees would likely be more aware of both any large price increases of company stock and which of their co-workers owned company stock than in the general stock market scenario. Accordingly, the company stock scenario may well be more regret inducing once these additional factors are considered.

In a recent "reenrollment", a large U.S corporation required its employees to sell all their 401(k) holdings unless they opted out. The 401(k) assets of those who did not opt out were allocated to a diversified mutual fund. Before the reenrollment, on average, employees had 20% of their 401(k) assets in company stock. After the reenrollment, that share declined to 2% (Mottola & Utkus 2009). Regret aversion might explain this dramatic reduction in holdings of company stock. Employee might have seen the switch out of company stock as involuntary, and therefore something for which they were not responsible. Therefore, regret is likely to have been lower than if employees themselves had taken the initiative to sell the company stock. Employees might also be less inclined to re-purchase company stock because of the reduction of the peer effects resulting from the knowledge that their co-workers also sold their company stock on the re-enrollment.

5.5. Choosing Riskless Assets

As discussed in section 4.3, regret aversion may do a better job than risk aversion of explaining the tendency to invest in a sure thing rather than a higher yielding risky asset. Accordingly, one reason for employees investing primarily in money market funds (or not switching out of the default of money market funds) might be that they anticipate feeling regret if they invest in equities and they lose money. While the return on money market funds

is low, there is little chance that employees who invest in them will lose money. Of course, equity funds could (and often do) lose value, especially over shorter time periods. Employees who are considering investing in an equity fund will be aware of the counterfactual (i.e. the low risk money market fund). Therefore, they may decide not to invest in equity funds to avoid the regret they would feel if the equity fund loses value (Larrick & Boles 1995; Reb 2008). Regret is likely to be even more salient if the money market fund is the default fund, as the employee will have to take a positive decision to transfer out of the money market fund, and this positive decision may induce regret. There is evidence from experimental economics that individuals are willing to accept a lower expected return rather than switching to a lottery that yields them a somewhat higher expected return in order to reduce regret (Arlen & Tontrup 2015a).

5.6. Rarely Rebalance

Regret may also explain the failure to rebalance. In order to make a decision to rebalance, an individual must focus on how his or her portfolio performed. Some assets will have performed better than others. The individual might feel regret that he or she had not purchased more of the high performing securities and less of the low performing securities. An effective approach to reducing regret with respect to a decision is to maintain ignorance of the outcome of the decision and the outcome of alternative decisions that could have been made. Rebalancing requires one to drop this veil of ignorance. As dropping the veil of ignorance is painful (i.e. it leaves open the possibility of regret), employees simply choose not to rebalance their portfolios.

In the study of a reenrollment of the DC plan of a large U.S. company, employees could rebalance without having to lift the veil of ignorance (Mottola & Utkus 2009). They simply had to fail to opt out of the default, and their plan assets would be sold and the proceeds used to buy a diversified mutual fund. Before the reenrollment, only 40% of employee portfolios were diversified portfolios having an appropriate share of equites. One year after the reenrollment, that share increased to 69%. Based on the regret research summarized in this paper, I suggest that there are three reasons why this method of ‘nudging’ employees into better DC plan portfolios worked. Firstly, employees would feel a reduced level of responsibility for rebalancing as they did not have to take any positive steps. Secondly, this method of rebalancing did not require employees to compare how their

portfolios performed compared to how alternative portfolios performed. Thirdly, employees know that most of their peers would also be rebalancing into the same fund as them, so the peer effects would point in favor of rebalancing.

Studies also show that employees spend very little time contemplating their retirement decisions. Fifty-eight percent of newly hired USC professors surveyed spent less than an hour on their asset allocation decisions, and most did not seek information other than the information provided by the mutual fund vendors (Benartzi & Thaler 1999, p.374). Maintaining the veil of ignorance may also explain this finding.

6. Discussion and Regulatory Implications

There are two distinct goals that government pension policy is intended to achieve. The first goal is to alleviate old age poverty. The second is to allow workers to maintain in retirement the standard of living they enjoyed in their working years (European Commission 2012a; European Commission 2010). The first goal is best accomplished through minimum state pensions that are paid independent of income earned in pre-retirement years (Holzmann & Hinz 2005). In these types of pension, all citizens are entitled to the pension (subject to minimum residency periods), and not just those who worked for most of their lives. Government and employer contributory pension plans (DC plans or DB plans) help accomplish the second goal; that is, to help those who worked for most of their lives maintain in retirement the standard of living they enjoyed in their working years. Governments promote and subsidize retirement savings to help workers fill the gap between the income they need to maintain their pre-retirement standard of living and the income that the state pension provides (Holzmann & Hinz 2005).[18]

On its face, a voluntary DC plan will be inferior to a DB plan or a mandatory DC plan along the dimension of the proportion of workers who will reach the goal of adequately replacing their pre-retirement income. There are at least two reasons for this. Firstly, no matter how well designed or how large the subsidy, some workers in a voluntary DC plan will not participate in or contribute sufficiently to the plan, while DB plans or mandatory DC plans can be designed to cover all workers. Secondly, DC plans have higher administrative

[18] Filling that gap can be very costly to governments. For example, tax subsidies for non-government pension plans in the U.S. amounts to $180 billion per year (Johnson 2014).

costs and earn lower returns than DB plans.[19] Accordingly, even if all workers participated in a DC plan, a given amount contributed to a DB plan will provide more retirement income than the same amount contributed to a DC plan.

On the other hand, an advantage of voluntary DC plans is that they allow workers greater flexibility in their retirement planning. For example, workers can time their contributions to complement their non-retirement spending needs and invest their retirement savings assets to match their preferences and risk aversion levels. However, financial advisors, academics and regulators increasingly seek to design DC plans to limit this choice. They advocate for rules, such as defaults and reenrollments, that will accomplish almost universal participation, high contribution rates and universal investment in well-diversified portfolios. In a sense, what they are advocating for is DC plan regulations that accomplish the same results as mandatory rules, while keeping only an illusion of choice (Bubb & Pildes 2014). This approach to DC regulation may be justified, however, by the evidence summarized in this chapter that individuals make costly mistakes in their retirement savings planning, that financial education does not reduce incidence of these mistakes and that individuals exhibit weak preferences in their DC plan investment decisions.[20]

It follows from the hypothesis of this chapter that individuals make what appear to be sub-optimal retirement savings decisions because they are trying to both amass retirement savings and to limit future regret. Accordingly, one regulatory response to a finding that a desire to avoid regret is a cause of DC plan mistakes is to use that knowledge to design nudges that play on the desire to avoid regret, which I discuss later in this section. However, a better response might be to move even further away from voluntary DC plans and more towards mandatory DC plans. Instead of nudging people to make the correct decisions with defaults and other tools, participation in plans would be mandatory. Mandatory plans

[19] A U.S. study found that from 1988 to 2004, DB plans earned a one percentage point higher return per year than 401(k) plans. The authors attributed at least part of this difference to high fees associated with 401(k) plans (Munnell & Sunden 2006).

[20] Evidence of these weak preferences is the study in which employees were asked to rank portfolios they constructed themselves and to compare them to "model portfolios" created by the plan administrator. Employees ranked the model portfolios higher than their self-constructed portfolios (Benartzi & Thaler 2002). In addition, when Sweden implemented a mandatory DC plan, it created a well-diversified default fund, but allowed individuals to choose between that fund and over 450 other funds. However, through an advertising campaign, the government encouraged individuals to switch out of the default fund, which most individuals did. In later years, the governments stopped encouraging individuals to opt out of the default fund, and less than 10% opted out (Benartzi et al. 2007; Tapia & Yermo 2007).

guarantee full participation and the desired contribution rate without impinging too much on choice for most employees, as most employees don't seem to exercise this choice. Mandatory plans could be designed to limit the choice of investments to low-cost, well-diversified stock and bond funds. They could also be designed to pool risks amongst large groups of participants, as in the Dutch mandatory employer-provided pension scheme (OECD 2015).

Mandatory plans would also have the benefit of reducing regret, as individuals would feel little responsibility for their retirement savings decisions. Of course, the cost of mandatory participation is that the small minority of employees who value choice in their retirement savings will suffer utility losses. However, it is difficult to quantify the utility loss since it is hard to distinguish between (i) those who don't participate because of inattention, (ii) those who don't participate because they wrongly believe that non-participation is best for them, and (iii) those who don't participate because, after careful consideration, believe that is the best course of action for them.[21] It is only for this latter group that moving from a voluntary to a mandatory system will reduce utility.

One criticism of mandatory plans is that the parameters chosen for the plan (e.g. contribution rates, asset allocation) may turn out to be less than optimal. However, because of the huge impact on choice that defaults have in the default with an opt-out regime, defaults also must be chosen carefully. For example, in a default with an opt-out regime, the default contribution tends to be too low to fund an adequate retirement income (Bubb & Pildes 2014). However, most participants stick to the default contribution rate. Because of this, even though the default with an opt-out regime increases participation, the aggregate contributions to DC plans is about the same as in opt-in regimes (Madrian & Shea 2001; Bubb & Pildes 2014). Increasing the default contribution rate would increase contributions for those who don't opt out, but perhaps at the cost of more employees opting out. Therefore, as is the case for mandatory plans, a bad default rule could be very costly to participants of voluntary plans.

In Canada, a recent expansion of a mandatory universal pension plan was well received by the public. By way of background, Canada has a three-pillar pension system. The first pillar is an unfunded government pension that is payable to all retired Canadians who meet minimum residency requirements. The policy goal of this pillar is to keep retirees out of

[21] There is evidence that retirees feel a moderate amount of regret for failing to save enough for their retirement (Gilovich & Medvec 1995).

poverty. The second pillar is the Canada Pension Plan (CPP), which is fully funded by mandatory contributions made by or on behalf of workers. The assets of the CPP are centrally managed and the assets are used to pay retirement incomes that are based on contributions. The third pillar consists of employer-sponsored DC or DB plans and individual pension plans (DC plans).[22] After a decade long debate about the adequacy of retirement savings in Canada, the CPP was recently expanded. Even though the expansion of the CPP will require additional worker contributions, the move seems to be very popular among Canadians. In a 2016 poll, 75% of Canadians reported that they approve of the CPP expansion.[23]

However, in some countries, moving to a mandatory plan where individuals have little or no investment choice may not be politically palatable. For these countries, the next-best solution may be to refine the use of defaults and reenrollments to more fully take regret aversion into account. In other words, to maintain the sham that people make well-informed choices which need to be respected, but to improve the effectiveness of the defaults.

As discussed in section 5.2, individuals are influenced in their retirement savings decision by the decisions of their peers. These peer effects seem to be particularly strong in the workplace. An interesting implication of my research is the possibility of using peer effects to increase regret aversion, with the objective of increasing participation and contribution rates and inducing employees to invest in high quality portfolios. For example, studies of the effects of a conversion to a default with an opt-out regime indicate that the participation rate in DC plans increase with employee tenure; that is, a higher percentage of more senior employees participate in DC plans than new employees. New employees could be given information on the average participation rate, contribution rate, and asset allocation of members of their department. As peer effects have been shown to amplify regret, providing this information as well as having an opt-out regime might increase participation over only having an opt-out. Informational nudges have been shown to be effective in increasing DC plan participation rates (Clark et al. 2014).

There is universal agreement among academics that it is unwise for employees to own company stock in their DC plans. The fact that many employees still hold large amounts of company stock in DC plans may be explained by regret aversion. New employees in

[22] For a fuller description of the Canadian retirement saving regime and the recent expansion to the CPP, see http://www.fin.gc.ca/n16/data/16-113_3-eng.asp.

[23] See http://angusreid.org/cpp-expansion/.

companies in which many employees hold company stock in their DC plans may also invest in company stock to avoid the regret they would feel if the stock performs well. As this effect is likely to be very strong because of the peer effects from co-workers, governments ought to consider limiting the percentage of company stock that an employee may hold in a DC plan. Proposals to limit the purchase of company stock in DC plans were put forward in the U.S. after the Enron and WorldCom bankruptcies, but they failed to be enacted (Benartzi et al. 2007). The legislation that did pass mandated only that employees be permitted to sell company stock issued as matching contributions after 3 years (Martin & Rafsky 2007).

Aside from investing in company stock, the two biggest investment mistakes that employees make in managing their DC plans is (i) investing in funds that have high management fees and (ii) maintaining very conservative portfolios with little or no equity exposure. As employees tend not to rebalance their portfolios, these investment mistakes tend to persist. As I have shown, regret may play a role both in the original investment decisions and in the failure to make changes to the portfolio. One way of quickly changing employee's portfolios is to undergo a reenrollment (with an opt-out). Accordingly, reenrollments (with an opt-out) ought to be encouraged as way to allow people to change into more appropriate investments on a regret-free basis. The non-voluntary rebalancing of employees' portfolios reduces employees' feeling of responsibility for the decisions A reenrollment also allows employees to make changes to their portfolios without having to be made aware of the counterfactuals (i.e. the past return on investments that they did not choose to purchase). A further benefit of a reenrollment for employees who do not opt out is that they will be aware that many of their peers will also fail to opt-out. Thus, opting out will mean that they will hold the same investments as their peers. All three of these factors will act to reduce regret aversion in moving from a low-quality portfolio to a well-diversified portfolio.

7. Conclusion

In this chapter, I catalogue evidence of mistakes that individuals make in managing their DC plans and show that people's DC plan choices are easily manipulated by, for example, default rules and the decisions of their peers. I follow that with a discussion of regret and decision-making under risk or uncertainty, and propose that decisions relating to DC plans are susceptible to regret aversion. I then discuss how regret aversion may explain

specific observed mistake in DC plan decisions discussed earlier in the chapter. Finally, I suggest some regulatory implications of regret aversion playing a role in those decisions.

I acknowledge that much of application of the regret theory and evidence to the mistakes that people make in managing their DC plans involves a measure of speculation. Empirical evidence will be required to move forward with this theory, including data from actual DC plans and data gathered through experiments. I take the first step in that regard in the next chapter. I report the results of an experiment designed to test the hypothesis that people follow defaults and make the same choices of their peers because that behavior reduces the regret that they anticipate feeling if it turns out that they would have been better off making another choice.

Chapter 5: A Regret Explanation for Default and Peer Effects[a]

Abstract

Behavioral economists have identified domains in which people stick to defaults when making decisions. As well, they have shown that decisions in some domains are strongly influenced by the decisions of peers. We hypothesize that people stick to defaults and peer choices because opting out of a default or choosing the non-peer preferred option induces regret (which we call "Opt-out Regret") in addition to any regret induced by the underlying choices. We tested this hypothesis with an incentivized online experiment. In the experiment, participants were randomly assigned to one of three treatments. In the Free Choice treatment, participants simply chose between two lotteries, Lottery A and Lottery B. In the Default treatment, Lottery B was set as the default from which participants could opt out. In the Peer Choice treatment, participants were told that Lottery B was preferred by most participants in an earlier study. In all treatments, after making their decision but before learning the outcome of the lottery, participants reported how much regret they would feel if the lottery they chose yielded a worse outcome than the other lottery. Participants also reported the regret that they would have felt if they had chosen the other lottery and that other lottery yielded a worse outcome. Participants who opted out of or imagined opting out of the default, or who chose or imagined choosing the non-peer-preferred choice reported feeling more regret than those who chose or imagined choosing Lottery A in the Free Choice treatment. However, those who stuck to the default or peer choice felt the same regret as those who chose Lottery B in the Free Choice treatment. The results of the experiment therefore support our hypothesis.

[a] *This chapter is coauthored with Pieter T.M. Desmet, Assistant Professor, Erasmus University Rotterdam, desmet@law.eur.nl*

1. Introduction

As discussed in sections 3.1 and 3.2 of chapter 4, in making their retirement savings decisions, people seem to be strongly influenced by defaults and by the decisions of their peers. People have also been observed to stick with default options and to make the same choices as their peers in other domains (Jolls et al. 1998; Thaler, R. H & Sunstein 2008). However, while default and peer effects are large in some domains, in other domains they are insignificant. Furthermore, there is no consensus about when defaults and peer effects will impact decision-making nor on why they can be so effective (Jachimowicz et al. 2017). The motivation for this chapter is to start to fill this knowledge gap.

The hypothesis of this paper is that people stick to defaults and choose the same option as their peers in retirement savings and other domains because opting out of the default or deciding on the non-peer-preferred option induces regret. This regret (which in this chapter we refer to as "Opt-out Regret") is over and above the regret associated with the underlying choices. Opt-out Regret will be greatest when establishing a default or communicating peer preferences induces people to choose an option that they would not have chosen but for the default or communication.

To illustrate how Opt-out Regret could affect decision-making, imagine that people must decide between two options, Alpha and Beta, both of which induce regret if the outcome turns out to be worse than the outcome of the other option. Also imagine that in a free choice between Alpha and Beta, most people choose Alpha because a bad outcome of Alpha is less regret-inducing to them than a bad outcome of Beta. Imagine now that either Beta is set as the default or that people are told that most of their peers prefer Beta. We hypothesize that people who decide for Alpha will anticipate feeling more regret than if they simply chose Alpha in a free choice between the two options. They will feel both Opt-out Regret and the regret associated with the potential bad outcome of Alpha. Accordingly, people might stick to the default or peer-

preferred choice because their regret from choosing Alpha (which consists of Opt-out Regret and the regret associated with the bad outcome of Alpha) is now greater than the regret associated with deciding for Beta.

We test our hypotheses using an incentivized online experiment in which participants had to decide between two lotteries. In the Free Choice treatment, participants simply chose between the two lotteries. In the Default Treatment, one of the lotteries was set as the default which participants could accept or opt out of. The Peer Choice Treatment was the same as the Free Choice treatment, except participants were told that others preferred one of the lotteries. In all treatments, participants knew that they would be aware of the outcome of both the lottery they chose and the lottery they did not choose. We chose a task that involved financial decision-making because studies using field data and laboratory experiments have shown that both defaults (e.g. Madrian & Shea 2001) and peer choices (e.g. Duflo & Saez 2002) influence the financial decisions that people make, including retirement savings decisions.

After making their decision but before the results of the lottery were known to them, participants reported the regret they anticipated feeling if the lottery they decided on paid out less than the other lottery. They also reported the regret they would have anticipated feeling if they had chosen the other lottery and that lottery paid out less than the lottery they in fact chose. Finally, they were asked to report their felt responsibility regarding their decision and their relative competence in making the decision.

In summary, the percentage of participants who stuck to the default lottery in the Default treatment was significantly greater than the percentage who chose that lottery in the Free Choice treatment. In addition, participants who decided for or imagined deciding for the non-default lottery in the Default treatment reported significantly higher levels of regret than participants who chose that lottery in the Free Choice Treatment. However, those who stuck with or imagined sticking with the default choice reported no significantly higher or lower regret than those who chose that lottery in the Free Choice treatment. This result supports the hypothesis that people stuck to the default to minimize regret.

The percentage of participants in the Peer Choice treatment who chose the peer-preferred lottery was not significantly different from the percentage of those who chose that lottery in the Free Choice treatment. However, those who chose or imagined choosing the non-peer-preferred lottery did report more regret than those who chose that lottery in the Free Choice treatment. In all treatments, on average, participants chose the lottery that they reported would give them the least regret in a bad outcome, which suggests that regret is a salient factor in their decision-making.

We also found that those who opted out of the default in the Default treatment felt more responsible for their choice of lottery than either those who stuck to the default or those who chose that lottery in the Free Choice treatment. However, those who stuck to the default felt as responsible for their decision as those who chose that lottery in the Free Choice treatment.

This chapter proceeds as follows. In section 2, we briefly review the domains in which establishing defaults and communicating peer preferences have influenced behavior. In section 3, we briefly summarize how the anticipation of regret may explain default and peer effects. In section 4, we describe the experiment and present the results. Section 5 contains a detailed discussion of the results of the experiment. Section 6 concludes.

2. Default and Peer Effects

As discussed in chapter 4, defaults have been shown to strongly influence decisions in numerous domains. One such domain is retirement savings: studies show that people overwhelming stick to participation defaults, contribution rate defaults and asset allocation defaults (Madrian & Shea 2001).[1] While most of the evidence of default effects comes from U.S. studies, strong default effects have been reported in the U.K. (Cribb & Emmerson 2016) and by the OECD in a multi-country study (Tapia & Yermo 2007).

[1] An interesting aspect of the Madrian and Shea (2001) study is that a money market fund is not the best investment option for most investors, as it is unlikely to produce enough return to fund a comfortable retirement. Accordingly, the default investment was not objectively the right choice for most people. Even so, 75% invested in that asset.

Defaults have also been shown to have a very large effect on organ donation decisions. Studies in numerous countries have shown that a large majority of people stick to the default (Johnson & Goldstein 2003). Another domain where people tend to stick to defaults is in end-of-life decisions; that is, the decision as to whether continue medical treatment or, rather, to limit treatment to palliative care. The default effect has been shown to be large, even for terminally ill patients who are asked to make that decision (Halpern et al. 2013).

However, in other fields, installing defaults has been shown to be ineffective: in a field study of low-income tax filers in the U.S., defaults had no impact on the amount of tax refund that participants in the study contributed to a savings instrument (Bronchetti et al. 2011). One potential reason for the lack of a default effect is that participants had prior plans to spend the refund. This is consistent with the conclusions of a recent meta-study that in many domains defaults are ineffective (Jachimowicz et al. 2017). In that study, the authors found that defaults will be less effective when the default is contrary to the preferences of the population that is subject to it (Jachimowicz et al. 2017).

Apart from relying on defaults, people tend to make the same financial decisions as their peers (Kaustia & Knupfer 2012). Studies of retirement savings plan investment choices also show a tendency to choose the same investments that their peers (Mugerman et al. 2014; Duflo & Saez 2002). However, these effects are not as large as the default effects that have been observed. Another domain in which providing people with information about the behavior of their peers influences decision-making is in electricity consumption. People who are provided with information about their neighbours' electricity consumption reduce their own consumption, and that reduction is sustained over time (Ayres et al. 2013).

In a laboratory experiment, Gioia (2017) found that peer effects with respect to financial decision-making increase with the strength of group identity (Gioia 2017). A similar result was observed in an Israeli study of employees' investment choices. People were more strongly influenced by others who had the same ethnic background than by employees from different ethnic backgrounds (Mugerman et al. 2014).

3. Regret, and Default and Peer Effects

In this section, we briefly summarize the relevant parts of the discussion in chapter 4 on regret and how regret might explain default and peer effects.

Regret is a negative emotion that is "uniquely tied to the making of decisions" (Martinez et al. 2011). Two conditions must be present for a person to experience regret over a bad outcome of a decision. Firstly, the person must have felt that he or she had been responsible for the decision that resulted in the bad outcome (Zeelenberg et al. 2007). Secondly, the person must have been able to at least imagine the outcome, the so-called counterfactual, that would have occurred if he or she had made an alternative decision (Martinez et al. 2011; Zeelenberg et al. 1998).

The anticipated regret associated with a decision has been found to be lower when an individual transfers responsibility for that decision, either implicitly or explicitly, to another person (Zeelenberg et al. 2007; Arlen & Tontrup 2015a). Accordingly, one approach to reducing anticipated regret is to make the decision in such a way as to reduce felt responsibility for the decision. Sticking to a default choice may be less regret-inducing than opting out of the default because, by sticking to the default, the person can share blame for a bad outcome with the person who set the default (Inman & Zeelenberg 2017). In this way, the person may feel less responsibility for the decision.

Actions have more potential for causing regret than inactions (Gilovich & Medvec 1995; Zeelenberg & Pieters 2004, p.167). Accordingly, another way for an individual to reduce the regret associated with a decision is to not make the decision at all. This might also explain the reliance on defaults – accepting the default is an inaction that is less likely to induce regret than opting out of the default, which is more clearly an action. A default might also be seen as the normal choice, and Marcel Zeelenberg and colleagues have shown that one way to avoid regret is "to opt for 'normal' choices that are easily justified" (Zeelenberg et al. 2007).

Huang *et al.* (2014) developed a theory that defaults might be economically justified because they can reduce the overall level of regret and, therefore, they may increase aggregate utility (Huang et al. 2014; also see Savage 1951).

There is evidence that decisions of peers amplify feelings of regret. For example, in experiments in which people choose between risky choices, feelings of regret are higher when a person knows that his or her peers made a different choice than when a person has no information on the choices made by peers (Cooper & Rege 2011, p.92; Boles & Messick 1995). The results were similar in an experiment in which subject had to allocate tokens between a safe and a risky choice; subjects imitated the choices of their peers to avoid regret. This was despite the fact that, under the experimental design, there could be no rational social learning from the decisions of others (Delfino et al. 2016). In a recent law and economics experiment, subjects who were told that subjects in a prior study chose to trade one lottery ticket for another were more likely to trade their tickets than those who were not given any information about the choices of other subjects. This was the case even though subjects in the later study understood that subjects in the earlier study had no better information than they had. They also reported feeling less regret from trading than those in the control group (Arlen & Tontrup 2015a). In summary, individuals who know that their peers made a particular choice under uncertainty are more likely to make the same decision than if they had no information on their peers' decisions, and making the same choices as peers reduces regret.

4. The Experiment

4.1. Set-up of the Experiment

Our experiment was designed to test the effects on anticipated regret of establishing a default choice or communicating the choices of peer. The experiment was programmed using software offered by Quatrics (Qualtrics, Provo, UT) and conducted online through Prolific Academic ("Prolific"). Conducting social science experiments through online platforms is becoming more common. Online platforms provide access to a more demographically diverse subject pool than the typical university social science laboratory, and the data quality compares favorably to data obtained through university laboratories (Buhrmester et al. 2011; Peer et al. 2017). Prolific also has the advantage of allowing researchers to easily screen for demographic and other attributes of participants. In our experiment, we specified that, to participate in the

experiment participants had to be U.S. residents, to have English as their first language and not to have participated in a pre-test of our experiment.[2]

The set-up of the experiment is as follows. Participants were randomly assigned to one of three treatments, Free Choice, Default and Peer Choice. In each treatment participants had to decide between one of two lotteries, Lottery A and Lottery B. They were advised that one in twenty of them would be paid the outcome of their chosen lottery.[3] The lottery choices were presented to them graphically as follows (amounts are in U.S. dollars):[4]

	Blue	Yellow	Red
Lottery A	7	7	0
Lottery B	30	0	0

Participants were told to imagine that the computer would randomly draw one of three marbles from a bag (a blue marble, a yellow marble and a red marble), and that the outcome of each lottery would depend on which marble was drawn. They were told that if they chose Lottery A and the blue or the yellow marble was drawn, they had a chance of winning $7, and if they chose Lottery B and the blue marble was drawn, they had a chance of winning $30. They were told that each marble had a one in three chance of being drawn and that, after they answered a few questions about their decision, the lottery on which they decided would be played.[5]

[2] The purpose of the pre-test was to find a value for Lottery A such that one of the two lotteries was the preferred but not overwhelmingly preferred choice. Participants in the pre-test chose between a series of pairs of lotteries that were each displayed in the same manner as Lottery A and Lottery B in the present experiment. For each pair, the payout on Lottery B was 30 but the payout on Lottery A varied between 6 and 20. The pre-test also allowed us to truthfully provide information to participants in the Peer Choice treatment about prior choices of participants.

[3] In a recent large scale study, a chance of receiving an incentive payment was found to be almost as effective in encouraging effort as a certain incentive payment (Dellavigna & Pope 2018). Based on this study, paying only 1 in 20 participants the outcome of their chosen lottery should yield similar results to paying all participants the outcome of their chosen lottery.

[4] A similar choice architecture was used in (Connolly & Butler 2006).

[5] The expected payout on Lottery A is $4.67, with a standard deviation of approximately $3.30. The expected payout on Lottery B is $10.00, with a standard deviation of approximately $14.41. Participants were not explicitly told the expected payout and variance of the lotteries.

After they made their choice but before they learned the results of their chosen lottery, participants were asked to indicate on a 5 point Likert scale how much regret they would feel if the lottery they chose paid out less than the lottery they did not choose. They were also asked to imagine how much regret they would feel if they had chosen the other lottery and that lottery paid out less than the lottery they in fact chose. They were then asked to report, on a 5 point Likert scale, how responsible they felt for their decision and their perceived competence in choosing between the lotteries compared to others.

In each of our treatments, participants would know the outcome of both the lottery they chose and the other lottery, since they knew that the result of both lotteries would be determined by the same drawn marble. However, the experiment manipulated the potential for feeling Opt-out Regret. In the Free Choice condition, participants merely chose one of the two lotteries and therefore had no chance to feel Opt-out Regret. In the Default treatment, participants were told that Lottery B had been pre-selected for them, but that they could opt for Lottery A by typing the word "switch" and clicking on a button.[6] In the Peer Choice treatment, participants were told that in a prior version of the experiment, most Prolific users who were residents of the U.S. chose Lottery B.[7] We hypothesized that some participants who opted out of the default or who chose the non-peer-preferred lottery (i.e. Lottery A) would feel Opt-out Regret. This would be reflected in (i) a larger percentage of participants deciding for Lottery A than in the Free Choice treatment, and (ii) those who decided for or imagined deciding for Lottery A feeling more regret than those who chose Lottery A in the Free Choice treatment.

After a participant answered the questions on regret, felt responsibility and perceived competence, his or her chosen lottery was played and the participant learned the outcome of the lottery. He or she then answered four demographic questions (age, gender, education, employment). The average time it took to complete the experiment was approximately 3½ minutes.

[6] To induce participants to accept a default Lottery B, we implemented this rather "hard" default. This hard default was more effective in inducing participants to stick with the default than a softer default that we used in an earlier pre-test.

[7] In the pre-test of the experiment referred to in footnote 2, 52% of participants chose Lottery B when the potential payout on Lottery A was $7.

Each participant was paid £0.40 (approximately US$0.55) for participating in the experiment.[8] In addition, 15 participants (i.e. 1 in 20 participants) were randomly chosen by a computer programme to be paid a bonus amount based on the outcome of their chosen lottery. Only 6 of these 15 participants won their chosen lottery, each of whom had chosen to play Lottery A. Accordingly, 6 participants were paid a bonus amount of £5.04 (approximately US$7.00).[9]

4.2. Results

The experiment was conducted on February 16, 2018 with 302 participants. Participants were evenly allocated among the three treatments. Table 1 lists the percentage of participants who decided on Lottery B in each treatment:

Table 1: Percentage Deciding on Lottery B, by Treatment

Treatment (n in brackets)	Percentage Who Decided on Lottery B
Free Choice (100)	34.0%
Default (99)	55.6%
Peer Choice (102)	40.2%

The Default treatment had a large effect on the percentage of participants who chose Lottery B. Participants in that treatment chose Lottery B 55.6% of the time, compared to 34% of the time in the Free Choice treatment. Applying a one-way ANOVA, we found that the effect of the Default treatment on the choice of Lottery B was statistically significant ($F(1, 197) = 9.71$, $p = .002$). Participants in the Peer Choice treatment chose Lottery B 40.2% of the time and that

[8] Prolific is a U.K. based platform. At the time we conducted the experiment, it required that payments be made to participants only in British pound sterling. Apparently, Prolific now permits payments to U.S. residents to be made in U.S. dollars.

[9] We paid the bonus payments in pound sterling at the prevailing US$:UK£ exchange rate.

percentage. However, this was not significantly different from the percentage who chose Lottery B in the Free Choice treatment ($F(1, 200) = 0.83$, $p = 0.36$).

Table 2 lists the means and standard errors of the measures of regret that we use in our analysis, broken down by treatment and overall. The variable that captures the regret that participants anticipated feeling if the lottery they decided on paid out less than the other lottery is Regret_chosenL. The variable that captures the regret that participants anticipated feeling if they had chosen the other lottery and that lottery paid out less than the lottery they in fact chose is Regret_nonchosenL. Difference is the difference between Regret_nonchosenL and Regret_chosenL.

Regret_A captures, for those participants who chose Lottery A, their reported regret on the lottery they chose and, for those who chose Lottery B, their reported hypothetical regret if they had chosen Lottery A. Similarly, Regret_B captures, for those participants who chose Lottery B, their reported regret on the lottery they chose and, for those who chose Lottery A, their hypothetical reported regret if they had chosen Lottery B.

Table 2: Measures of Regret, by Treatment and Overall (SE in brackets)

Treatment	Regret_nonchosenL	Regret_chosenL	Difference	Regret_A	Regret_B
Free Choice (n = 100)	3.11 (0.14)	2.64 (0.12)	0.47 (0.18)	2.98 (0.13)	2.77 (0.14)
Default (n = 99)	3.38 (0.14)	2.97 (0.13)	0.41 (0.17)	3.31 (0.13)	3.04 (0.14)
Peer Choice (n = 102)	3.27 (0.14)	2.93 (0.13)	0.34 (0.17)	3.33 (0.12)	2.87 (0.14)
Overall (n= 301)	3.26 (0.08)	2.85 (0.07)	0.41 (0.01)	3.21 (0.07)	2.89 (0.08)

In all treatments, Difference (i.e. the difference between Regret_nonchosenL and Regret_chosenL) was large and statistically significantly greater than 0. For example, in the Free Choice treatment, this difference was 0.47 on a 5 point Likert scale ($t(99) = 2.63$, $p = .01$ as against a Difference of 0). This suggests that regret was salient to participants' decision on which lottery to play, as they chose the lottery that they anticipated would give them the least amount of regret.

Regret_A in the Default and in the Peer Choice treatments is higher than Regret_A in the Free Choice treatment. Applying a one-way ANOVA, these differences in Regret_A are statistically significant. Comparing Regret_A in the Default treatment to Regret_A in the Free Choice treatment, $F(1, 197) = 3.22$, $p = .07$. Comparing Regret_A in the Peer Choice treatment to Regret_A in the Free Choice treatment, $F(1, 200) = 4.03$, $p = .05$. This means that, when we account for both (i) those who chose Lottery A and (ii) those who chose Lottery B and reported their anticipated regret on Lottery A, the Default and Peer Choice treatments had the effect that we hypothesized; that is, anticipated regret with respect to the non-default or non-peer choice (Lottery A) was higher than the regret associated with choosing Lottery A in the Free Choice treatment. Regret B in the Default or the Peer Choice treatments is not significantly different than Regret B in the Free Choice treatment: $F(1, 197) = 1.90$, $p = .17$ for Default compared to Free Choice and $F(1, 200) = 0.28$, $p = .60$ for Peer Choice compared to Free Choice. We attribute this higher regret associated with Lottery A to Opt-out Regret. That is, opting out of or imagining opting out of a default or peer-preferred choice generates regret that is in addition to the regret associated with the underlying choice.

The average Regret_chosenL for participants in the Default treatment was 2.97. In the Peer Choice treatment, average Regret_chosenL was 2.93. In both cases, this was marginally significantly higher than the average Regret_chosenL for participants in the Free Choice treatment of 2.64: $F(1, 197) = 3.37$, $p = .07$ for Default compared to Free Choice and $F(1, 200) = 2.72$, $p = .10$ for Peer Choice compared to Free Choice. As discussed further in section 5, this lends additional support for our hypothesis that Opt-out Regret results in average regret for those who are subject to a default or peer effect being higher than the average regret associated with a simple choice between the options.

To determine whether reported regret differed by treatment or lottery choice, we conducted an OLS regression on Regret_chosenL (self-reported regret with respect to the lottery decided on) using dummy variables and interactive variables. Table 3a displays the results of this OLS regression. The interactive variable FreeChoice*LotteryB is 1 if the participant was in the Free Choice treatment and chose Lottery B, and 0 otherwise. Similarly, Default*LotteryB and Peer*LotteryB are 1 if the participant was in the respective treatment and chose Lottery B, and 0 otherwise. Taken together, these interactive variables capture the Regret_chosenL reported by all those who decided for Lottery B. Accordingly, the intercept and the Default treatment and Peer treatment variables in the regression capture the treatment effect for those who chose Lottery A. More precisely, (i) the intercept is equal to Regret_chosenL for those who chose Lottery A in the Free Choice treatment and (ii) the Default treatment and Peer treatment variables capture the amount by which Regret_chosenL for subjects in Default and Peer treatments differs from those who chose Lottery A in the Free Choice treatment. Table 3b summarizes the results of the regression in a matrix format.

Table 3a: OLS Regression Results of Regret_chosenL on Treatment and Lottery Choice (SE in brackets)

Dependent Variable: Regret_chosenL	
Default treatment	0.204 (0.25)
Peer treatment	0.297 (0.22)
FreeChoice*LotteryB	-0.524** (0.267)
Default*LotteryB	-0.095 (0.26)
PeerChoice*LotteryB	-0.456* (0.25)
Intercept	2.81
n	*301*
R-squared	0.0371

* p < 0.1; ** p < 0.05; *** p < 0.01

Table 3b: Regret_chosenL, by Treatment and Lottery Decision (SE in brackets)

	Free Choice	Default	Peer
Decided for Lottery A	2.81 [a]	3.02	3.11 [b]
	(0.15)	(0.19)	(0.16)
Decided for Lottery B	2.29	2.93 [a]	2.66
	(0.22)	(0.18)	(0.21)

[a] $p < 0.05$, compared to Regret_chosenL for those who decided on Lottery B in Free Choice.
[b] $p < 0.10$, compared to Regret_chosenL for those who decided on Lottery B in Peer Choice.

Table 3b indicates that, in all treatments, those who decided on Lottery A reported more regret than those who decided on Lottery B. However, the difference was not significant in the Default treatment. In the Free Choice treatment, those who chose Lottery A reported 0.52 points more regret than those who chose Lottery B ($F(1, 295) = 3.89$, $p = .05$). In the Peer Choice treatment, those who chose Lottery A reported regret of 0.46 points more than those who chose Lottery B ($F(1, 295) = 3.22$, $p = .07$). In the Default treatment, this difference was only .09 points and not significant ($F(1, 295) = 0.14$, $p = .71$). Our explanation for why participants who chose Lottery A reported more regret than those who chose Lottery B is that those who chose the safer lottery, Lottery A, were inherently more regret-averse than those who chose the riskier Lottery B. We discuss this in detail in section 5.

Participants who decided for Lottery A in the Default and in the Peer Choice treatment reported higher regret than those who chose Lottery A in the Free Choice treatment. However, in neither case was the difference significant ($F(1, 295) = 0.70$, $p = .40$ and $F(1, 125) = 1.76$, $p = .19$, respectively). In the Peer Choice Treatment, reported regret for those who chose Lottery B was not significantly higher than in the Free Choice treatment ($F(1, 295) = 1.56$, $p = .21$). However, in the Default treatment, reported regret for those who decided for Lottery B was significantly higher than for those who chose Lottery B in the Free Choice treatment (($F(1, 295) = 5.32$, $p = .02$). We suggest that this result also arises from the heterogeneity in regret aversion mentioned in the previous paragraph . This we discuss in detail in section 5.

We next conducted a regression analysis on self-reported felt responsibility using the same independent variables as in the regression reported in table 3a. The dependent variable was "Felt_responsibility", which is a self-report of how responsible participants felt for their decision (on a 5-point Likert scale, with 5 being high responsibility). For both the Default and Peer Choice treatments, the significance of felt responsibility was tested against the Free Choice treatment. The results of the regression are reported in table 4a and summarized in matrix form in table 4b.

Table 4a: OLS Regression Results of Felt_responsibility on Treatment and Lottery Choice (SE in brackets)

Dependent Variable: Felt_responsibility	
Default treatment	0.394** (0.18)
Peer treatment	0.201 (0.16)
FreeChoice*LotteryB	0.204 (0.19)
Default*LotteryB	-0.345* (0.19)
PeerChoice*LotteryB	0.104 (0.19)
Intercept	4.06
n	*301*
R-squared	0.0371

* p < 0.1; ** p < 0.05; *** p < 0.01

Table 4b: Felt_responsibility, by Treatment and Lottery Decision (SE in brackets)

	Free Choice	Default	Peer
Lottery A Chosen	4.06	4.45 [a, b]	4.26
	(0.12)	(0.13)	(0.11)
Lottery B Chosen	4.26	4.11	4.37
	(0.18)	(0.11)	(0.15)

[a] $p < 0.05$, compared to Felt_responsibility for those who decided on Lottery A in Free Choice.
[b] $p < 0.10$, compared to Felt_responsibility for those who decided on Lottery B in Default.

In the Free Choice treatment, participants who chose Lottery A felt as responsible for their decision as those who chose Lottery B (($F(1, 295) = 1.10$, $p = .29$)). However, in the Default treatment, those who opted out of the default and chose Lottery A felt more responsible for their decision (an increase of 0.34 points, $F(1, 295) = 3.44$, $p = .06$)) than those who stuck to the default. In addition, those who opted out of the default felt more responsible for their decision (an increase of 0.39 points, ($F(1, 295) = 4.84$, $p = .03$) than those who chose Lottery A in the Free Choice treatment. Those who stuck to the default felt as responsible for their decision than those who chose Lottery B in the Free Choice treatment. These results suggest that imposing a default is associated with more felt responsibility, but only for those who opt out of the default.

5. Discussion

In the Free Choice treatment, there were two potential regret inducing outcomes. Both outcomes result from the fact that participants knew that they would be aware of the outcome of the lottery they did not decide for – the so-called counterfactual. For those who chose Lottery A, the regret inducing event is a draw of the blue marble (we call this the "Blue A Outcome"). In the Blue A Outcome, the payout is $7 rather than the $30 it would have been had they decided for Lottery B. For those who decided for Lottery B, the regret inducing event is a draw of the

yellow marble (we call this the "Yellow B Outcome"). A Yellow B Outcome means that the payout is $0 rather than the $7 it would have been had they decided on Lottery A.

The expected payout from deciding for Lottery A was less than half the expected payout from deciding for Lottery B ($4.67 for Lottery A versus $10.00 for Lottery B). This suggests that those in the Free Choice treatment who chose Lottery A anticipated more regret from a Yellow B Outcome (we call this "Yellow B Regret") than from a Blue A Outcome (we call this the "Blue B Regret") and were willing to accept a much lower expected payout to avoid Yellow B Regret.[10] This is consistent with previous theories and observations that the regret associated with winning $0 while another option yields a modest amount is higher than the regret associated with earning a modest amount while the other lottery yielded a large amount.[11]

The Default treatment increased the percentage of participants who decided on Lottery B from 34% to 55.6%, which is an increase of more than 60%. One explanation for this large effect is that the default simply increased the cost of opting for Lottery A, and participants stuck to the default to avoid incurring this cost.[12] However, the regret explanation is that opting out of the default induced feelings of regret over and above any regret associated with the underlying choices. By opting out of the default, participants give up (i) the opportunity to share responsibility for their decision (Arlen & Tontrup 2015a), (ii) the opportunity to avoid deciding at all (Gilovich & Medvec 1995) and (iii) the opportunity to make the normal or expected choice (Zeelenberg et al. 2007), all of which have been shown to reduce the regret associated with a decision. As discussed earlier, we refer to the additional regret associated with opting out of the

[10] This discussion assumes that regret aversion is not a homogeneous trait, which assumption is consistent with recent regret research (Gigerenzer & Garcia-Retamero 2017; Rehan & Umer 2017; Bleichrodt et al. 2010).We also assume that regret is the only factor that impacts the choice of lottery, but we acknowledge that there may be other factors which impact that decision, such as risk aversion. Note, however, that regret aversion has been shown to better explain reluctance to taking risk than risk aversion (Zeelenberg et al. 1996; Reb 2008). Our argument still holds if regret is not the only factor that impacts lottery choice; only the magnitude of the regret discount changes.

[11] For example, it is consistent with the minimax theory of regret that people choose the option under which they will experience the lowest regret in a bad outcome, and that earning nothing while they would have earned something in they had made another choice is more regretful than earning a positive but lower amount than if they had made another choice (Savage 1951; Reb 2008).

[12] Another potential explanation for the difference between treatments in the percentage who chose Lottery B is that they those in one treatment were more risk averse than those in another treatment. However, as participants were randomly assigned to the treatments, there is no reason to believe that the average risk aversion of those in one treatment differs from the average risk aversion of those of another treatment.

default as Opt-out Regret. Our finding that those in the Default treatment reported, on average, more regret with respect to their chosen lottery than those in the Free Choice treatment also supports our Opt-out Regret hypothesis. The higher average regret in the Default treatment is due to Opt-out Regret, which is present in the Default treatment but not in the Free Choice treatment.

The mechanism by which Opt-out Regret may have increased the percentage of participants who decided on Lottery B is as follows. For some participants in the Default treatment, Yellow B Regret was greater than Blue A Regret. Accordingly, in a free choice, those participants would have chosen Lottery A to avoid the chance of a Yellow B Outcome. However, opting out of the default Lottery B and deciding on Lottery A in the Default treatment may have induced Opt-out Regret. If, for a participant, the sum of the Opt-out Regret and the Blue A Regret is greater than the Yellow B Regret, that participant will stick to the default Lottery B rather than opt out in favour of Lottery A. Accordingly, Opt-out Regret could have caused some participants in the Default treatment to decide for Lottery B but who would have chosen Lottery A had they been in the Free Choice treatment and not experienced Opt-out Regret.

In the Peer Choice treatment, there was no significant increase from the Free Choice treatment in the percentage of participants who chose Lottery B. It may be that participants did not identify strongly with other Prolific users (Duflo & Saez 2002; Gioia 2017). While the Peer Choice treatment had no effect on the percentage of participants who chose Lottery B, we did observe a significant increase in Regret_A between those in the Peer Choice treatment and those in the Free Choice treatment. This suggests that, for those who chose (or imagined choosing) Lottery A, the knowledge that Lottery A was the non-peer-preferred lottery caused Opt-out Regret, but the increase in Opt-out Regret was not enough for them to switch to Lottery B. In addition, average regret in the Peer Choice treatment was higher than in the Free Choice treatment, which may be attributable to Opt-out Regret.

In both the Default treatment and the Peer Choice treatment, Regret_A was higher than in the Free Choice treatment. However, Regret_B was not significantly different in the Default treatment or the Peer Choice treatment than in the Free Choice treatment. An increase in Regret_A but no increase in Regret_B in the Default treatment supports the proposition that opting out or imagining opting out of the default caused participants to feel more regret than if

they were merely choosing the non-default lottery in a free choice. Those who opted out of the default also felt more responsible for their decision than those who stuck to the default or those who chose the non-default in the Free Choice treatment. These differences were large and significant,[13] and are consistent with the prior literature (e.g. Zeelenberg et al. 2007; Arlen & Tontrup 2015b). Accordingly, it may be that participants stuck to the default in the Default treatment to avoid feeling more responsible for their decision, which in turn minimized their anticipated regret.

As described in table 3b, the Default treatment is associated with an increase in regret for both those who chose Lottery A and for those who chose Lottery B. However, the result is only significant for those who chose Lottery B. In the Peer Choice treatment, regret also increased for those who chose Lottery A and for those who chose Lottery B, but the increase was not significant. These results suggest that the role that regret played in our experiment was not as straightforward as we had anticipated.

It is possible that our results were influenced by the fact that participants had a strong preference for Lottery A. Based on the results of the pre-test discussed in footnote 2, we conducted a previous experiment in which Lottery A was the default and peer choice.[14] In the free choice treatment in that experiment, 74% chose Lottery A, meaning that there was little scope for either the default or peer choice treatments in that experiment to significantly increase the percentage of participants who decided on Lottery A. The only relevance of that experiment to the present experiment is that, in the earlier experiment, those in the peer choice treatment who chose Lottery A reported significantly *less* regret than those in the free choice treatment. There was no significant difference in regret reported by choosers of Lottery B between the peer choice treatment and the free choice treatment (finding a significant result was unlikely given the small number of participants who chose Lottery B). As well, in that earlier experiment, Regret_chosenL was significantly lower in the peer choice treatment than in the free choice

[13] Against choosers of Lottery A in the Free Choice treatment, they felt 0.39 points more responsible ($F(1, 295) = 3.44$, $p = .06$). Against Lottery B choosers in the Default treatment, they felt 0.34 points more responsible *(*$F(1, 295) = 3.44$, $p = .06$).

[14] The potential payout on Lottery A in that experiment was $9, rather than $7. The potential payout on Lottery B was $30.

treatment. The results for the default treatment were similar, but the results were not significant (see Appendix for selected tables of results for this earlier experiment). This suggests that defaults or reliance on peers may reduce regret for those who choose the default or rely on their peers, but only when the default or peer choice is the preferred choice or when people do not have a strong preference for a non-default choice (Jachimowicz et al. 2017).

In the present experiment, the finding that those who opted out of the default felt more regret than those who chose Lottery A in the Free Choice treatment can be attributed to Opt-out Regret caused by introducing a default that is not the preferred choice of most participants. What is, on its face, more difficult to explain is why those who stuck with the default of Lottery B in the Default treatment also felt more regret than those who chose Lottery B in the Free Choice treatment. Our explanation for this follows from the discussion at the beginning of this section. Those in the Free Choice treatment who were least regret averse would have chosen Lottery B since they were unwilling to accept a lower expected payout to avoid the more regret-inducing Yellow B Outcome. It follows that those in the Default treatment who stuck to the default, but who would not have chosen Lottery B in the Free Choice treatment, were, on average, more regret averse than those who chose Lottery B in the Free Choice treatment. Adding those participants to the pool of Lottery B choosers increased the average regret aversion level of that pool and, accordingly, increased the reported regret of those in that pool.

Additional support for that proposition is that those who chose Lottery B in the Free Choice treatment anticipated feeling less regret than those who chose Lottery A (see table 3a), while that difference was insignificant in the Default treatment. This suggests that participants who chose Lottery B in the Free Choice treatment would have felt more regret by giving up the higher expected payout associated with Lottery B than the regret they would have felt in the Yellow B Outcome. These results are consistent with the proposition that those who chose Lottery B in the Free Choice treatment were less regret averse than those who chose Lottery A in that treatment. Put another way, those who chose Lottery B were less regret averse because the higher expected return on Lottery B more than compensated them for the increased probability of winning nothing while the other lottery yields something (Zeelenberg et al. 1996), while the higher expected return was not enough to induce those who chose Lottery A to choose Lottery B.

The Default treatment induced some people (about 20% of the participants of that treatment) to switch from Lottery A to Lottery B. The ones for whom the Default treatment induced the greatest Opt-out Regret would be most likely to stick to the default rather than opt out in favour of their preferred lottery. Accordingly, adding these participants to the pool of Lottery B choosers necessarily increased the average regret aversion level of that pool from that of the pool of Lottery B choosers in the Free Choice treatment.[15] So, the increased reported regret of choosers of Lottery B in the Default treatment over choosers of Lottery B in the Free Choice Treatment of 0.63 points is at least partly attributable to the addition to the group of Lottery B choosers people with higher regret aversion than the pool of Lottery B choosers in the Free Choice treatment.

This proposition is also supported by the fact that the average felt responsibility for those who stuck with the default in the Default treatment was not statistically different than the average felt responsibility for those who chose Lottery B in the Free Choice treatment. Accordingly, the higher regret reported by those who stuck with the default was not caused by an increase in felt responsibility, but rather because the pool of Lottery B choosers now had people with innately higher regret aversion than in the pool of Lottery B choosers in the Free Choice Treatment.

6. Conclusion

The default in our experiment worked, in the sense that participants in the Default treatment were more likely than participants in the Free Choice treatment to decide on Lottery B (the default lottery). In addition, participants who decided for or imagined opting out of the default lottery reported that they would feel more regret in a bad outcome than those who chose Lottery A in the Free Choice treatment. These results are consistent with our hypothesis that default effects are caused by regret. Those who opted out of the default in the Default treatment

[15] Those who would have chosen Lottery B even if it was not the default likely felt less regret in the Default than in the Free Choice Treatment (see our results when Lottery A was the default). Accordingly, the regret effect of the Default on switchers is likely even higher.

also reported feeling more responsible for their decision than those who stuck to the default or those who chose Lottery A in the Free Choice treatment. However, further research is required to determine if the increase in anticipated regret for those who opted out of the default was because they felt more responsible for that decision.

A justification for establishing defaults is that they reduce aggregate regret (e.g. Huang et al. 2014). However, the effect on regret of establishing a default option or communicating preferences of peers appears to be more complex than theoreticians suggest. In our experiment, the average regret that participants reported regarding the lottery they chose was higher in the Default treatment than in the Free Choice treatment. It was also higher in the Peer Choice treatment, even though that treatment had no effect on lottery choice. The effect of defaults and peer choice on regret might be different if the default or peer-preferred option were the preferred choice in the Free Choice treatment or if participants had no strong preference. For example, preferences might be weaker if it were more difficult to determine expected payout and variance of the lotteries (something that makes the choice closer to a choice between two stocks). Further research is required to determine when establishing defaults and communicating peer choices increase regret and when they decrease regret.

Appendix

Selected Results from an Experiment in which Lottery A was the Default

Table A1: Measures of Regret, by Treatment (SE in brackets)

Treatment	Regret_chosenL	Regret_A	Regret_B
Free Choice (n = 98)	2.95 (0.116)	3.02 (0.127)	3.11 (0.151)
Default (n = 100)	2.86 (0.130)	2.73 (0.137)	2.96 (0.158)
Peer Choice (n = 101)	2.66 (0.124)	2.64** (0.131)	2.90 (0.154)

* p < 0.1; ** p < 0.05; *** p < 0.01

Table A2: Regret_chosenL, by Treatment and Lottery Decision (SE in Brackets)

	Free Choice	Default	Peer
Decided for Lottery A	2.93 (0.135)	2.73 (0.151)	2.55 [a] (0.145)
Decided for Lottery B	3.00 (0.236)	3.13 (0.249)	2.88 (0.230)

[a] p < 0.05, compared to Regret_chosenL for those who decided on Lottery A in Free Choice.

Chapter 6: Concluding Remarks

1. Summary and Findings

The evidence from finance and behavioral economics is that people are generally not very good at managing their retirement savings.[1] People tend to save too little, pay high investment management fees, under-diversify their portfolios and draw down their savings too soon (Benartzi & Thaler 2007).

While behavioral economists have identified the biases and heuristics behind many of the bad financial decisions that people tend to make, they have yet to even propose an overarching theory for why people make these mistakes. The contribution of this dissertation is to suggest a framework within which to explain why people make bad financial decisions. The framework that I develop in this book is based on natural selection and evolutionary psychology.

Evolutionary psychologists assume that we use different modules of the brain to solve different problems. As saving for retirement using financial instruments is a very recent problem, and not one that our distant ancestors had to solve to survive and reproduce, the human brain has not evolved to effortlessly solve problems of saving for consumption far into the future. Accordingly, we use modules that evolved to solve other problems to solve problems relating to retirement savings. As a result, the retirement savings decision that a person makes may depend on which evolutionarily important issue is salient at the time of making the decision. For example, if mate-seeking is salient, the person might make riskier decisions and if self-protection is salient (e.g. because a terror attack is in the news), the person might make a less risky decision.

As discussed in detail in chapter 2, evolutionary psychology assumes that humans use different systems to solve different evolutionarily important problems. Economists, on the other hand, assume that the human brain is a general-purpose instrument – that it uses the same systems to solve all problems. This is perhaps one reason why economists have been very slow

[1] As discussed in section 2 below, this may explain why governments are involved in regulating retirement savings at all.

to adopt evolutionary psychology to explain peoples' tendency to make poor retirement savings decisions (Kenrick & Griskevicius 2013).

In chapter 2, I develop a comprehensive theory as to how evolutionary psychology can explain the observations that individuals make systematic mistakes in their retirement savings planning, focussing on the mistake of portfolio under-diversification. I base this theory on existing empirical evidence from finance, evolutionary psychology, psychology and neuroscience. I show how evolutionary psychology and neuroscience experiments, and recent psychology literature on gambling may all help to explain the data from finance and behavioral economics which shows that people make systematic mistakes in their investment behavior. The intent of that chapter is only to suggest how evolutionary psychology could explain the retirement savings mistakes that have been observed. The chapter does not prove that those mistakes are caused by brains that are ill-evolved to deal with modern finance. It merely sets the groundwork for designing and conducting experiments that may eventually support or disprove the theory.

In chapter 3, I report the results of an experiment which I conducted to test one of the hypotheses that I developed in chapter 2. The hypothesis is that males for whom mate-seeking is salient will under-diversify their stock portfolios more than other males. The results of the experiment show that males for whom mate-seeking is made salient did under-diversify their stock portfolios more than men in the control treatment for whom mate-seeking was not made salient. While this result lends support for using an evolutionary psychology approach, caution must be taken when applying the results. I was not able to fully rule out other reasons for the difference in behavior for those in the treatment group from those in the control group, such as a differential impact of the treatment on mood. Furthermore, the result was from just one experiment, and that experiment was not incentivized. The results could well be different in an incentivized experiment or when males are investing for retirement in the real world. A follow-up experiment to further test the theory would be to run the same experiment using only female subjects and showing those in the treatment group photographs of attractive males. Evolutionary psychology theory is that viewing those photographs would have no impact on the diversification decisions of females. Thus, a finding that females' diversification decisions are unaffected by the treatment would further support the theory. Another follow-up experiment would be to make self-preservation salient (e.g. by showing photographs of war scenes) to see whether, as

evolutionary psychologists predict, subjects would diversify their portfolios more than those in the control treatment.

Chapter 4 is a theory paper in which I develop the hypothesis that the evolutionarily important emotion of regret may explain many of the mistakes we observe people making in their retirement savings planning. The importance of regret is that people who feel it tend to make better decisions than those who do not (Camille et al. 2004), which would have helped our ancestors survive and reproduce. I describe many of the retirement savings mistakes and anomalies that finance scholars have observed (mostly) using data from actual retirement savings plans. These include an excess reliance on defaults, making the same decisions as peers and paying for costly management advice. I then describe the empirical evidence from regret experiments conducted by psychologists and economics. Based on the those experiments, I suggest that a desire to minimize future regret may explain the observed retirement savings mistakes and anomalies. As is the case for chapter 2, I make no claim in chapter 4 to have proven that regret explains retirement savings mistakes. I merely set the groundwork for future experiments that may support or disprove the hypotheses set out in that chapter.

Chapter 5 reports on an incentivized online experiment that I conducted with Pieter Desmet to test two of the hypotheses developed in chapter 4; namely that people rely on defaults and that they make the same investment decisions as their peers to minimize future regret. In the experiment, subjects decided between 2 lotteries, Lottery A and Lottery B, and reported on their anticipated regret and how responsible they felt for their decision. Those in the Free Choice treatment simply chose between the two lotteries. In the Default treatment, Lottery B was set as a default and, in the Peer Choice treatment, subjects were told that in a previous experiment, Lottery B was preferred. The Default treatment "worked", in the sense that a much greater percentage of subjects chose Lottery B than in the Free Choice treatment. However, the Peer Choice treatment had no significant effect on lottery choice.

Those in the Default treatment who opted out or imagined opting out of the default reported that they would feel more regret in a bad outcome of that lottery than those in the Free Choice treatment who chose or imagined choosing Lottery A. Accordingly, the results support the hypothesis that the default was effective because opting out of a default induces regret and that people stick to the default to avoid this regret. However, as with the experiment reported in

chapter 3, caution should be exercised in applying the results to the real world. We conducted just one experiment, and the result we obtained may well be an artifact of the specific design of the experiment. In addition, we could not identify the pathway through which regret functions; that is, whether people who opted out of the default felt more regret because they felt more responsible for their decision or for some other reason.

Further research is required to come to firmer conclusions. For example, one reason for people to accept the default is that they find it difficult to calculate the expected return or variance of the lotteries. Choosing the default allows them to avoid the cost of making such a choice. One refinement of our experiment would be use payouts and percentages that are not round numbers (e.g. 43.6% chance of winning $3.79). Perhaps people would be more likely to stick to the default in these cases to avoid the cost of making the calculations.

In conclusion, the experiments that are reported in this dissertation support the hypotheses that they tested. The first experiment showed that people's portfolio diversification decision may be affected by which evolutionarily important problem is salient. The second experiment showed that the evolutionarily important emotion of regret may play a role in people's decisions to accept defaults.

The framework that I have developed in this book for analyzing why people make retirement savings mistakes assumes that our brains have not had enough time to evolve to easily solve problems relating to retirement saving planning, including portfolio diversification. Accordingly, people will use modules that were evolutionarily designed to solve other problems to solve problems such as how much to diversify their portfolios. The results of the experiment reported in chapter 3 lend some support for that framework of analysis. The evidence from evolutionary psychology is that males take greater risk when mate-seeking is made salient because taking more risk provides a greater chance of a larger, more immediate gain, which may help in obtaining a mate. In the experiment, when mate-seeking was made salient, subjects under-diversified their portfolios more (i.e. they took more risk) than subjects for whom mate-seeking was not made salient. This suggests that subjects relied on a module that was evolutionarily designed to solve problems related to finding aa mate to help solve portfolio diversification decision.

As discussed in chapter 4, regret evolved at a time that humans were hunter-gatherers living in small groups. The ability to experience regret was likely fitness enhancing because it induced people to take more care in their decision-making, thereby reducing the chance of feeling that emotion. The results of the experiment reported in chapter 5 suggests, however, that regret may not be well suited for making decisions that were not relevant to our distant ancestors. Subjects' decision-making was influenced by whether there was a default, and the experiment provided evidence that the default was effective because subjects wanted to avoid Opt-out regret. Rather than assess the two lotteries, some subjects in the Default treatment merely stuck to the default lottery, perhaps to avoid deciding at all. This suggests that the evolved emotion of regret is not well-suited to financial decision making as their choice depends, to some extent, on which option happens to be set as a default.

The achievement of this dissertation is to take the first steps in developing a coherent theory to explain the biases and heuristics that have been identified by behavioral economists, at least as they apply to retirement savings planning and stock market investing. While others have suggested that these biases and heuristics arise from our evolutionary past, to my knowledge, no one has yet attempted to apply evolutionary principles to explain these biases and heuristics in the retirement savings domain. I hope that I am not the last to do so, and that others will build upon my work.

2. Implications for Retirement Savings Policy

In a nutshell, the hypothesis of this dissertation is that people make systematic mistakes in their retirement savings planning because the human brain has not evolved to easily solve problems relating to retirement savings. In this section, I summarize below the policy implications for government regulation of retirement savings regulation that have previously been discussed in section 6 of chapter 3 and in section 6 of chapter 4. Before doing that, however, I provide some background to (i) what I believe is the main policy rationale for why governments regulate retirements savings and (ii) why governments and employers have shifted from defined benefit plans to defined contribution plans.

Why are governments involved at all in providing pensions or mandating and subsidizing retirement savings? According to standard economic models, individuals temporally maximize their utility by smoothing their income over their lifetimes. That is, they will borrow early in their working lives, save in their middle years and draw down their savings in retirement. If, indeed, people act in accordance with this theory, the need for governments to be involved in retirement savings is not obvious – individuals will maximize their utility by acting in accordance with their temporal consumption preferences.[2] Most countries, however, either provide pensions to their citizens, mandate a minimum amount of retirement savings or provide tax benefits to encourage individuals to save for their retirement.[3]

There are two rationales in the pension policy literature for governments being involved in the provision of pensions. The first is the alleviation of poverty. Through misfortune, some people will not be able to save enough to support themselves in retirement. The rationale is that these people ought to be able to live out their old age in at least a modicum of comfort (European Commission 2015). The second, and by far the most commonly stated rationale, however, is that working individuals ought to be able to maintain in retirement the standard of living that they enjoyed while working. This second rationale has been the implicit focus of this dissertation. The very fact that policymakers throughout the world (including intergovernmental organizations such as the World Bank and the OECD[4]) call for government provision or subsidization of

[2] Within the traditional economics framework, one reason for providing pensions and subsidizing retirement savings is the externality identified in overlapping generations models (Weiss 1991). Those models suggest that savings in a society will be less than the socially optimal amount because some of the benefits of savings and investment accrue to future generations. In the absence of compulsion or subsidies, individuals will not take this externality into account and will save too little. Accordingly, compulsory or subsidized pensions can increase social welfare by increasing the aggregate savings rate. However, it is not clear that, even if this externality exists, pension legislation is the appropriate regulatory tool to get to the socially optimal level of savings. In any event, neither government policy discussions nor the academic pension literature suggests that an increase in aggregate savings is a policy objective of pension legislation.

[3] See (OECD 2016) for a recent summary of pension legislation in OECD and selected other countries.

[4] The World Bank suggests that countries institute multi-pillar pension systems (Holzmann & Hinz 2005). The first pillar, a non-contributory minimum retirement income, is intended to relieve against old age poverty. The additional pillars, which provide for mandatory and voluntary retirement savings, are intended to provide for replacement income based on income earned during working years. See also (OECD 2013).

retirement income suggests that there is a widespread belief that people will not save enough for their retirement without government involvement.

As discussed in chapter 1, due to steadily increasing life expectancies and for other reasons, providing retirement income became much costlier for governments and employers than they forecasted at the time that the plans were established. Over the past few decades, many governments instituted changes to their pension systems to reduce these costs and to reduce the uncertainty of future pension funding costs. One of the changes that government made was to switch from providing pension benefits through DB plans to mandating (or subsidizing) savings through DC plans in which individuals take on the risks associated with future increases in longevity and risks such as investment returns being lower than forecast. In some cases, like Australia, governments provided for mandatory contributions to self-administered DC plans. In other cases, like Germany, governments provided tax subsidies to those who contribute to DC plans, but did not mandate contribution levels. At the same time, private-sector employers in the Anglo countries also switched from DB plans to DC plans.

In almost all cases, the switch from DB plans to DC plans resulted in much of the decision-making relating to retirement savings plans (e.g. contribution rate decisions, asset allocation decisions, drawdown decisions) being transferred to individuals. Given the implicit rationale for retirement savings legislation that people do not, on their own, save enough for retirement, this seems like an odd policy proscription. It is important to note, however, the dearth of discussion in the literature on whether switching to DC plans would result in individuals would making better or worse pension decisions than governments and employers did under DB plans. The transfer to individuals of responsibility for managing retirement savings plan was, in a sense, merely a by-product of a desire on the part of governments and employers to reduce pension costs by, in part, shifting from DB plans to DC plans. Little thought appears to have been given as to whether most individuals would make good retirement savings decisions.

The reason for reducing pension payments and transferring risk to individuals is clear. Pension payments as a percentage of GDP were increasing rapidly and were forecast to increase even more in the future. There was a feeling in many countries that pension systems were not sustainable in the long-run. The mistake, I believe, was putting responsibility onto individuals for retirement savings decision-making despite the evidence that they were not be up to the task. If,

as hypothesized in the dissertation, people make mistakes in managing their retirement savings plans, such as under-diversifying, paying excess fees and under-contributing to their DC plans, because the human brain has not evolved to easily solve problems relating to saving for retirement, then it will be very difficult to change this behavior. In fact, to the disappointment of economists, there is a substantial amount of evidence that financial education and disclosure has not lead to better retirement savings decision-making (Willis 2011; Bubb & Pildes 2014; Benartzi & Thaler 2007).

As discussed, the main policy goal of government involvement in providing retirement income is to increase the percentage of retirees who enjoy the same standard of living in retirement that they did during their working years. I suggest that, for two reasons, that policy goal would be better accomplished through DB plans. Firstly, DC plans are much costlier to administer than DB plans. Therefore, a given amount contributed to a DC plan will generate less retirement income than the same amount contributed to a DB plan. A major reason why DC plans are more expensive than DB plans is that people pay asset management fees for actively managed funds which generate returns that are no higher than passively managed, lower-cost funds. As discussed in chapter 4, regret may explain this tendency to pay for active management, and this may make it difficult to induce people to switch to lower cost, well-diversified index funds.

Secondly, in DB plans where participants contribute a set percentage of their income to pooled investments (i.e. all participants in the plan have an undivided interest in the plan assets), all participants in the same cohort will receive a similar retirement income (as a percentage of their earnings). However, in DC plans, where participants contribute at different rates and invest in different assets, retirement incomes among those in the same cohort will vary much more than in DB plans. Accordingly, some DC plan participants (e.g. those who did not contribute enough or those who under-diversified and got unlucky) will not have enough DC plan assets to allow them to maintain in retirement the standard of living that they enjoy while working. If, as hypothesized in the dissertation, people make mistakes of under-diversifying and under-contributing to their DC plans because the human brain has not evolved to easily solve problems relating to saving for retirement, then it will be very difficult to change this behavior.

Mandatory DC plan regimes would solve the problem of individuals not contributing enough to provide a sufficient retirement income. However, mandatory plans still leave open the possibility of under-performing the market (and therefore earning low retirement income) due to paying excess management fees or under-diversifying. Therefore, the policy approach that my research suggests is to move away from individual, self-managed retirement plans and towards a pooled, funded system, but one in which retirement income can be adjusted if forecasts of factors such as investment returns or longevity turn out to be inaccurate. In my view, the Dutch private pension regime is a very good model.

The Dutch system consists of a public PAYG pension plan which pays to all retirees who have lived in the Netherlands for a minimum number years a pension that is a percentage of the country's minimum wage. The unique part of the Dutch system, however, is the quasi-mandatory pension scheme offered by employers (either on a company-wide or industry-wide basis) that cover more than 90% of employees. Those private pension schemes pay in the range of 70% of average lifetime earnings for the average worker (OECD 2015; OECD 2013). The Dutch private pension system is called quasi-mandatory because there is no legal requirement for employers to provide a pension, but most do. If an employer provides a plan, however, the plan must comply with pension funding rules that are much stricter than in most other countries (Beetsma et al. 2015).

Under the Dutch pension legislation, the value of a pension plan's assets must, at all times, exceed the present value of its liabilities. If a plan fails to be fully funded because, for example, average life expectancy increases or investment income falls, steps must be taken to become fully funded. These steps may include adjusting payments to existing retirees or increasing contribution rates. Part of the reason for this feature is that it would be unfair for one generation to be subsidizing the retirement benefits of another generation. The flexibility to adjust pension payments allows fund managers to fully fund the plan in a way that maintains fairness among generations. During the recent financial crisis, pensioners had their payments frozen (i.e. not indexed to inflation) to allow the private pension funds to meet their funding requirements. In other cases, pension payments were cut and contribution rates were raised (Beetsma et al. 2015).

In conclusion, the Dutch private pension system gives the benefits of pooling (i.e. low cost, professional asset management and mandatory contributions) with the flexibility to adjust pension payments and contribution to meet changed circumstances. For those reasons, I suggest that it is superior to DC plans. This is even more relevant if the reason that individuals make systematic mistakes in managing their retirement savings plans is that the human brain has not evolved to easily make retirement savings decisions.

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Summary

I was motivated to write this book by the evidence that individuals make costly systematic investment mistakes in their retirement savings planning, such as investing in the wrong assets and under-diversifying their portfolios. These mistakes are difficult to explain using the toolbox of traditional economists. Behavioral economists have stepped into the breach to explain that people make these mistakes because they rely on heuristics and have certain biases in their thinking. However, behavioral economists have yet to develope a unifying theory as to why people have these biases and rely on heuristics.

In this book, I develop and test the theory that this bad investment behavior results from traits that evolved to help our distant ancestors survive and reproduce. I describe why it is important to understand the evolutionary history of our brains in order to understand why we may not be very good at solving retirement savings problems.

In the first substantive chapter, chapter 2, I apply evolutionary psychology to explain one of the mistakes that individuals have been shown to make in their retirement planning – the mistake of under-diversifying their portfolios. While the chapter is focussed on explaining when and why individuals may under-diversify their stock portfolios, the theoretical discussion on evolutionary psychology theories put forward in the chapter can explain why and when individuals will make other seemingly sub-optimal decisions relating to their retirement planning.

In chapter 3, I report on an online experiment that I conducted to test a hypothesis that I put forward in chapter 2; that is, that males for whom mate-seeking is salient under-diversify their stock portfolios more than other males. The results of the experiment support this hypothesis.

Regret is an emotion that evolved to help humans learn from their mistakes, which enhanced their survival and rates of reproduction. I hypothesize in chapter 4 that people make retirement savings decisions in such a way as to minimize regret. I also explain in that chapter why regret may also explain why defaults work so well in the retirement savings domain – people follow defaults because it is a regret reducing strategy.

Chapter 5 reports on an experiment that was conducted to test the hypothesis that regret may explain why defaults and communicating preferences of peers are so effective in changing behavior. The results of the experiment support this hypothesis.

Samenvatting

Ik was gemotiveerd om dit boek te schrijven omdat blijkt dat individuen bij hun pensioenplanning kostbare systematische investeringsfouten maken, zoals het investeren in de verkeerde activa en het onvoldoende diversifiëren van hun portefeuilles. Deze fouten zijn moeilijk te verklaren met behulp van de instrumenten die traditionele economen ter beschikking hebben. Gedragseconomen zijn in de bres gesprongen om uit te leggen dat mensen deze fouten maken omdat ze vertrouwen op heuristiek en bepaalde vooroordelen hebben in hun denken. Maar gedragseconomen moeten nog steeds een verbindende theorie ontwikkelen over waaróm mensen deze vooroordelen hebben en op heuristiek vertrouwen.

In dit boek ontwikkel en test ik de theorie dat dit slechte beleggingsgedrag het gevolg is van eigenschappen die zijn ontwikkeld om onze verre voorouders te helpen overleven en zich voort te planten. Ik beschrijf waarom het belangrijk is om de evolutionaire geschiedenis van onze hersenen te begrijpen om te begrijpen waarom we misschien niet erg goed zijn in het oplossen van problemen op het gebied van pensioensparen.

In het eerste inhoudelijke hoofdstuk, hoofdstuk 2, pas ik evolutionaire psychologie toe om een van de fouten te verklaren die individuen aantoonbaar maken in hun pensioenplanning - de fout om hun portefeuilles onvoldoende te diversifiëren. Terwijl het hoofdstuk vooral is bedoeld om uit te leggen wanneer en waarom mensen hun aandelenportefeuilles onvoldoende zouden kunnen diversifiëren, kan de theoretische discussie over theorieën uit de evolutieve psychologie die in het hoofdstuk wordt gepresenteerd verklaren waarom en wanneer personen andere schijnbaar suboptimale beslissingen nemen met betrekking tot hun pensioenplanning.

In hoofdstuk 3 doe ik verslag over een online experiment dat ik heb uitgevoerd om een hypothese te testen die ik in hoofdstuk 2 heb uiteen gezet; de hypothese dat mannen met een opvallende drang naar het vinden van een maatje hun aandelenportefeuille meer onderdiversifiëren dan andere mannen. De resultaten van het experiment ondersteunen deze hypothese.

Spijt is een emotie die is ontwikkeld zodat de mens leert van zijn fouten, waardoor zijn kans op overleven en voortplanting is toegenomen. In hoofdstuk 4 stel ik de hypothese dat mensen hun beslissingen over pensioensparen zodanig nemen dat ze er zo min mogelijk spijt van krijgen. Ik leg in dat hoofdstuk ook uit waarom spijt tevens kan verklaren waarom standaard oplossingen zo

goed werken op het gebied van pensioensparen - mensen volgen standaard oplossingen omdat het een spijt-reducerende strategie is.

Hoofdstuk 5 beschrijft een experiment dat werd uitgevoerd om de hypothese te toetsen die stelt dat spijt kan verklaren waarom standaardinstellingen en communicatievoorkeuren van gelijkgestemden zo effectief zijn in het veranderen van gedrag. De resultaten van het experiment ondersteunen deze hypothese.

Academic Positions

Since 10/2015

European Doctorate in Law and Economics (EDLE)
Ph.D. Candidate, University of Haifa, Israel, an EDLE affiliated university.
Focus: law and economics analysis of finance.

01/2014 – 09/2015

Ghent University School of Law: Center for Advanced Studies in Law and Economics
Ph.D. Candidate.
Focus: law and economics analysis of finance.

Non-Academic Experience

1998 – 2010

Billion Capital Management Limited
I operated a small business that was focused on buying and selling publicly-traded Canadian securities (the "derivative securities") that derived their value from other publicly-traded securities (the "underlying securities"). The business objective was to take advantage of pricing differences between the derivative securities and the underlying securities.

1987 - 1998

Torys LLP
I practiced tax law at a Toronto based corporate law firm, Torys, where I primarily provided Canadian corporate tax advice on transactions such as mergers and acquisitions and financings. I started at Torys in 1987 as a summer student and became a partner in 1997.

Education

10/2012 – 08/2013

Master in Laws (LL.M.)
University of Haifa, Israel

European Master in Law and Economics
Ghent University, Belgium

Master in Law and Economics
University of Bologna, Italy

Note: the foregoing 3 degrees were all granted pursuant to the European Master in Law and Economics program.

08/2010 – 07/2011 **Master of Science (M.Sc.) – Finance (Cum Laude)**
Tilburg University, The Netherlands
Focus: investment analysis, corporate governance, capital structure and empirical methods.

09/1985 – 06/1988 **Bachelor of Laws (LL.B.)**
University of Toronto, Canada
Focus: business and tax law

09/1983 – 06/1985 **Bachelor of Arts (B.A.) – Economics**
University of Western Ontario, London, Canada

Honors and Academic Awards

11/2013 **Covington & Burling Prize – European Master in Law and Economics**
For writing the best thesis of the year.

06/1987 **Smith, Lyons, Torrance, Stevenson & Mayer Prize – University of Toronto**
For attaining the highest place in Business Organizations II: Corporate Finance.

06/1985 **Governor General's prize – University of Western Ontario**
For attaining the highest place in a three-year degree program.

Conferences, Workshops, etc.

2017 **Empirical Legal Studies Workshop, May 24th, Erasmus University Rotterdam**
Presentation: "Do Men Take Greater Stock Market Risk When Seeking a Mate?"

EMLE Midterm Conference in Law & Ecomonics, February 17th, Ghent Univeristy
Presentation: "Do Men Take Greater Stock Market Risk When Seeking a Mate?"

2016 **Human Evolution and Behavior Network, December 15th-16th, University of Antwerp**
Presentation: "Do Men Take Greater Stock Market Risk When Seeking a Mate?"

Course in Programming Economic Experiments with z-Tree, February 29th–March 2nd, University of Konstanz

2015 **11th Italian Society of Law and Economics Conference, December 17th–18th, Università di Napoli Federico II**
Presentation: "Investing in the Stock Market for Sex: Evidence and Regulatory Approaches"

32st European Association of Law and Economics Conference, September 18th–20th, University of Vienna.
Presentation: "Investing in the Stock Market for Sex: Evidence and Regulatory Approaches"

2015 Comparative Law and Economics Forum (CLEF), June 11th–14th, Belgium (Leuven and Ghent).
Presentation: "Stock market Investing and Evolutionary Psychology"

2014

31st European Association of Law and Economics Conference, September 18th–20th, Aix-Marseille Université.
Presentation: "Is Underwriter Hold-up a Cause of Too Few IPOs?"

26th Human Behaviour and Evolution Society Conference, July 29th–August 2nd, Natal, Brazil.
Presentation: "Stock Market Investing as Evolutionary Driven Current Consumption"

1st Ghent University Center for Advanced Studies in Law and Economics Conference and 12th Annual German Law and Economics Conference, July 11th–12th, Ghent University.
Presentation: "Stock Market Investing as Evolutionary Driven Current Consumption"

2014 EMLE Law & Economics Workshop, February 14th, University of Bologna.
Presentation: "Is Underwriter Hold-up a Cause of Too Few IPOs?"

2013

9th Italian Society of Law and Economics Conference, December 12th–13th, University of Lugano (USI).
Presentation: "Is Underwriter Hold-up a Cause of Too Few IPOs?"

EDLE PhD Portfolio

Name PhD student : Stephen Billion
PhD-period : 2015 - 2018
Promoters : Prof. dr. Michael Faure; Dr. Alan Miller
Co-promoter : Dr. Pieter Desmet

PhD training

Bologna courses	***year***
Introduction to European Competition Law	2015
Experimental Economics - Methods	2015
Causal Inference	2015
Modelling Private Law	2015
Experimental Economics - Topics	2015 - 2016
Behavioural Law and Economics	2016
Game Theory and the Law	2016
Specific courses	***year***
Seminar 'How to write a PhD'	2016
Academic Writing Skills for PhD students (Rotterdam)	2016
Seminar Series 'Empirical Legal Studies'	2017
Seminars and workshops	***year***
Bologna November seminar (attendance)	2015
BACT seminar series (attendance)	2016 - 2017
EGSL lunch seminars (attendance)	2016 - 2017
Joint Seminar 'The Future of Law and Economics' (attendance)	2017
Rotterdam Fall seminar series (peer feedback)	2016
Rotterdam Winter seminar series (peer feedback)	2017
Empirical Legal Studies Workshop	2017, 2018
Presentations	***year***
Bologna March seminar	2015
Hamburg June seminar	2016
Rotterdam Fall seminar series	2016
Rotterdam Winter seminar series	2017
Bologna November seminar	2017

Joint Seminar 'The Future of Law and Economics'	2018
Attendance (international) conferences	***year***
European Association of Law and Economics Conference (Vienna)	2015
Italian Society of Law and Economics Conference (Naples)	2015
Human Evolution and Behaviour Network Conference (Antwerp)	2016
EMLE Mid-term Meeting (Ghent)	2017
Teaching	***year***
Others	***year***
zTree Programming course (Konstanz, Germany)	2016