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When Are We Predictably Irrational?

Limited Resource Model and Risk Preferences

RM Thesis 2012-008

Netspar Research Master Scholarship: Research Report

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Abstract

While classic economics theories have posited that individuals are rational decision-makers that make choices to maximize expected utility, recent research in both psychology and economics have repeatedly demonstrated that individuals deviate from the standard economic models in a predictable fashion. Our work aims to extend on such research by revealing when these predictable deviations occur, more specifically, when are individuals predictably irrational? Extending on the limited resource model (Vohs & Mascicampo, 2011), we carried out two studies to demonstrate that individuals were irrationally risk averse when they were depleted and had high perceived control. Study 1 revealed that individuals were more risk averse in situations of high control (i.e. investment) than low control (i.e. lottery), albeit insignificantly so. Whilst Studies 2a and 2b also yielded non-significant findings, a combined exploratory analysis showed that while individuals were risk averse in general, depleted individuals with high perceived control were more risk averse than their counterparts with low perceived control. Study 3 attempted to demonstrate that depletion was psychologically different from cognitive load. Despite our insignificant findings, these studies revealed that individuals became more "irrationally" risk averse when they were depleted and possessed high control and these effects differ from those of cognitive load.

Introduction

People currently have more freedom in deciding how to live their lives than ever before in historical times. It is a common supposition in modern society that the more freedom, the better - that individuals are capable to make the right decisions. According to decision-making models that are based in classical economic theories this responsibility should not be a problem. These models assume that individuals are rational and make choices to maximize a utility function, using the information available and processing this information appropriately (DellaVigna, 2009). According this standard economic model, individual decision-making behavior should adhere to the axioms of rational choice such as transitivity, dominance and invariance (Neumann & Morgenstern, 1947). Consequently, individual preferences are assumed to be time-consistent, affected only by personal payoffs and independent of external influences such as framing effects (DellaVigna, 2009). However, recent research in behavioral economics and psychology suggests that people systematically deviate from the behavior predicted by the standard models and – as a consequence – more freedom does not automatically lead to better (i.e., utility-maximizing) decisions.

Examples of systematic deviations have been described by numerous researchers in both economics and psychology. For instance, Thaler (1981) showed that individual preferences are time-inconsistent. Charness and Rabin (2002) as well as Fehr and Gächter (2000) demonstrated that individuals do have a concern of welfare of others on top of profit-maximization during decision-making. Kahneman and Tversky (1979) found that individual attitude towards risk that depends on framing and reference points. In addition, the literature has showcased various individual violations of rationality assumptions. Camerer and Lovallo (1999), for example, showed that people routinely overestimated their skills and over-project from their current state (Read & van Leeuwen, 1998). Individuals are affected by transient emotions (Loewenstein & Lerner, 2003) and employ heuristics to solve complex problems

(Gabaix & Laibson, 2006). These examples are very instructive in showing how people deviate from rational economic models of decision-making. However, they have much less to say about when people deviate.

If it simply were the case that people are predictably irrational (Ariely, 2008) then all that would need to be done was adjust standard economic models such that they are more descriptively accurate. However, many deviations from rationality occur only with certain people or under certain circumstances. In other words, people are irrational some of the times and rational at others. Thus, what seems to be missing is an account of when people deviate from standard decision making models. That is the topic of our research.

Limited Resource Model & Pension-related Decisions

Using the limited resource model (Vohs & Mascicampo, 2011), the following studies attempt to uncover when violations of the economic theory occur with regards to risk preferences. More specifically, we argue that anomalies in risk preferences occur during depletion. Our study will also highlight the situations relevant to pension consumers that may elicit depletion.

Our choice to use the limited resource model to illustrate when economic violations occur is not coincidental. According to the limited resource model, self-control can be conceptualized as a limited and diminishable set of resources that individuals have within themselves and use throughout the course of their day (Vohs & Masicampo, 2011). This state of reduced self-control from prior exertion is referred to as depletion (Baumeister, Sparks, Stillman, & Vohs, 2008). Previous research has repeatedly highlighted the importance of self-control in pension related issues. For instance, the (β,δ) model of self-control has helped explain puzzling feature of life-cycle savings and credit-card borrowing data (DellaVigna, 2009). Laibson, Repetto and Tobacman (2007) estimated a fully specified model of lifecycle accumulation with liquid and illiquid saving. They show that the (β,δ) model can reconcile two anomalies of the economic model: high credit card borrowing (11.7 percent of annual income) and substantial illiquid wealth accumulation (216 percent of annual income for the median consumer age of 50-59). These anomalies have surprised standard economic models because credit card borrowing implies high impatience, which contradicts sustainable wealth accumulation. Through incorporating self-control problems, the model of Laibson, Repetto and Tobacman (2007) reconciled these anomalies by predicting that high spending on liquid assets and also high demand for illiquid assets work as commitment devices. Such research illustrates the importance of including self-control when studying pension related issues. This notion is echoed by Vohs and Masicampo (2011) who argued that the normatively correct approach of "smoothing" consumption and savings over one's life course stated by life-cycle savings and consumption theories (Modigliani & Brumberg, 1954; Friedman, 1957) is "also a model of self-regulation since individuals have "to mete out their time, energy and effort in order to reach a goal" (p. 1).

Research on default effects on pensions itself have also showcased the importance of self-control. Several researchers such as Madrian and Shea (2001), Cronqvist and Thaler (2004) have shown that a change in default had a very large effect on participation rates in pension plans: the participation rate is 86 percent for the when there was a default option and 49 percent in the control condition. What is the reason behind the large default effect? Given that employees can change their retirement decision using the phone or a written form, these transaction costs are dwarfed by the tax advantages of pension investments (DellaVigna, 2009). O'Donoghue and Rabin (1999b & 2001) provided an explanation for this anomaly by showing that self-control problems, coupled with naiveté can explain the aforementioned default effects even for small transaction costs.

To demonstrate how the (β,δ) model operates in O'Donoghue and Rabin (1999b and 2001), I first provide a simplified example of how the (β,δ) model works. Consider a good with immediate payoff (relative to comparison activity) b_1 at t =0 and delayed payoff b_2 at t =1. An investment good, like a pension plan, has the features $b_1 < 0$ and $b_2 > 0$: the good requires effort now and delivers benefits in the future. Conversely, a leisure good (i.e. potato crisps) has the features $b_1 > 0$ and $b_2 < 0$; providing immediate gratification and future cost (DellaVigna, 2009). Since this study focuses on pension plans which are investment goods, we should assume that t =1 and the agent consumes if

$$b_1 + \beta\delta b_2 \geq 0.$$

Compared to the desired consumption, a (β,δ) agent consumes too little investment good ($b_2 >$ 0) and too much leisure good ($b_1 > 0$). This equation reflects on the self-control problem in action. Consequently, the agent simply chooses to postpone the activity of choosing a good pension plan in favor of more instant rewards. Moreover, O'Donoghue and Rabin (1999b & 2001) postulated that the agent would inaccurately overestimate that he will choose a good pension plan tomorrow as shown in the following equation:

$$b_1 + \hat{\beta}\delta b_2 \geq 0,$$

with $\hat{\beta} \geq \beta$. Thus, in contrast with the previous equation, the agent overestimates the consumption of the investment good ($b_2 > 0$) and underestimates the consumption of the leisure good ($b_1 <0$). As a result, this naiveté agent postpones the activity day after day, never ending up choosing a pension plan (DellaVigna, 2009). By showing that the presence of naiveté and a lack of self-control can generate procrastination, O'Donoghue and Rabin (2001) also underscore the importance of self-control in pension research.

Limited Resource Model & Risk Preferences

Although the aforementioned research repeatedly emphasized the importance of self-control in pension-related decisions, the literature regarding risk preferences appears to be limited. However, pension schemes usually do not consist of life-savings plan alone; numerous pension schemes also incorporate investment plans that necessitate risky choices. Hence, our study aims to demonstrate that the effects of self-control could also extend to pension-related decisions regarding risk preferences. The limited resource model posits that individuals lose some of their ability to engage in self-control after they used self-control in an earlier period (Vohs & Masicampo, 2011). Consequently these individuals are said to experience depletion which refers to a "temporary reduction in the self's capacity and willingness to engage in volitional action caused by a prior exercise of volition" (Baumeister, Bratslavksy, Muraven, & Tice, 1998). Thereby, depletion can limit intentionality for pension-related risk preferences in a number of ways. First, conflicting standards and goals are can be seen as an essential cause of depletion (Baumeister, 2002). In pension-related decisions, the conflicting goal of minimizing risk and maximizing outcomes can be deemed as depleting. Consequently, the very act of making a risky choice can result in depletion. Furthermore, Baumeister (2006) argued that depletion also prevents individuals from realizing their planned high aspirations. Again, this is relevant for pension-related decisions as individual usually have high aspirations to possess large retirement funds. This argument also seems reminiscent of the procrastinating behavior demonstrated by O'Donoghue and Rabin (1999b & 2001) earlier. Thus, depletion is not only a crucial influence on risk preference but minimizing depletion could also be beneficial towards pensions by reducing procrastinating behavior.

Although research in the decision-making psychology has started unveiling the link between depletion and risk preferences, there is still little consensus on whether depletion enhances risk-seeking or risk-aversion. While some research have shown that depletion increases risk-taking (Freeman & Muraven, 2010; Bruyneel, Dewitte, Franses, & Dekimpe, 2009), others argue that depletion decreases risk-taking (Unger & Stahlerg, 2011). The key to these seemingly contradictory findings could lay in the risk preference measures. In both experiments, Freeman and Muraven (2010) adopted risk preference measures that assigned participants with relatively little control and responsibility. For instance, in Experiment 1, participants were instructed to "the play the role of an advisor to the character in the vignette". Since this measure essentially required participants to make risky choices on another's behalf, participants could be relieved of some responsibility compared to making risky choices for themselves. Although risk preference measure in Experiment 2 corrected for this problem by stimulating an actual risk-taking scenario, the Balloon Analogue Risk Task (BART) resembles a lottery. Participants earned $0.01 each time they pumped the balloon. At any point in the trail, participants could press "Press to Collect $$$ and transfer their earnings to their "bank". They were given 20 trials and trail ended when they pressed the "Press to Collect $$$" button or the balloon burst. Since participants only lost money of that particular trail when the balloon exploded, this task results in little losses. More importantly, the "fun" and gambling element of the task could also provide participants with the sense of little control and responsibility. Similarly, Bruyneel et al., (2009) employed a lottery task to measure risk preferences. Given that "participants were given an opportunity to engage in a pari-mutuel 6/42 numbers lottery game" (p. 157), they might have given participants a fun gambling task and induced relatively small sense of responsibility and control. Together, these findings seem to imply that perceived control mediates the link between ego-depletion and risk-taking. Thus, we hypothesize:

H1: Depletion increases risk-taking in situations of little perceived control and responsibility.

Contrary to the findings of Freeman and Muraven (2010) and Bruyneel et al., (2009), Unger and Stahlberg (2011) stated that depletion decreased risk-taking. By using an investment scenario, participants were placed in a “prominent position as a decision maker” and assigned relatively more “control over the results and are, thus more responsible for their actions” (Unger & Stahlberg, 2011, p. 29). Following their findings, we predict that:

H2: Depletion decreases risk-taking in situations of perceived control and responsibility.

In addition to unveiling the effects of depletion and perceived control on risk preferences, our studies aimed to provide a clearer perspective into risk preferences by using a continuous measure with explicitly stated probabilities. Since the expected payoff difference can be clearly calculated, such a measure not only provides a clear indication of a switching point from safe to risky choice, but also creates a benchmark of a rational, risk neutral individual. Thus, on top of classifying individuals as risk averse or risk seeking in relation to risk neutrality, our measure shows the degree to which risk preference change in given situations. To the best of our knowledge, past research has yet to measure risk preferences in such a manner. For instance, Bruyneel et al. (2009) operationalized lottery expenditure as a risk preference where increased lottery expenditure was simply associated with increased risk-taking. Similarly, Freeman and Muraven (2010) employed a Balloon Analogue Risk Task (BART) which only demonstrated that depleted individuals were more risk-taking compared to their non-depletion counterparts. However, with no benchmark of a rational, risk neutral individual, their measures do not pinpoint if individuals were actually risk averse, just less so during depletion.

Study 1 – Effect of Perceived Control on Risk Preferences

Given that lottery winnings are usually picked at random, it would be logical to assume that individuals who are given lotteries would possess less perceived control compared to those given investments. Thus, before we start establishing the effect of depletion and perceived control on risk preferences, Study 1 aims to establish the effect of perceived control on risk preferences first. Based on the previous findings (Freeman & Muraven, 2010; Bruyneel et al., 2009; Unger & Stahlberg, 2011), we expect that higher levels of perceived control increase risk aversion.

Method

Participants. 45 individuals (33 male), between the ages 17 to 54 were approached on campus at Fontys Hogescholen to fill in our several questionnaires for €8. Participants were randomly assigned into high or low perceived control conditions. Risk preference and personal causality measures were then given to participants of both conditions.

Perceived control. Given that past risk preference measures differed on whether the researchers deemed them as investments or lotteries, we decided to test if simply framing the risk preferences measure as a lottery or a gamble would alter individuals' perception of control. In the high perceived control condition, participants were given the following instructions:

<u>Lottery</u>

Imagine that you are going to participant in a lottery.

On the following pages, you will be given 10 choices between two lotteries: Option A and Option B.

In Option A, you will win €2000 or €1600.

In Option B, you will win €3850 or €100.

The 10 choices will differ in the probabilities of winning either amount.

For each of the 10 choices, please indicate whether you prefer Option A or Option B.

Your aim is to maximize the amount that you can win.

Participants in the low perceived control condition were given:

Investment Plan

Imagine that you are choosing an investment plan.

In the following pages, you will be given 10 choices between two investment plans: Option A and Option B.

In Option A, you will win €2000 or €1600.

In Option B, you will win €3850 or €100.

The 10 choices will differ in the probabilities of earning either amount.

For each of the 10 choices, please indicate whether you prefer Option A or Option B.

Your aim is to maximize the amount that you can earn.

Risk preferences. To measure individual risk preferences, participants were presented with a list of paired options (see Table 1) adapted from Holt and Laury (2002). Given that participants were asked to participate in a lottery or an investment plan, the original payoff was transformed them by 1000 times for increased realism. The payoffs for the safer option, Option A, €2000 or €1600 are less variable than the potential payoffs of €3850 or €100 in the riskier option, Option B. In the first decision, the probability of the higher payout is low (1/10) for both options, so only an extreme risk-taker would choose

Option B. When the probability of the higher payoff increases down the table, we expect the individual to cross over to the riskier choice, Option B. Given that past research have often used dichotomous measures to assess risk preferences, participants' choices were often arbitrarily defined as risky or safe choices. Hence, similar to Holt and Laury (2002), aversion was measured by the number of safe options (Option A) that participants chose. By adopting of more continuous measure of risk preferences with varying probabilities, our research hopes to add to current literature on risk preferences by capturing the varying levels of risk inherent in pension-related investment plans, as well as pinpointing the switching point between safe and risky options.

Personal Causality. Finally, to measure perceived control, participants were given a measure of personal causality (Figure 1) adapted from Botti and McGill (2011). They were asked to rate the extent they agreed with five statements on 9-point scales (1= strongly disagree, 9 = strongly agree). These statements directly follow from the definition of perceived personal causality as the feeling that an outcome has emanated from self instead of external forces (deCharms, 1968), leading to the full endorsement of one's own actions and decisions (Moller et al, 2006).

Results

An independent –samples t-test revealed non-significant differences in the number of safe options between the lottery and the investment conditions, t (43) = -.21, p > .05. Post hoc analysis revealed that those in the lottery condition chose lesser safe options (M = 6.28, SE = .39) than those in the investment condition (M = 6.40, SE = .43). Though the results were insignificant, participants in the investment condition did seem to make more safe choices than those in lottery condition, in line with our expectations. However, given the small sample size and that relatively weak perceived control manipulation, the findings does seem to indicate that perceived control did elicit risk aversion by encouraging greater number of safe choices.

Although the personality causality measure was adopted by previous studies (e.g. Botti & McGill, 2011), it had a low reliability (5 items, α =.58). Unsurprisingly, with such low reliability, the perceived control manipulation was non-significantly correlated with the average of the personal causality items, r (45) = .023, p > .05. Similarly, independent-samples t-test revealed no significant differences on the personal causality measure across conditions, t (43) = -0.15, p > .05. Thus, our non-significant findings might stem from the low reliability of the personal causality measure.

Discussion

In spite of the non-significant findings, participants' responses seem to be in line with our intuition that perceived control decreases risk-taking with participants in the investment frame making more safe options than their counterparts in the lottery condition. Since the lottery and investment frames simply involved a change of labels, it is likely that they were weak manipulations of perceived control which in turned limited its effect on risk preferences. In spite of this, our findings were still in the direction of our hypotheses, suggesting that the conflicting findings in depletion and risk preferences (Freeman & Muraven, 2010; Bruyneel et al., 2009; Unger & Stahlberg, 2011) could lie in the degree of perceived control allocated to participants through the experimental paradigm.

One possible explanation could lie in individual preference towards risk aversion. Kahneman and Tversky (1979) posited for the tendency that individuals are risk averse in choices involving sure gains and risk seeking when choices involving sure losses. Given that all are choices involves gains with varying certainties, it is likely that participants have a general tendency for risk aversion. Since control allows individuals to act in accordance to this tendency for risk aversion, it is logical to argue that high perceived control further heightens risk aversion.

Studies 2a & 2b - Depletion, Perceived Control and Risk Preferences

Given that Study 1suggested that perceived control might influence risk preferences in accordance to our expectations, Studies 2a and b aims to further explore the interplay between depletion, perceived control, and risk preferences. As aforementioned, we expected depleted participants in situations of more perceived control to choose a greater number of safe choices than their counterparts in situations of less perceived control.

Study 2a – Methods

Study 2a adopted a 2 (depletion: yes, no) x 2 (perceived control: high, low) between subjects design. 40 participants (8 male), ranging from 18 to 28 years old, from Tilburg University participated in this experiment in exchange for course credit. The experiment was initially presented to 96 undergraduate students; however, those that took the experiment in the first two days had to be removed from the sample due technical glitches in the depletion manipulation and risk preference measure. The remaining 40 participants were randomly assigned to four groups: the depletion high control group, depletion low control group, non-depletion high control group and non-depletion low control group. At the beginning of the experiment, participants were told that the study was about financial decision-making. Next, they were given the perceived control manipulation, followed by the risk preference measure (Holt & Laury, 2002) we used in Study 1. Finally, all participants indicated their demographics before they were paid out for their choice, thanked and debriefed.

Depletion Task. In the depletion condition, we gave participants a preliminary task of self control by instructing them to complete a reasoning test consisting of 20 IQ and Math questions before making ten financial decisions. They had to get at least 17 out of 20 questions correct in order to be paid out based on their choices As these questions had to be completed mentally, without the aid of pen and paper, many found them were difficult and frustrating, which has been shown to lead to depletion (Baumeister, Bratslavsky, Muraven, & Tice, 1998). Their counterparts in the non-depletion condition simply to move on to the instructions of the risk preference measure where perceived control was manipulated.

Perceived Control. Prior to receiving the risk preference measure used in Study 1, participants were presented with a page of instructions, indicating that participants have to choose between Option A and B ten times. Two 10-face die rolls were used to determine which one of the ten choices will be paid out as well as the amount. For instance, if the participant threw a “2” in the first die roll, then the second option on the list would be paid out. Participants would then roll the die again to determine their exact earnings. For example, assuming that the participant chose Option A, a throw of “1” would result in €2 payout, while a throw of “2” to “10” would result in a €1.60 payout. Thus, all payouts would be based on the random roll of a ten-faced die.

The level of perceived control was manipulated in the instructions. In the high perceived control manipulation, participants’ control over their payout was emphasized in the instructions:

> Although the outcome of each option is uncertain (any amount has a certain probability of being chosen), YOU have a big impact on your final results.
>
> YOU can choose the options that maximize the chances of having the best earnings.
>
> At the end of the study, YOU also roll the dice to determine which option is recorded.

In contrast, in the low perceived control condition, the instructions highlighted the fact that the payout is decided by random die rolls:

Although you can decide which options will maximize your earnings, the final outcome is based on CHANCE.

At the end of the study, you will roll a die to determine which option will be chosen. The OUTCOME OF THE TOSS will determine which option is paid.

Risk Preferences. Just like our previous study, our study provided a menu of choices adapted from Holt & Laury (2002) to measure the degree of risk-taking. Payoffs for the safer option, Option A, were €2.00 or €1.60 and the payoffs for the riskier option, Option B, were €3.85 or €0.10. Similar to Study 1, the probability of the higher payout is low (1/10) for both options in the first decision, so only an extreme risk-taker would choose Option B. As the probability of the higher payoff increases down the table, we expect the individual to cross over to the riskier choice, Option B at some point. Also, similar to Holt and Laury (2002), aversion was measured by the number of safe options (Option A) that participants chose. By adopting a more continuous measure of risk preferences with varying probabilities and incentivizing the options, our research hopes to add to current literature on risk preferences by capturing the varying levels of risk inherent in pension-related investment plans, as well as pinpointing the switching point between safe and risky options.

Study 2a – Results

An ANOVA on the number of chosen safe options revealed non-significant effects for both depletion, $F(1, 36) = .71$, $p > .05$ and perceived control, $F(1, 36) = .31$, $p > .05$. Depleted individuals ($M = 6.14$, $SD = 0.56$) did not differ significantly from non-depleted individuals ($M = 5.53$, $SD = 0.44$) in terms of risk preference. Likewise, the risk preferences of individuals given more perceived control ($M = 5.64$, $SD = 0.47$) also did not differ significantly from those with less perceived control ($M = 6.03$, $SD = 0.54$). There was a marginally significant interaction between depletion and perceived control, F (1, 36) = 3.46, p =. 07.

There may be several methodological reasons why we did not find significant effects (assuming that our reasoning was right). One could be the small sample size, due to which the distribution of the dependent variable's residual did not follow a normal distribution, D (40) = .18, $p < .01$ Given that the number of participants in each condition was unequal, with 15 in the non-depleted low control condition, 9 in the non-depletion high control condition, 5 in the depletion low control condition and 11 in the depletion high control condition, the F –statistic was not robust to the normality violation, was likely to be biased and had less statistical power (Wilcox, 2005).

Another reason could be the strength of the depletion manipulation. Since our sample consisted of highly educated undergraduates, it could be that they did not find the reasoning tasks as difficult and frustrating as we expected. Given that our depleted manipulation hinged on the fact that self-control was required to persist in this difficult and frustrating task, it was likely that the manipulation was not as strong as we assumed.

Study 2b - Methods

We replicated the 2 (depletion: yes, no) x 2 (perceived control: high, low) between-subjects design of Study 2a with a stronger depletion manipulation. The experimental procedure was exactly the same as Study 2a with 108 participants (29 male, 18 to 33 years old) being randomly assigned into depletion high control, depletion low control, non-depletion high control and non-depletion low control conditions. Similar to Study 2a, participants in the depleted conditions started with the depletion tasks, followed by the perceived control manipulation and risk preference measure. Participants in the non-depletion conditions simply read the perceived control manipulation then filled up the risk preference measure. Finally, all participants indicated their demographics before they were paid out, thanked and debriefed.

Depletion Task. To increase the strength of the depletion manipulation, we increased the number of IQ and Math questions as well included a Stroop task. Akin to Study 2a, participants had to complete 10 IQ and 10 Math questions without the help of a pen and paper.

In addition, to increase the depletion effects, we added two Stroop tasks (see Govorun & Sheeran, 2006; Wallace & Baumeister, 2002; Webb & Sheeran, 2003). Just like in a typical Stroop task, participants were presented with 15 colored words printed in ink colors that were incongruous with their meaning (e.g. the word red was printed in blue). They were then instructed to name the ink color of the word as quickly as possible. Participants had to get at least 80% of the questions and Stroop task correct in order to be paid out based on their choices.

Perceived Control. Perceived control was manipulated in the instructions of the risk preference measure. One of the 10 options was paid out according to two die-rolls. In the low perceived control condition, the randomness of the payout was highlighted, whereas personal control over the payout was emphasized in the high perceived control condition (identical to Study 2a).

Risk Preferences. The risk preference measure was identical to Study 2a. Participants were given a menu of choices, with varying levels of probabilities to attain the higher payout. Just like previous studies, the degree of risk-taking was measured by the number of safe options (i.e. Option A).

Study 2b – Results

ANOVA revealed no significant differences in the number of safe choices between depletion conditions, F (1, 104) = 0.58, $p > .05$. There was also no significant main effect of perceived control on the number of safe choices, F (1, 104) = 0.44, $p > .05$. Similarly, there were no significant interaction effects of depletion and perceived control on the number of safe choices, F (1, 104) = 0.17, $p > .05$. Despite these non-significant findings, participants did response in line with our expectations. In the depletion condition, participants high control condition chose a greater number of safe options (M = 4.43, SD = 1.83) than those in low control condition (M = 4.10, SD = 1.35). In the non-depletion condition, participants in the high control condition (M = 4.08, SD = 1.51) made about the same number of safe choices as their counterparts in the low control condition (M = 4.00, SD = 1.26). Despite our non-significant findings, participants seemed to have responded in the general direction f our hypotheses; hinting that depletion increases risk-taking in situations of high perceived control and decrease risk-taking in situations of low perceived control. In contrast, the perceived control had little effect on risk-taking when participants were not depleted.

There could be several reasons for the lack of significant results in Study 2b. The weak perceived control manipulation could be a potential reason behind our non-significant results. An additional experiment where participants were given the exact instructions in Studies 2a and 2b and asked to rate their level of perceived control on a 7-point Likert scale with *1 (very much in control)* and 7*(not at all in control)* revealed no significant differences between perceived control in the high and low control conditions, t (25) = .54, $p > .05$.

Another possible reason behind our non-significant results could be the fact the distribution of the dependent variable (the number of safe options) was not normally distributed, D (108) = .11, $p < .01$. Given that the group sizes are unequal with 14 participants in the depletion high control group, 29 in the depletion low control group, 40 in the non-depletion and high control group and 25 in the non-depletion low control group, it is likely the *F*-statistic is not robust to the violations of normality. Thus, the non-significant results could be attributed to a biased *F* and decreased statistical power (Wilcox, 2005).

To address the non-normality violation, non-parametric analysis was adopted given that log transformation did not rectify non-normality in the data. Kruskal-Wallis test revealed no significant differences among the non-depletion low control, non-depletion high control, depletion low control and depletion high control groups, H (3) = 1.61, p >.05. All groups shared the same median (*Mdn* = 4).

All in all, despite the non-significant results, Study 2b hinted when “irrational” risk preferences occurred. Given that the expected payout difference between Option A and B for the fourth decision is €0.16 and the expected payout difference between Option A and B in the fifth decision is - € 0.18, the rational risk-neutral individual is assumed to pick switch to Option B on the fifth decision (Holt & Laury, 2002). Since the average number of safe options was 4.11, it appeared that individuals were mostly rational and risk neutral (Holt & Laury, 2002). However, when depleted, individual tended to become more risk averse (*M* = 4.21, *SD* = 1.50). Contrary to Study 2a, the effect of depletion was heighted in situations of high perceived control, where individuals became even more risk averse (*M* = 4.43, *SD* = 1.83).

Exploratory Analysis

Although different depletion manipulation were adopted in Studies 2a and 2b, both manipulation were theoretically similar since they both require persistence in frustrating and difficult tasks. In addition, the same dependent measure, the risk preference measure by Holt and Laury (2002) were employed in both studies. Thus, we decided to combine the data for exploratory analysis.

As mentioned previously, there were technical glitches in the first two days of data collection for Study 2a. After a closer look at the data; participants who failed to complete the depletion manipulation as well as were given the wrong risk preference measure were removed, leaving 91 participants in our sample. This sample was then combined with those in Study 2b, yielding 199 participants (69 male), ranging from 18 to 37 years of age.

Similar to Holt and Laury (2002), we also compared our findings with the rational, risk neutral decision-maker. Kolmogorov-Smirnov Z test revealed significant differences between of the distribution function of risk-taking for depleted and high perceived control individuals with the rational, risk neutral individual assumed by Holt and Laury (2002), Kolmogorov-Smirnov Z = 3.67, $p < .01$. Similarly, the same test showed that the distribution function of the depleted and low perceived control individuals differed significantly from that expected of a rational, risk neutral individual, Kolmogorov-Smirnov Z = 3.10, $p < .01$. There were also significant differences between the distribution function of the non-depleted high perceived control individual with the rational risk neutral counterpart, Kolmogorov-Smirnov Z = 2.65, $p < .01$. Likewise, the distribution function of the average non-depleted low perceived control individual also varied significantly with the rational, risk neutral decision-maker, Kolmogorov-Smirnov Z = 2.40, $p < .01$. Taken together, these findings suggest that individuals, regardless of their level of depletion and perceived control, are more risk-averse that rational, risk neutral decision-maker assumed by Holt and Laury (2002).

While the previous analysis revealed a general trend of risk aversion in our sample, further analysis illustrated the situations that amplified this “irrationality”. ANOVA revealed a significant main effect of depletion, F (1, 195) = 10.58, $p < .01$, indicating that depleted participants made a greater number of safe choices (M = 5.47, SD =0.21) than their non-depleted counterparts (M = 4.81, SD =0.20). However, there was neither a significant main effect of perceived control, F (1, 195) = 2.25, $p > .05$ nor a significant interaction effect of depletion and perceived control, *F* (1, 195) = 1.68, $p > .05$. An exploratory post-hoc t-test revealed marginally significant differences between high and low perceived control in the depletion condition, *t* (91), 1.85, $p = .07$. Consistent with our hypotheses, depleted individuals tended to be more risk averse in situations of high perceived control (*M* = 6.14, *SD* = 2.12) than in situations of low perceived control (*M* = 5.34, *SD* = 2.05). An independent samples t-test showed no significant differences between high and low perceived control in the non-depleted conditions, *t* (104) = 0.16, $p > .05$. In the non-depleted condition, participants with high perceived control (*M* = 4.84, *SD* = 2.03) made about the same number of safe choices as those with low perceived control (*M* = 4.78, *SD* = 1.84). These findings appear to be in line with our hypotheses, indicating that depletion decreases risk-taking in situations of high perceived control while increase risk-taking in situations of low perceived control.

Kolmogorov-Smirnov test revealed that the distribution of our dependent variable (i.e. the number of safe choices) did not follow a normal distribution, *D* (199) = .09, $p < .01$. This normality violation, coupled with unequal group sizes across conditions necessitated the use of non-parametric analysis similar to Holt and Laury (2002). Kruskal-Wallis test revealed significant difference in risk-taking between groups, *H* (3) = 1.61, $p >.05$ Follow-up Mann-Whitney U test showed that significant differences in risk-taking between high and low perceived control condition in the depletion condition, *U* = 820.00, z =-1.99, $p < .05$. As hypothesized, participants with high perceived control made a greater number of safe choices (*Mdn* = 6.00), while their counterparts in the low perceived control condition (*Mdn* = 5.00). There were no significant differences in risk-taking between high and low perceived control conditions in the non-depleted condition, *U* = 1397.50, *z* = -.02, $p > .05$. Hence, non-parametric tests reinforces the notion that individuals are more “irrationally” risk averse when depleted and have high perceived control.

Although our findings in Studies 2a and b revealed no significant effects of depletion and perceived control on risk preferences, the exploratory analyses suggested that individuals did act in the direction of our hypotheses. Individuals were "irrationally" risk averse on average, they became more so when depleted and in situations of high perceived control.

Study 3 – Cognitive Load and Risk Preferences

As aforementioned, the limited resource model postulates that all acts of self-control draw on a common limited resource that is akin to energy or strength (Vosgerau, Bruyneel, Dhar, & Wertenbroch, 2008). Consequently, an exertion of self-control is followed by a period of diminished capacity to exert subsequent self-control (Vosgerau et al., 2008). With sufficient rest, this diminished capacity would eventually dissipate (e.g. Muraven and Baumeister, 2002). While previous literature stated that depletion occurs for wide range of behaviors such as thought suppression (Muraven, Tice, & Baumeister, 1998), persistence in difficult and frustrating tasks (Baumeister et al., 1998), emotion control (Vohs & Heatherton, 2000), response inhibition (Wallace & Baumeister, 2002) and active choice-making (Vohs, Baumeister, & Ciarocco, 2005), this pattern of findings raises questions if depletion theoretically specific to self control conflicts or simply another form of mental fatigue (Vosgerau et al., 2008).

Traditionally, mental fatigue is associated with reduce cognitive capacity. One way of decreasing cognitive capacity is to cognitively load participants. While previous research has highlighted the similar effects of depletion and cognitive load on decision making (Vosgerau et al., 2008), Study 3 attempts to ascertain if similar findings could be extended to risk preferences.

Methods

80 undergraduate students (35 Male, ranging from 18 to 30 years of age) participated in this experiment in exchange for partial course credit. Similar to Study 2a and 2b, the experiment adopted a 2 (cognitive load: high, low) x 2 (perceived control: high, low) between subjects design. In place of the depletion manipulation, participants were first given the cognitive load manipulations. They were told to keep the numbers in mind throughout the entire experiment since they would need to be able to recall the number completely to be paid out. Subsequently, all participants received the risk preference instructions manipulating perceived control before completing the Holt and Laury (2002) risk preference measure. They were then asked to recall the given number, fill out a quick questionnaire and indicate their demographics. Finally, they were paid according to their choices before they were thanked and debriefed.

Cognitive load. Participants were randomly assigned into the high or low cognitive load condition. Analogous to Chun and Kruglanski (2006), participants in the high cognitive load condition were given 30 seconds to memorize a nine-digit number while those in low cognitive load condition had to memorize a one-digit number. They were instructed to keep this number in mind throughout the experiment as they would only be paid according to their decisions if they could recall the entire number in sequence correctly.

Perceived Control. Perceived control was manipulated in the same fashion as in Studies 2a and 2b. Prior to getting the risk preference measure (Holt & Laury, 2002), participants were told that one of the ten options will be paid out. This was decided by 2 rolls of a ten-faced die. In the low perceived control condition, the fact that their payout was determined at random was emphasized. In contrast, personal control was underscored in the high perceived control condition.

Risk Preferences. Similar to Studies 2a and 2b, risk-taking were measured using the risk preference measure used by Holt and Laury (2002). Participants were given a menu of choices labeled as financial decisions, with varying probabilities of attaining the higher payoff. The degree of risk-taking was gauged by the number of safe options (i.e., Option A) that participants chose.

Recall Task. After completing the risk preference measure, participants were asked to recall the number they were given in the cognitive load manipulation. Participants would only be paid out if they were able to recall the number in its entirety.

Manipulation Checks. Finally, participants answered three questions about the experiment – the extent to which they found the financial decisions task difficult, to which the memory task interfered with the financial decisions task, and the amount of effort was required to deal with the memory tasks while doing the financial decision tasks – on 7-point Likert scales.

Results

ANOVA showed that participants in the high cognitive load condition ($M = 3.23$, $SD = 0.23$) indicated that the memory task interfered to a greater degree than participants in the low cognitive load condition ($M = 1.38$, $SD = 0.21$), F (1, 76) = 35.92, $p < .01$.

Cognitively loaded participants ($M = 4.81$, $SD = 0.24$) also required greater effort to deal with the memory task while completing the risk preference measure than their counterparts ($M = 1.56$, $SD = 0.21$), F (1, 76) = 105.53, $p < .01$. There were no significant differences across conditions for difficulty, F (1, 76) = .54, $p > .05$. These findings suggest that our cognitive load manipulation successfully reduced the experienced cognitive capacity of our participants.

ANOVA on the number of safe choices, revealing no significant main effects of cognitive load, F (1, 76) = 0.03, p > .05, and perceived control, F (1, 76) = 0.19, p > .05 on the number of safe options chosen. There were also no significant interaction effect of cognitive load and perceived control, F (1, 76) = 0.01, p > .05 on the number of safe options chosen.

Discussion

While Studies 2a, b, and 3 all yielded insignificant results, the results of Study 3 differed slightly with our findings on depletion in Studies 2a and b. For instance, Studies 2b and the exploratory analysis revealed that risk aversion was accentuated when individuals were depleted and had high perceived control while Study 2a revealed a marginal significant interaction between depletion and perceived control. Contrary to Vosgerau et al. (2008) that postulate the depletion and cognitive load had similar effects on recall and recognition, we illustrate the cognitive load and depletion (when coupled with perceived control) had differential effects on risk preferences. Hence, while Vosgerau et al., (2008) theorized that cognitive load and depletion recruited the same underlying processes, our findings suggest otherwise.

According to Baumeister and Heatherton (1996), the capacity to exert self-control is an important feature in human nature. Given the adaptive benefit of being able to control inner states and urges, self-control is essential for achieving success in life (Baumeister and Heatherthon, 1996). Undoubtedly, self-control is also an essential part of pension-related decision making. While past research have unveiled the deviations from rationality in decision-making (e.g. Kahneman & Tversky, 1979; Thaler, 1981; Fehr & Gächter, 2000 Charness & Rabin, 2002), our studies attempt to ascertain when are we predictably irrational using the limited resource model of self control (Vohs & Masicampo, 2011).

In spite of the inconsistent and non-significant results, we believe that our studies may have started to unveil situations where “irrationality” occurs. In contrast to previous studies whose risk preference measures did not allow an exact calculation of expected utility and simply gauged relative risk preferences, our adoption of a continuous measure of risk preferences (Holt & Laury, 2002) provided a clearer insight of risk preferences by benchmarking participants’ response to a quantifiable rational risk-neutral position. Given that individuals picked the safe option for more than the first four choices, our studies consistently found that individuals were generally risk averse compared to the rational decision-maker. In Study 1, we found that this general tendency for risk aversion were heightened in situations of high perceived control (i.e. when deciding for an investment plan) than in situations of low perceived control (i.e. when deciding for a lottery).

While Study 1 attempted to establish to the effect of perceived control on risk preferences; Studies 2a and 2b introduced depletion into the picture, yielding inconsistent findings. Study 2a demonstrated a marginal significant interaction between depletion and perceived control. Whilst our hypotheses expected that perceived control would increase risk aversion in the depleted condition, risk aversion of depleted individuals was heightened in situations of low perceived control rather than high perceived control. For non-depleted participants, the effect was reversed with situations of low perceived control attenuating risk aversion. Although Study 2b yielded non-significant findings, the trend was in line with our hypotheses. The findings of Study 2b hinted when individuals are predictably irrational by suggesting that risk aversion occurred when individuals are depleted in situations of high perceived control. An exploratory analysis combining the data of Study 2a and b provided first support for our hypotheses. We found marginally significant differences in risk aversion between high and low perceived control situations in depleted participants. In fact, just as hypothesized, situations of high perceived control amplified risk aversion in depleted individuals.

In the light of previous depletion research, our findings also extend on previous findings. Consistent with our findings, Kahneman and Tverksy (1979) postulated that individuals are generally risk averse in the gains domain, preferring a sure option of a low payout rather than an uncertain option of a high payout. Thus, risk aversion does appear to be general inclination, at least when it comes to financial decisions in terms of gains. Baumeister et al., (1998) repeatedly showed that depleted participants were more likely to give in to temptation or urges. For instance, after exerting self control in prior tasks, individuals are more likely perform impulsive and compulsive buying (Faber & Vohs, 2004), and procrastinate on difficult choices (Baumeister, 2003). Given that depletion makes one more susceptible to our inclinations and urges, it is not surprising that depletion heightens our tendency for risk aversion. When coupled with high perceived control, individuals exercise their choice in line with their innate inclination for risk averse, making even conservative choices. To summarize, our studies reveal that while individuals are “irrationally” risk averse, this tendency is amplified in situations of high perceived control when individuals are depleted.

While Studies 1, 2a and 2b tried to establish the effects of depletion and perceived control on risk preferences, Study 3 addressed the theoretical concern that depletion was simply another form of mental fatigue. To induce mental fatigue, we replaced the depletion manipulation with cognitive load. In contrast to previous findings (Vosgerau et al., 2008), we found no significant differences in risk taking. By providing differential effects on risk preferences, our findings imply that depletion and cognitive load could be theoretically dissimilar constructs, with varying underlying psychological mechanisms.

All in all, our studies tried to explore when individuals are “predictably irrational”. More specially, we demonstrated that individual have a general tendency for risk aversion in financial decisions and this inclination is heightened in situations of depletion and high perceived control. In addition, depletion did not seem to be just another form of mental fatigue, since they did not share the similar effects on risk preference with cognitive load.

Table1 – The ten paired lottery/ investment choice decisions

Option A	*Option B*	*Expected payoff difference*
1/10 of $200, 9/10 of $160	1/10 of $385, 9/10 of $10	$117
2/10 of $200 , 8/10 of $160	2/10 of 385, 8/10 of $10	$83
3/10 of $200, 7/10 of $160	3/10 of 385, 7/10 of $10	$50
4/10 of $200, 6/10 of $160	4/10 of 385, 6/10 of $10	$16
5/10 of $200, 5/10 of $160	5/10 of 385, 5/10 of $10	-$18
6/10 of $200, 4/10 of $160	6/10 of 385, 4/10 of $10	-$51
7/10 of $200, 3/10 of $160	7/10 of 385,3/10 of $10	-$85
8/10 of $200, 2/10 of $160	8/10 of 385, 2/10 of $10	-$118
9/10 of $200, 1/10 of $160	9/10 of 385, 1/10 of $10	-$152
10/10 of $200, 0/10 of $160	10/10 of 385,0/10 of $10	-$185

References

Ando, A., & Modigliani, F. (1963). The "lifecycle" hypothesis of saving: Aggregate implications and tests. *The American Economic Review, 53*, 55-84.

Ariely, D. (2008). *Predictably irrational: The hidden forces that shape our decisions.* New York, NY: HarperCollins Publishers.

Baumeister, R. F. (2002). Yielding to temptation: Self-control failure, impulsive purchasing, and consumer behavior. *Journal of consumer research, 28*, 670-676.

Baumeister, R. F. (2006). Ego-depletion and self-regulation failure: A resource model of self-control. *Alcoholism: Clinical and Experimental Research, 27*, 281-284.

Baumesiter, R. F., Bratslavsky, E., Muraven, M., & Tice, D. M. (1998). Ego depletion: Is the active self a limited resource? *Journal of Personality and Social Psychology, 74*, 1252-1265.

Bruyneel, S. (2008). Symposia Summary: The role of cognitive processes in overcoming self-control difficulties. *Advances in Consumer Research, 35*, 217-220.

Bruyneel, S. D., Dewitte, S, Franses, P. H., Dekimpe, M. G. (2009). I felt low and my purse feels light: Depleting mood regulation attempts affect risk decision making. *Journal of Behavioral Decision Making, 22*, 153-170.

Camerer, C. & Lovallo, D. (1999). Overconfidence and excess entry: An experimental approach. *American Economic Review, 89*, 306-318.

Charness, G., & Rabin, M. (2002). Understanding social preferences with simple tests. *Quarterly Journal of Economics, 117*, 817-869.

Cronqvist, H., & Thaler, R. H. (2004). Design choices in privatized social-security system: Learning from the Swedish experience. *American Economic Reviews, 94*, 424-428.

DellaVigna, S. (2009). Psychology and Economics: Evidence from the field. *Journal of Economic Literature, 47*, 315-372.

Fehr, E. & Gächter, S. (2000). Fairness and retaliation: The economics of reciprocity. *Journal of Economic Perspectives, 14*, 159-181.

Freeman, N., & Muraven, M. (2010). Self-control depletion leads to increased risk-taking. *Social Psychology and Personality Science, 1*, 175-181.

Friedman, M. (1957). *A theory of consumption function*. Princeton, NJ: Princeton University Press.

Gabaix, X., & Laibson, D. (2006). Shrouded attributes, consumer myopia, and information suppression in competitive markets. *Quarterly Journal of Economics*, *121*, 505-540.

Holt, C. A., & Laury, S. K. (2002). Risk aversion and incentive effects. *American Review, 92,* 1644-1655.

Kahneman, D. & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica, 47*, 263-291.

Laibson, D.. Repetto, A., & Tobacman, J. (2007). *Estimating discount functions with consumption choices over the lifecycle*. Unpublished Manuscript.

Loewenstein, G., & Lerner, J. (2003). The role of affect on decision making. In R. J. Davidson, K. R. Scherer & H. H. Goldsmith (Eds.). *Handbook of affective sciences* (pp. 619-642). New York, NY: Oxford University Press.

Madrian, B., & Shea, D. F. (2001). The power of suggestion: Inertia in 401(k) participation and savings behavior. *Quarterly Journal of Economics*, *116,* 1149-1187.

Von Neumann, J., & Morgenstern, O. (1947). *Theory of games and economic behavior*. Princeton, NJ: Princeton University Press.

O'Donoghue, T., & Rabin, M. (1999b). Procrastination in preparing for retirement.In H. J. Aaron (Ed.). *Behavioral Dimensions of Retirement Economics* (pp. 125-156). Washington, DC: Brookings Institution Press.

O'Donoghue, T., & Rabin, M. (2001). Choice and procrastination. *Quarterly Journal of Economics*, *116,* 121-160.

Read, D., & Van Leeuwen, B. (1998). Predicting hunger: The effects of appetite and delay on choice. *Organizational Behavior and Human Decision Processes, 76,* 189-205.

Thaler, R. (1981). Some empirical evidence on dynamic inconsistency. *Economic Letters*, *8*, 201-207.

Unger, A., & Stahlberg, D. (2011). Ego-depletion and risk behavior: Too exhausted to take a risk. *Social Psychology, 42*, 28-38.

Vohs, K. D., & Masicampo, E. J. (2011). The Psychology of willpower: It is limited and centrally involved in economic decision. *Book chapter in preparation.*

Wheeler, S. C., Brinol, P., & Hermann, A. D. (2007). Resistance to persuasion and self-regulation: Ego-depletion and its effects on attitude change processes. *Journal of Experimental Social Psychology, 43,* 150-156.